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Global renewable energy transition in fossil fuel dependent regions

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Abstract

The worldwide shift towards renewable energy, as defined by the United Nations' Sustainable Development Goals (SDGs) in 2015, is a crucial milestone in achieving a sustainable future. The core focus of SDG 7 is to advance the accessibility, dependability, and environmentally-friendly nature of energy, aiming to substantially enhance the proportion of renewable energy sources and enhance energy efficiency. Although there have been significant developments in renewable energy, notably in solar and wind technologies, the rate of transition is still inadequate to achieve climate objectives. This study examines the imperative of implementing policy changes and integrated strategies to align global and local goals, while tackling the issues of resource allocation and the pressing need to transition away from fossil fuels in order to mitigate global temperature increase. Case studies showcase effective national endeavors, such as Brazil's Proalcool, Germany's Energiewende, and India's ambitious renewable energy objectives, illustrating diverse strategies for bolstering renewable energy capability. The report also analyzes the economic consequences for emerging nations that heavily rely on fossil fuels and the expected effects of reduced fossil fuel consumption. This article offers a detailed analysis of the current advancements, difficulties, and variations across different regions in the field of renewable energy. It gives valuable information on the future of global renewable energy plans, highlighting the importance of unified worldwide endeavors to attain a sustainable energy future.

Keywords: SDG; Renewable Energy; Solar Energy; Wind Energy; Fossil Fuel

1. Introduction

The United Nations General Assembly (UNGA) proposed the Sustainable Development Goals (SDGs) in 2015. These goals provide a comprehensive framework for global cooperation in achieving a sustainable future (Jeremic & Sach, 2014). The 17 Sustainable Development Goals (SDGs) and associated 169 goals, which are the central focus of "Agenda 2030," provide a comprehensive plan to eliminate extreme poverty, address inequality and injustice, and protect the ecology of the world. An essential component for the achievement of Agenda 2030 is the implementation of sustainable energy. SDG 7 has three primary goals: guaranteeing cheap, dependable, and widespread availability of modern energy services; substantially raising the proportion of renewable energy in the global energy combination; and doubling the worldwide rate of progress in energy efficiency (TO, 2015). The objectives of SDG 7 also contribute to the attainment of other SDG goals, which is a subject of increasing study focus (Allen et al., 2016). Prior evaluations have demonstrated the technological feasibility of concurrently improving energy availability, air quality, and energy security, while also preventing hazardous climate change. Different combinations of resources, technology, and policies can be used to attain these goals (Ergas, 1987). Nevertheless, achieving a successful transition necessitates prompt policy implementation and significant political reforms to synchronize global problems, such as climate change, with local and national needs, including health, pollution, energy availability, and security. Integrated policy design is crucial for identifying cost-effective solutions that simultaneously meet numerous objectives. The utilization of land, energy, and water is essential, but it also contributes to climate change, and the systems that provide these resources are susceptible to climatic alterations. Effective allocation of resources is crucial for both reducing the impact and adjusting to the effects

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of a situation. Inconsistent strategies and inefficient resource utilization result from the absence of integration in resource evaluations and policy-making. By adopting a comprehensive strategy to climate, land-use, energy, and water solutions, we can effectively reduce the impact of these concerns (Howells et al., 2013). An immediate and imperative shift towards other sources of energy is necessary in order to restrict the average rise in global surface temperature to less than 2°C. The Paris Agreement has significant ramifications for the energy sector that are not completely accounted for in current energy models (Rogelj et al., 2015). It is imperative to shift from fossil fuels to low-carbon alternatives due to the fact that energy-related carbon dioxide (CO2) emissions contribute to two-thirds of all greenhouse gases (GHG) (Kabeyi et al., 2022). The shift will be propelled by technical advancements, particularly in the field of renewable energy. The significant decline in expenses and growing competitiveness, especially for solar photovoltaics (PV) and wind power, have resulted in unprecedented increases in newly built renewable energy capacity. Renewable energy sources constituted 25% of the total worldwide electricity generation in the year 2017. Nevertheless, the transition is not advancing at a satisfactory pace: following three years of consistent CO_2 emissions from energy (2014-2016), there was a 1.4% increase in 2017 (Levin & Rich, 2017).

Anticipating the precise time and magnitude of energy changes is a difficult task. The anticipated advancements in nuclear and hydrogen technologies, as mentioned by Holland and Provenzano (2007), have not yet come to fruition. Recent assumptions, such as exaggerated natural gas predictions and underestimated expansion of renewable energy sources, have also been found to be incorrect (Liao et al., 2016). According to Sovacool (2016), it usually takes around 50 years for energy transitions to go from first market adoption to being the dominant choice in the market. The transitions mentioned are motivated by technology advancements, economic factors, access to resources, and the desire to provide better energy services to customers. These transitions emphasize the importance of business possibilities, energy advantages, and individual self-determination (Unger, 2009).

