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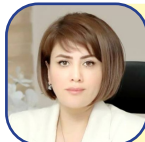
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GREEN ENERGY DEVELOPMENT TENDENCIES IN THE WORLD

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Abstract: This article analyzes the reforms of renewable energy technologies in electricity, transport and heat to 2030, while also exploring key challenges facing the industry and identifying barriers that are preventing faster growth. It covers market analysis and forecasts, and also examines key developments for the sector, including policy trends driving deployment, solar PV and wind manufacturing, the costs of renewable technologies, electrolyser and renewable capacity for hydrogen production, prospects for renewable energy companies, and system integration of renewables, along with grid connection queues.

Key words: green energy, renewable capacity, solar PV, grid infrastructure, global onshore, bioenergy.

INTRODUCTION

As the world faces increasing environmental challenges, the need for sustainable energy solutions has never been greater. Green energy development refers to the advancement and implementation of renewable energy sources such as solar, wind, hydro, and biomass to reduce dependence on fossil fuels and mitigate climate change. Unlike conventional energy sources, green energy is clean, sustainable, and often more cost-effective in the long run.

The transition to green energy is driven by multiple factors, including government policies, technological advancements, and growing awareness of climate change. Many countries are investing in renewable energy infrastructure to enhance energy security, create jobs, and meet international climate commitments such as the Paris Agreement. However, despite the benefits, challenges remain in financing, policy implementation, and integrating renewable energy into existing power grids.

This paper explores the significance of green energy development, the role of policy and financing in accelerating its growth, and the challenges that must be addressed to ensure a sustainable energy future. By understanding these factors, governments and stakeholders can develop effective strategies to transition toward a cleaner and more resilient energy system.

REVIEW OF LITERATURE ON THE SUBJECT

The development of green energy has been widely studied across multiple disciplines, including environmental science, economics, and public policy. Existing literature explores the role of renewable energy technologies, policy frameworks, and financial mechanisms in accelerating the transition toward sustainable energy.

Studies indicate that renewable energy sources such as solar, wind, hydro, and bioenergy have the potential to replace fossil fuels while reducing environmental degradation (REN21, 2023). However, research by Jacobson et al. (2015) [1] points out that large-scale renewable deployment still faces technical challenges, such as grid integration and intermittency issues.

Studies show that countries with strong policy support, such as Germany's Energiewende and China's renewable energy targets, have experienced significant growth in green energy capacity (Huenteler et al., 2018). However, challenges persist in policy implementation, particularly in developing countries, where regulatory uncertainty can deter private investment (Altenburg & Assmann, 2017). [2]

Studies by Mazzucato & Semieniuk (2018) suggest that state investment banks and multilateral financial institutions play a pivotal role in de-risking renewable energy investments. [3]

Despite progress, multiple challenges hinder the large-scale adoption of green energy. Infrastructure limitations, policy inconsistencies, and financial risks are among the primary obstacles identified in the literature (Sovacool et al., 2020). Additionally, a lack of access to financing in low-income countries slows down renewable energy deployment (Bhattacharyya, 2013). The need for stronger international cooperation, technological transfer, and policy alignment is frequently highlighted as essential for overcoming these barriers (IEA, 2022). [4]

Recent studies call for a more integrated approach to green energy development, combining technological innovation, policy reform, and inclusive financing mechanisms (Goldthau, 2018). The role of digitalization, such as smart grids and AI-driven energy management, is also emerging as a key research area (IRENA, 2023). Furthermore, scholars emphasize the importance of just energy transitions, ensuring that the shift to renewables is equitable and benefits all communities, particularly in the Global South (Newell & Mulvaney, 2013). [5]

RESEARCH METHODOLOGY

The research methodology for this study primarily involved gathering data from official government documents, reports issued by international organizations, and scientific publications. The collected information was analyzed using a structural-analytical approach, assessing the current state of the field and the impact of reforms through statistical and theoretical examination. Additionally, a comparative analysis was conducted during the evaluation process, leading to the development of key conclusions.

ANALYSIS AND RESULTS

Between 2024 and 2030, renewable energy consumption in the power, heat, and transport sectors is projected to grow by nearly 60% in the baseline forecast. As a result, the share of renewables in total energy consumption is expected to rise from 13% in 2023 to almost 20% by 2030. The majority of this increase—over three-quarters will come from renewable electricity generation, driven by ongoing policy support in more than 130 countries, decreasing costs, and the growing adoption of electricity in road transport and heating through heat pumps.

