INTRODUCTION OF RENEWABLE ENERGY: PRESENTS TRENDS AND OBJECTIVES

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(Received: 12 October 2024; Accepted: 20 November 2024; Published on-line: 1 December 2024)

ABSTRACT: This study provides a comprehensive analysis of renewable energy sources, focusing on wind, hydropower, solar thermal, and ocean energy, while evaluating current trends and future objectives. Wind energy, with roots dating back to ancient Persia, has evolved significantly with advancements in turbine technology and efficiency enhancements. Hydropower remains a key player in global energy supply, though it faces environmental scrutiny leading to the development of more sustainable systems. Solar thermal power has gained traction with innovations in Concentrated Solar Power (CSP) technology. Ocean energy, utilizing tidal and wave systems, is also emerging as a vital resource. The manuscript emphasizes the integration of renewable technologies into smart grids and aligns these initiatives with the Sustainable Development Goals (SDGs). Ultimately, this work advocates for collaborative efforts among governments, businesses, and communities to foster a sustainable energy landscape, addressing climate change while promoting economic growth.

KEYWORDS: Renewable Energy Technologies; Sustainable Development Goals; Turbomachinery Systems; Environmental Impact and Sustainability.

1. WIND ENERGY

Wind energy represents one of the most mature and widely deployed forms of renewable energy [1]. Wind turbines harness the kinetic energy of the wind, translating it into mechanical energy and eventually into electricity [2]. The evolution of wind technology dates back to ancient Persia, with significant advancements occurring in the 19th and 20th centuries. Charles F. Brush's development of the horizontal-axis wind turbine in 1888 marked a critical milestone, followed by the 1970s energy crisis, which spurred further research and innovation, particularly in Denmark and the United States [2][3].

Modern wind turbines, characterized by larger rotor diameters and taller towers, demonstrate enhanced efficiency due to advancements in materials, aerodynamics, and control systems. These developments have facilitated the growth of large-scale onshore and offshore wind farms, further integrating wind energy into the global energy grid and contributing significantly to efforts for decarbonization [4].

2. HYDROPOWER: A Tried and Tested Technology with a Focus on Sustainability

As one of the oldest and most established forms of renewable energy, hydropower plays a crucial role in the global energy landscape. Historically, water wheels were utilized in ancient Rome, but the invention of the hydroelectric power plant in Appleton, Wisconsin, in 1882 signaled the transition from mechanical to electrical applications of water power [5]. The construction of large dams, such as the Hoover Dam in the 20th century, dramatically increased the capacity for electricity generation from hydropower, meeting significant portions of global energy demands [6].

Despite its contributions, traditional hydropower has faced scrutiny regarding its environmental impacts, including habitat disruption and community displacement. In response, recent research has focused on developing small-scale and run-of-the-river systems to alleviate these concerns and align more closely with environmental and social sustainability objectives [7].

3. SOLAR THERMAL POWER

Solar thermal power, particularly Concentrated Solar Power (CSP) systems, emerged significantly during the energy crises of the 1970s. Early advancements by pioneers like Augustin Mouchot laid the groundwork for solar energy utilization, but widespread adoption accelerated in the mid-20th century with projects such as the Solar Energy Generating Systems (SEGS) in California [8]. These systems utilize mirrors or lenses to focus sunlight onto a receiver, generating thermal energy to drive turbines connected to electricity generators.

The innovation in CSP technology has continued with enhancements in heat storage systems and mirror efficiency, making solar thermal power a competitive option in the renewable energy market. These technological advancements position solar thermal energy as a key player in reducing fossil fuel reliance and supporting global renewable energy targets [9].

4. OCEAN ENERGY

Ocean and tidal energy harness the kinetic and potential energy of seawater through technologies like tidal stream and wave energy converters. The concept of harnessing energy from tides has historical roots, but significant technological experimentation and deployment have occurred predominantly in the 20th century and beyond [10]. The Rance Tidal Power Station in France, commissioned in 1966, is a landmark example that showcases the feasibility and potential scale of tidal energy [11].

Contemporary research focuses on improving the design and efficiency of tidal turbines, with projects underway in regions like the UK, Canada, and Norway. These efforts aim to minimize environmental impacts while maximizing energy capture from the ocean’s vast and predictable resources [12].

5. PRESENT TRENDS

Current research across these renewable energy technologies highlights a focus on integration with smart grids, embracing innovative designs, and conducting comprehensive environmental impact studies. These efforts are critical in optimizing renewable energy systems' efficiency, reducing costs, and ensuring environmental sustainability [13]. By integrating renewable energy within an intelligent grid infrastructure, energy systems can better manage variability and enhance reliability, paving the way for a sustainable energy future that aligns closely with the SDGs.

This article aims to evaluate how these renewable energy sources are utilized globally as part of sustainable living initiatives. By leveraging technology-driven advancements and aligning with critical sustainable development goals, the transition towards a low-carbon future fosters not only environmental sustainability but also economic growth and energy security.

By focusing on these goals, renewable energy technologies are set to mitigate climate change effects while addressing societal energy needs. Through effective integration, innovative design improvements, and environmental stewardship, renewable energy sources such as wind, hydropower, solar thermal, and ocean energy are well-positioned to transform our energy landscape in a sustainable manner.

6. OBJECTIVES

The objective of this manuscript is to provide a comprehensive analysis of the current and future state of renewable energy sources, specifically focusing on wind, hydropower, solar thermal, and ocean energy. It will evaluate the following:

1. **The Potential and Installed Capacity**: An in-depth look at the estimated renewable energy potential in various regions, alongside the current figures reflecting installed capacity.
2. **Technological Advancement**: Detailing the innovations in turbine design, materials, and overall systems that contribute to enhanced efficiency and cost-effectiveness.
3. **Environmental Considerations**: Addressing the ecological impacts of renewable energy projects and highlighting the importance of environmental impact studies in shaping responsible energy development.
4. **Future Business Prospects**: Analyzing the profitability of renewable energy installations and understanding the market dynamics that present opportunities and challenges for investors and companies.
5. **Alignment with Sustainable Development Goals (SDGs)**: Exploring how renewable energy solutions contribute to global sustainability efforts by supporting essential SDGs outlined by the United Nations.

7. SUMMARY

The transition towards renewable energy represents not only a response to global climate change impacts but also a pathway towards sustainable economic development. Countries willing to invest in and prioritize renewable technologies will benefit from both energy independence and enhanced economic opportunities tied to green jobs, business innovation,

and technological leadership. By evaluating the renewable energy landscape through the lens of water potential for hydropower, solar incidences for solar thermal power, wind patterns for wind energy, and marine currents for ocean energy, this manuscript seeks to illuminate how such resources can be harnessed sustainably. As awareness grows regarding the implications of climate change and the necessity for sustainable energy systems, engaging stakeholders—including governments, businesses, and communities—will be vital for fostering a collaborative approach towards a cleaner and more sustainable future.

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