2. Regional distribution renewable energy production capacity

National energy transition narratives encompass both achievements and shortcomings. Effective transitions frequently need governments to implement policy frameworks that facilitate and expedite the transition process. Thoughtfully crafted policies take into account the attributes of energy systems and incorporate both the supply and demand components (Kakodkar et al., 2022). Some examples of successful initiatives in the field of climate change mitigation are Brazil's Proalcoolprogramme, which has utilized a combination of evolving policy instruments since 1975, Germany's Energiewende, which is driven by a national consensus to reduce greenhouse gas emissions by 80% by 2050, and Denmark's climate objectives, which are supported by policies promoting the renewable energy industry (Fouquet & Johansson, 2008).

Nations are continuously increasing their goals for renewable energy due to a variety of causes. In 2018, the European Union raised its objective for 2030 from 27% to 32%. There are plans to review and perhaps boost this target in 2023 (Gielen et al., 2019). India has established a challenging goal of achieving 175 GW of energy production by 2022, which was subsequently raised to 227 GW by 2027. This objective is motivated by advancements in wind and solar energy technologies (Phadke & Deshmukh, 2016). In 2017, the United States achieved a significant transformation in its energy sector by implementing tax incentives for renewable energy. As a consequence, renewable sources accounted for 11% of the country's total energy consumption and 17% of its power output (Newell et al., 2019). China's objective is to decrease its carbon emissions per unit of GDP by 60-65% by 2030 compared to the levels in 2005. This goal will be achieved by relying heavily on renewable energy sources (Godarzi&Maleki, 2020). Additional major energy consumers are also actively engaging in the worldwide shift towards alternative energy sources. Russia has expedited the implementation of solar and wind energy by conducting auctions, with the goal of exceeding its target of 5.9 GW of renewable energy capacity by 2024 (Pekar, 2019). Turkey is actively expanding its use of solar and wind energy sources in order to decrease its reliance on imported energy. The implementation of feed-in tariffs has been essential in facilitating the achievement of Turkey's goal of reaching 5GW of solar photovoltaic capacity by 2018 (Bradshaw, 2018). Figure 1 displays the spatial arrangement of projected increases in renewable energy production capacity between 2020 and 2050. According to Ram et al. (2022), China is expected to increase its energy capacity by 5991.6 GW, while the United States and India are forecast to add 3007.2 GW and 2154 GW, respectively. These figures underscore the substantial commitment of these countries to shift towards renewable energy sources.

Figure 1 Regional distribution renewable energy production capacity from 2020–2050 (Ram et al., 2022)

Figure 2 depicts the distribution of CO2e emissions within industries, highlighting the diverse effects of different emission scopes within sectors. Upon examination of the logarithmic scale, it becomes evident that several sectors, such as Fossil Fuels, Materials, and Power Generation, exhibit much more emissions in comparison to other businesses. Figure 3 underscores the worldwide shift towards expanding renewable energy capacity, emphasizing the need of regional approaches and investments in harnessing a variety of renewable resources.

According to Figure 4, the industrial sector consumes the most power, with a consumption of around 40 million MWh. The consumer with the second largest consumption utilizes a range of 20 to 30 million MWh. Another industry utilizes a substantial quantity of power, ranging from 10 to 20 million MWh. The power consumption in one sector is significant, projected to be between 5 and 10 million MWh, whereas the consumption in another sector is moderate, presumably ranging from 2 to 5 million MWh. Certain industries have comparatively lower levels of electricity usage, with estimated figures ranging from 0 to 2 million MWh. The Manufacturing and Materials industries are the primary users of electricity, jointly representing a substantial proportion of the overall demand. Power Generation consumes a significant amount of power, as predicted due to its function in the energy supply chain. Fossil Fuels and Services provide a significant contribution to power consumption, whilst the other industries have relatively smaller levels of electricity use.