Renewable fuels including liquid, gaseous, and solid bioenergy, as well as hydrogen and e-fuels—are expected to contribute approximately 15% of the projected increase in renewable energy demand. These fuels experience the fastest growth in sectors where electrification is less feasible, such as aviation and maritime transport, and they also provide energy access in rural areas and industries with abundant biomass resources, such as sugar and ethanol production and the pulp and paper industry. The remaining 10% of growth comes from other renewable energy sources, including solar thermal and geothermal energy (figure 1).

Renewable energy demand and growth, main case, 2023-2030

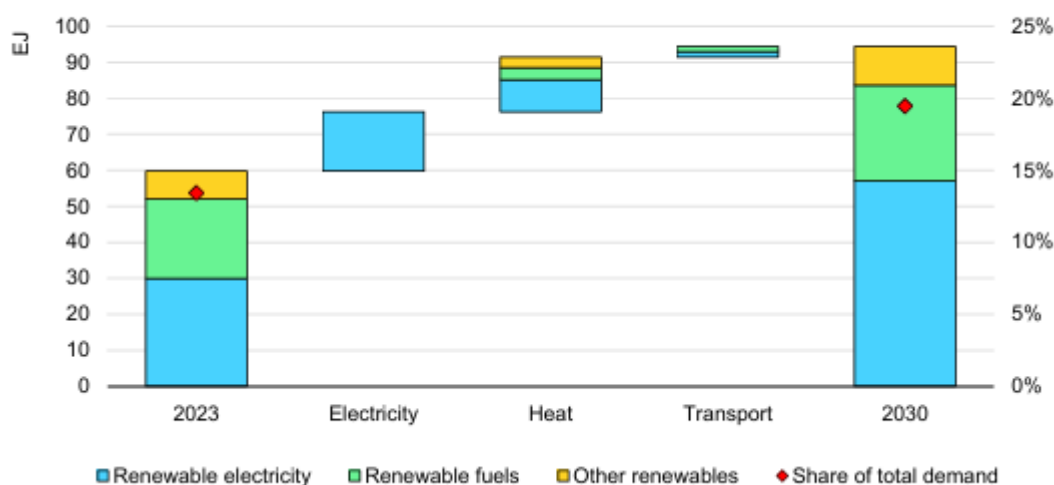


Figure 1. Renewable energy demand and growth, main case, 2023-2030. [6] <https://www.iea.org/reports/renewables-2024/renewable-fuels>.

The share of renewable energy in the electricity sector is projected to grow from 30% in 2023 to 46% by 2030, with solar and wind power driving nearly all of this increase. This rapid growth has a ripple effect, aiding the decarbonization of other sectors where electricity is used for industrial processes, heating buildings, and charging electric vehicles. Additionally, renewable electricity plays a key role in producing renewable hydrogen, which is primarily utilized in materials production, chemicals, and power generation—accounting for nearly three-quarters of renewable hydrogen demand by 2030 in the baseline scenario. Consequently, renewable electricity also becomes a major contributor to renewable energy expansion in the heat and transport sectors. The share of renewables in heat demand rises to approximately 20%, supported by solid and gaseous bioenergy, solar thermal, geothermal energy, and ambient heat. In the transport sector, the share of renewable energy increases to 6% of total demand, driven by the growing use of liquid biofuels in road transport, aviation, and maritime applications, with hydrogen and e-fuels providing a smaller contribution (figure 2).