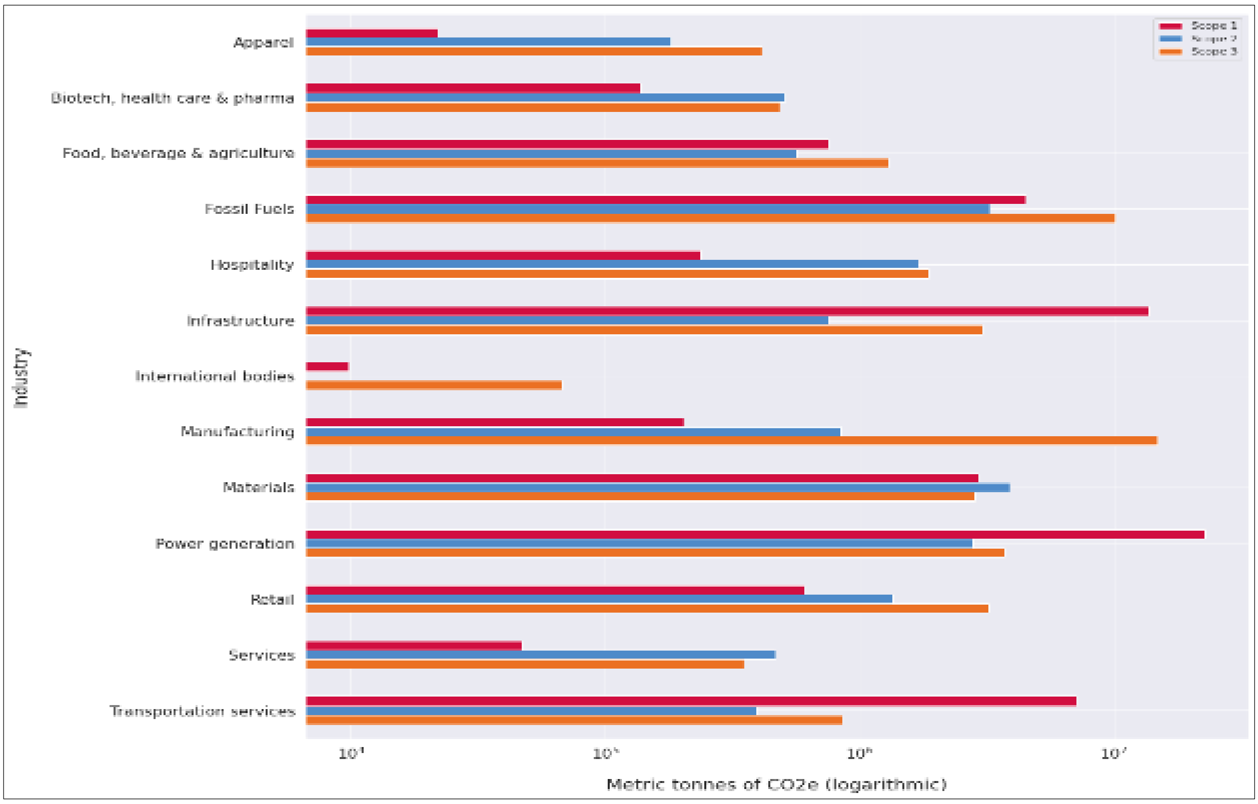

Figure 2 Global Average Emissions by industry

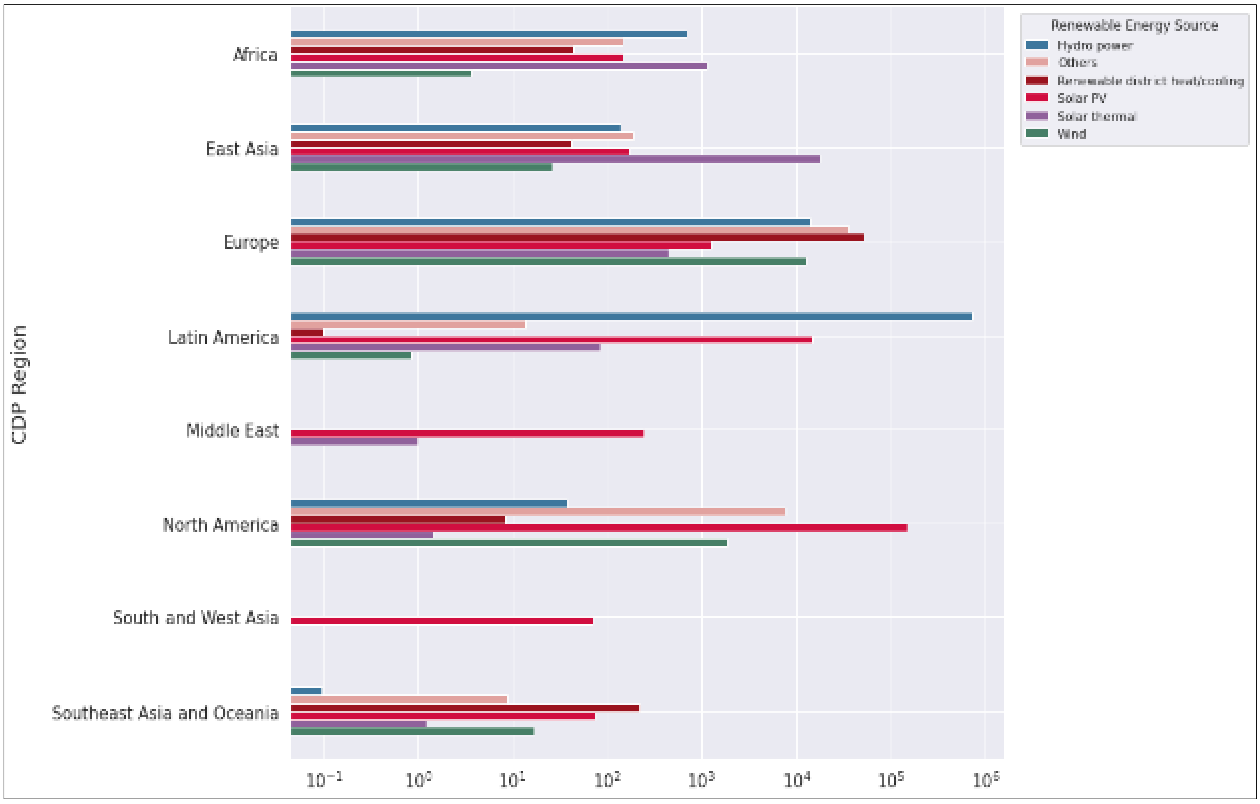