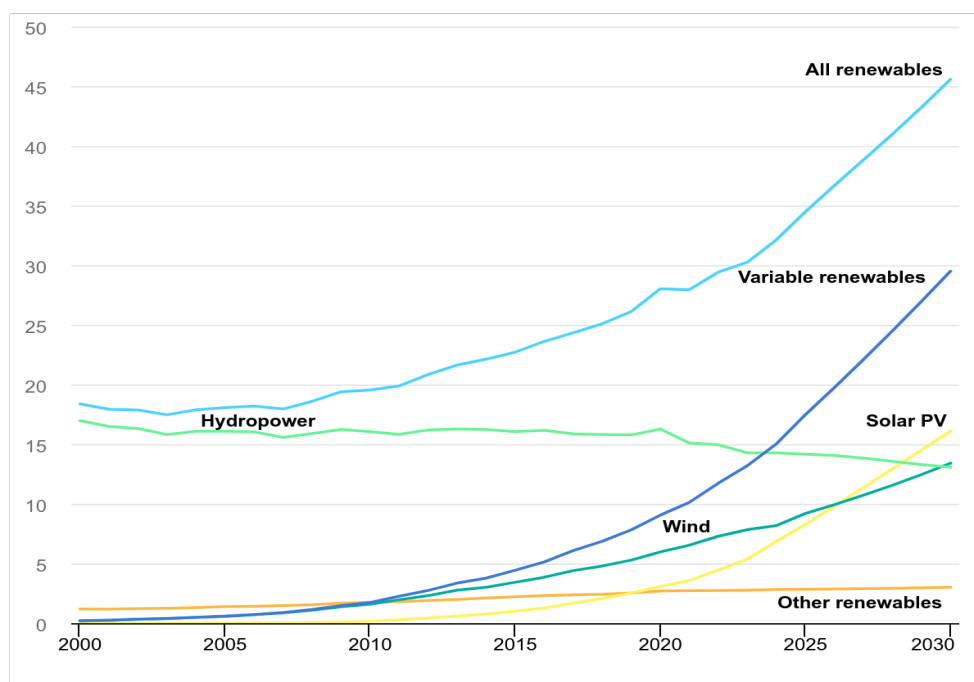


Figure 2. Global electricity generation by technology, 2000-2030. [7] <https://www.iea.org/data-and-statistics/charts/share-of-renewable-electricity-generation-by-technology-2000-2030>.

Global renewable electricity generation is expected to exceed 17,000 terawatt-hours (TWh) by 2030, marking an increase of nearly 90% compared to 2023. This level of production would be sufficient to supply the total electricity demand of both China and the United States by the end of the decade.

Several key milestones in renewable energy are anticipated over the next five years. By 2025, electricity generation from renewable sources is projected to exceed that of coal. In 2026, both wind and solar power are expected to individually surpass nuclear power generation. By 2029, solar photovoltaic (PV) generation is set to overtake hydropower, becoming the world's largest renewable energy source, while wind power is forecast to surpass hydropower by 2030.

By 2030, renewable energy sources will account for 46% of global electricity generation, with solar PV and wind contributing a combined 30%. However, by that time, solar PV will emerge as the leading renewable electricity source, followed by wind, with both surpassing hydropower in overall generation capacity.

By 2030, variable renewable sources will make up two-thirds of global renewable electricity generation, up from less than 45% today. Throughout the forecast period, solar PV's contribution to global power demand is expected to triple, while wind generation nearly doubles. Meanwhile, hydropower's role becomes less dominant, although its overall generation continues to grow, driven by new projects primarily in emerging and developing countries. However, hydropower's share of total electricity generation is projected to see a slight decline.

The share of other renewable sources, such as bioenergy, concentrated solar power, and geothermal energy, remains steady at under 3%. Since variable renewables contribute 90% of the global increase in renewable generation during the forecast period, additional measures to enhance power system flexibility will be necessary. However, the expansion of bioenergy, geothermal, and concentrated solar power remains limited, despite their essential role in supporting the integration of wind and solar PV into electricity systems worldwide (figure 3).

Global electricity generation by renewable energy technology and country/region, main case, 2023 and 2030