Figure 3 Global Average Renewable Energy capacity (MW) in cities

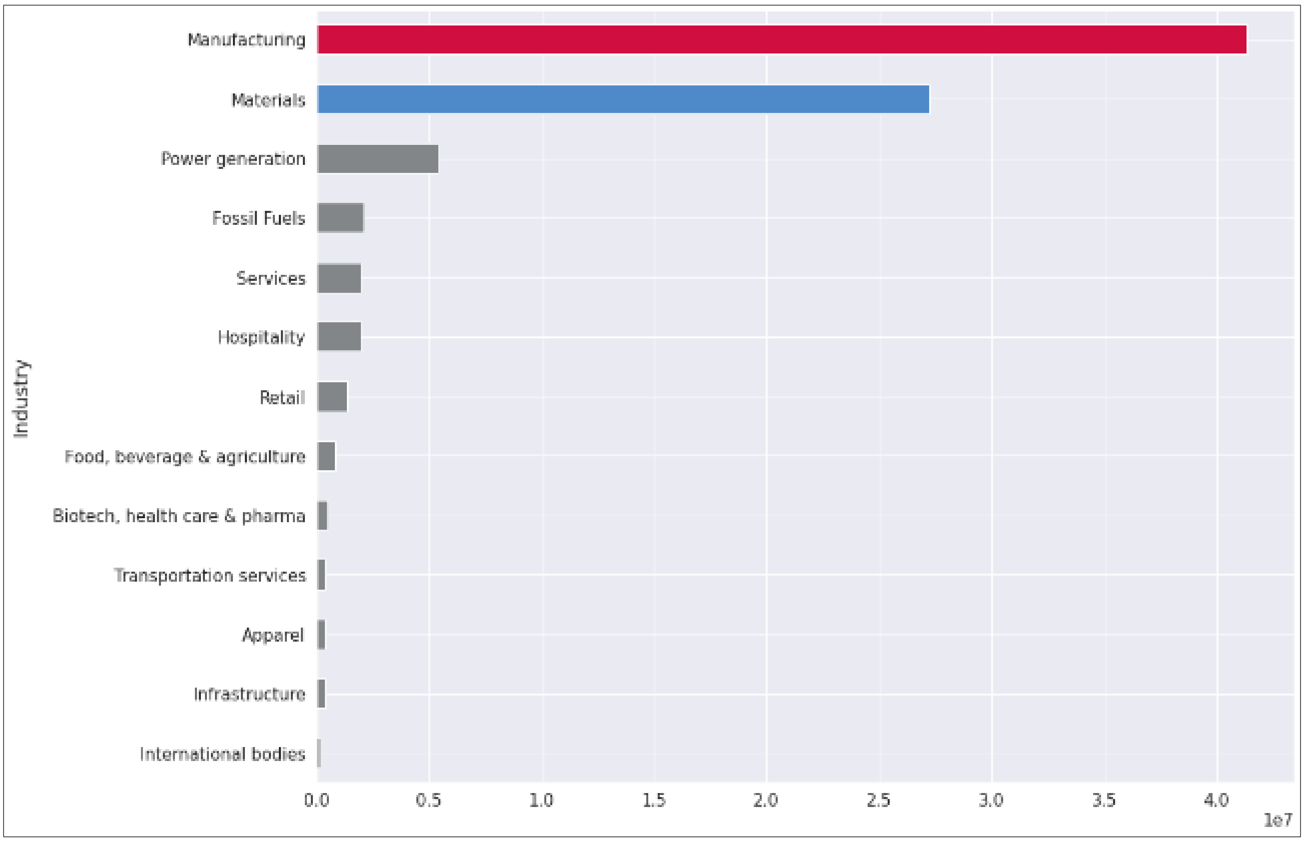

Figure 4 Average Electricity Consumption by Industry (in MWh)

3. The Opportunities and Challenges of a Global Renewable Energy Goal

Implementing a worldwide goal for renewable energy will improve energy security by broadening the range of energy sources and decreasing dependence on imported fossil fuels (Pode, 2010). Countries endowed with ample renewable resources would have the opportunity to harness their own energy sources, so guaranteeing a consistent and dependable supply. This might reduce their susceptibility to geopolitical conflicts and the volatility of fossil fuel markets.

Moreover, the establishment of a worldwide objective for renewable energy will stimulate the advancement of clean energy technology through research and development, hence promoting innovation (Jänicke, 2012). This would result in enhanced efficiency and cost-effectiveness of renewable energy systems. Progress in energy storage, integration with the power grid, and intelligent technologies would enhance the overall efficiency of renewable sources, rendering them superior alternatives to conventional energy sources. Additionally, renewable energies provide significant health advantages (Cowell et al., 2011). Shifting towards renewable energy sources will enhance air quality and promote public health. Through the mitigation of air pollution caused by the burning of fossil fuels and the use of biomass for cooking, the presence of cleaner air will lead to a reduction in respiratory and cardiovascular illnesses, so improving the overall health and well-being of communities. The transition to renewable energy can enable governments to give greater importance to public health in addition to addressing climate issues.

4. Adaptation to the Energy Transition in Fossil Fuel-Dependent Developing Countries

Fossil fuels now satisfy more than 80 percent of the global energy demand (Abas et al., 2015). Nevertheless, the urgency of the climate change challenge requires a significant transition in the energy sources that fuel global enterprises and homes. The ongoing shift from fossil fuels to renewable energy is already underway. Currently, there is an investment of $1.80 in clean energy technology and infrastructure for every dollar invested in fossil fuels. This transition is anticipated to gain momentum in the upcoming years. The anticipated decline in the use of fossil fuels and the subsequent substitution with renewable energy sources is projected to have a substantial effect on commodity-dependent developing countries (CDDCs) that heavily depend on fossil fuel production and export for foreign exchange, foreign direct investment (FDI), public revenue, and economic growth. Out of the 95 nations categorized as CDDCs, 28 depend on the export of fossil fuels as their main source of commodity exports. In addition, in 17 of these nations, a single fossil fuel commodity is responsible for more than 50% of their entire item exports. The nations heavily depend on money generated from the production and sale of fossil fuels to finance their government public expenditure programs. In many circumstances, more than half of their fiscal revenues come from the commodities sector, and in certain instances, this figure exceeds 80 percent.

The projected increase and subsequent decrease in the demand for fossil fuels will have an impact on both the quantity and economic worth of energy-dependent CDDCs' commerce, as stated by De Almeida et al. (2011). Presently, the global trade in energy items accounts for around 40 percent of all worldwide commodity exports, which amounts to almost $2.1 trillion. The changes in global trade patterns will have large macroeconomic and microeconomic effects for developing nations that rely heavily on money from exporting fossil fuels. Three repercussions of global decarbonization are especially pertinent for fossil fuel-exporting CDDCs(Pickbourn et al., 2022).

5. Conclusion

The study's theoretical implications arise from its comprehensive assessment of worldwide renewable energy patterns, offering unique insights into the dynamics of energy transition in different locations. This approach provides a structure for comprehending the intricate interplay among policy, technology, and market factors in defining the landscapes of renewable energy. The study's conclusions are crucial for governments, investors, and international organizations as they strategize and guide their efforts towards achieving more efficiency and fairness in the adoption of renewable energy. Nevertheless, the study is subject to many limitations, including possible biases in data collecting and the dynamic nature of energy regulations, which might impact the long-term applicability of the conclusions. In addition, directing attention towards extensive regional patterns may disregard particular intricacies within individual countries. Although there are limits, the conclusions of the study have important consequences. They provide a blueprint for a coordinated worldwide effort to attain a sustainable energy future. The study also emphasizes the accomplishments and obstacles that lie ahead in the pursuit of a more environmentally friendly globe.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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