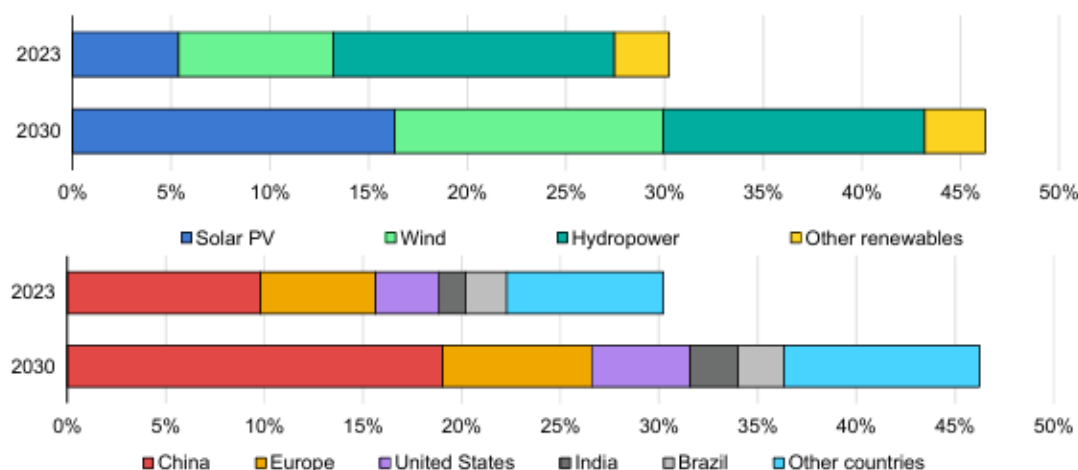


Figure 3. Global electricity generation by renewable energy technology and region, main case, 2023-2030. [8] <https://www.iea.org/data-and-statistics/charts/global-electricity-generation-by-renewable-energy-technology-main-case-2023-and-2030>.

China's rapid expansion in renewable energy is set to double its share of global renewable power generation, with wind and solar PV project costs becoming comparable to or slightly lower than coal-fired generation, depending on the province. By 2030, Europe and the United States will collectively account for nearly 30% of global renewable electricity output, while Brazil and India will each contribute an additional 5 percentage points. Among major economies, India will experience the fastest growth, with its share more than doubling over the forecast period. Beyond these key markets, renewable electricity generation is also expected to rise, but many emerging and developing countries that rely heavily on fossil fuels still have substantial untapped potential for expansion.

The main-case forecast for renewable electricity is not on track to meet the IEA Net Zero Emissions by 2050 Scenario targets, which aim for renewables to account for nearly 60% of global electricity generation by 2030. As a result, the main-case projection falls 14 percentage points (5,000 TWh) short of the Net Zero by 2050 Scenario model.

Several key challenges hinder faster renewable energy growth. Policy uncertainties and implementation challenges involving financing, permitting, social acceptance and grid integration remain significant obstacles. Enhancing policy frameworks and regulatory environments to mobilise private capital more effectively will be necessary to remedy these issues.

CONCLUSION AND SUGGESTIONS

Green energy development is a crucial step toward achieving a sustainable and low-carbon future. Renewable energy sources such as solar, wind, hydro, and biomass provide a viable alternative to fossil fuels, reducing greenhouse gas emissions and mitigating climate change. Governments, private investors, and international organizations have recognized the importance of green energy and have taken various initiatives to accelerate its adoption. However, challenges such as high initial investment costs, policy uncertainties, and technological limitations still hinder large-scale deployment, especially in developing countries.

To ensure a successful transition to green energy, a multi-stakeholder approach is necessary, involving governments, financial institutions, businesses, and communities. Effective policies, sufficient funding mechanisms, and technological innovation are essential to overcoming existing barriers. With the right strategies, green energy can drive economic growth, create jobs, and improve energy security while protecting the environment.

Governments should establish clear and stable policies that encourage renewable energy investments, such as subsidies, tax incentives, and feed-in tariffs. Strong regulatory frameworks will create a favorable environment for investors and developers. Financial institutions and governments should provide low-interest loans, green bonds, and grants to make renewable energy projects more accessible, especially in developing regions. Public-private partnerships (PPPs) can also play a significant role in funding large-scale projects.

Continuous technological innovation is essential to improving the efficiency and affordability of green energy solutions. Governments and private sectors should allocate resources to R&D initiatives in battery storage, smart grids, and emerging renewable technologies. Many developing countries struggle with weak grid systems that cannot support renewable energy expansion. Investment in modernizing infrastructure and integrating smart grid technology will enhance energy efficiency and reliability.

Public engagement and education programs should be encouraged to increase awareness about the benefits of renewable energy. Consumers and businesses should be incentivized to adopt green energy solutions. Global partnerships and knowledge-sharing between countries can accelerate green energy development. Developed nations should support developing countries through technology transfer, capacity-building programs, and financial aid. By implementing these strategies, green energy development can be accelerated, leading to a cleaner, more sustainable future for all.

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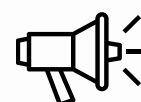
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