НАУЧНИ ТРУДОВЕ НА УНСС (2) 2024, ИК – УНСС
ISSN (online): 2534-8957; ISSN (print): 0861-9344; http://unwe-research-papers.org/
DOI: https://doi.org/10.37075/RP.2024.2.09

RENEWABLE ENERGY FOR COMPETITIVE GROWTH: CHALLENGES AND OPPORTUNITIES

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Abstract

Renewable energy has emerged as a crucial solution to address the challenges posed by climate change and the increasing demand for energy. This paper aims to explore the challenges and opportunities associated with the adoption of renewable energy for achieving competitive growth. The study examines the current state of renewable energy technologies, identifies the barriers to their widespread implementation, and highlights the potential benefits and opportunities for economic growth. The findings suggest that while there are challenges to overcome, renewable energy presents significant opportunities for sustainable development and a competitive advantage in the global market. The literature review was supplemented by an additional review on the criteria used by different policymakers and case studies. The final presentation of the results creates a taxonomy landscape of criteria for the social and political perspectives as well as success story in terms of CSR. The strategical importance in this regard is related to the perspective in the decision-making by policy makers in different countries.

Keywords: renewable energy, competitive growth, challenges, opportunities, sustainable development, policy framework, economic growth

JEL: Q42, F43, Q001, Q28, F43

Introduction

The global energy landscape is undergoing a significant transformation driven by the need to reduce greenhouse gas emissions and mitigate the impacts of climate change. Renewable energy sources, such as solar, wind, hydro, geothermal, and biomass, have gained traction as viable alternatives to fossil fuels. This paper explores the challenges and opportunities (Sen and Ganguly, 2016) associated with the use of renewable energy (also called renewables) for achieving competitive growth.

This section provides an overview of the current state of renewable energy developments. It discusses the advancements in solar photovoltaic (PV) systems, wind turbines, hydroelectric power, geothermal energy, and biomass. The section

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also highlights the increasing efficiency and decreasing costs of these technologies, making them more economically viable.

The current state of the renewable energy landscape is promising and rapidly evolving. Firstly, the most important part is related to the growing opportunities in the sector. There has been a significant increase in investment in renewable energy sources such as solar, wind, hydro, and geothermal (Rahman, Farrok, Haque, 2022). According to the International Energy Agency (IEA), global investment in renewable energy reached a record high of $1.3 trillion in 2022 (Global landscape of renewable energy finance, 2023).

Secondly, the increasing cost (price) competitiveness of technologies using renewable energy compared with the technologies using the "classical" fossil fuels. Solar and wind energy, in particular, have seen significant cost reductions (Bird et al., 2016), making them more accessible and economically viable. In this regard, we have seen and increasing capacity in the sector. The International Environmental Agency IEA estimates that in the projected period 2022 – 2028 up to 90% of the extension of the capacity for electrical production (2400 GW) will be based on renewable sources: mainly solar and wind energy (IEA, 2022a). Thirdly, policy support is very important since that many European countries have started the initiative on the Green Deal. Many countries have implemented policies and incentives to promote the adoption of renewable energy. These include feed-in tariffs, tax credits, and renewable portfolio standards. International agreements like the Paris Agreement (2015) for reduce carbon dioxide and other greenhouse gas emissions strongly encourages countries to increase the share of renewable energy sources.

Renewable energy technologies have significant competitive advantage (Shrivastava, 1995). For example, the development of cost effective solar panels and more powerful wind turbines has increased the energy output of these sources. The integration of energy storage systems, such as batteries, has become crucial for the widespread adoption of renewable energy. Energy storage helps address the intermittent nature of renewable sources and ensures a stable and reliable power supply. The shift towards electric vehicles (EVs) is driving the demand for renewable energy. As more EVs are adopted, the need for clean and sustainable energy sources will continue to grow (York and Bell, 2019).

Despite these positive developments, challenges remain (Strielkowski et al., 2021). The intermittency of renewable sources (Barton and Infield, 2004), the need for grid infrastructure upgrades and the creation of smart grids (Rehmani et al., 2018), and the dependence on governmental regulations need (Smirnova et al., 2021) to be addressed for further growth in the renewable energy landscape. However, the overall outlook for renewable energy is optimistic, with continued advancements and increasing global commitment to decarbonization.

Literature review: Research objective & Methodology

The transition to renewable energy sources is crucial for addressing climate change and achieving sustainable development goals. This literature review aims to explore the challenges and opportunities in the renewable energy sector (Pineda, 2020, pp. 4-6; Bource, 2020; Agora Energiewende and Sandbag, 2020; WindEurope, 2019; Šener et al., 2018; Fouquet, 2016). By examining existing research and scholarly articles, this review provides insights into the key obstacles and potential avenues for growth and development in renewable energy. In this regard, here is a summary of policy and regulatory challenges. One of the significant challenges in the renewable energy sector is the lack of consistent and supportive policies and regulations (Painuly, 2001). In many countries (Poland, Germany, China, Russia, India) fossil fuel direct and indirect subsidies have increased dramatically in the recent years. By estimations of the IEA, global subsidies for fossil fuels consumption exceeded one trillion USD in 2022 (IEA, 2022b). One of the key factors for a such revers trend is the disrupted supply of "green natural gas" (because of the sanctions against Russia).

The literature highlights (Pickering et al., 2015; Pickering and Byrne, 2014; Sadorsky, 2009a, Sadorsky, 2009b; Chang et al. 2009) the importance of establishing clear and stable policy frameworks that promote renewable energy deployment and attract investment. On the other hand we deal with intermittency and grid Integration (Šener et al., 2018). Renewable energy sources such as solar and wind are intermittent, meaning their generation fluctuates based on weather conditions. Still they remain on of the most competitive renewables in terms of prices compared to traditional energy sources. This intermittency poses challenges for grid integration and stability. The literature emphasizes the need for advanced grid infrastructure, energy storage systems, and smart grid technologies to effectively manage and integrate renewable energy into existing power systems. The expert's arguments are based on the technological advancements and cost reduction. Technological advancements play a crucial role in the growth of the renewable energy sector. The literature highlights the importance of research and development in improving the efficiency and reliability of renewable energy technologies. Additionally, cost reduction is essential for the widespread adoption of renewable energy. The review identifies the need for continued innovation and economies of scale to drive down the costs of renewable energy technologies. Yet, another important pillar of the renewables is the cost structure, financing and investment. Access to financing and investment is a significant challenge for renewable energy projects, particularly in developing countries.

The literature emphasizes the importance of creating favorable investment climates (IPCC, 2018; Sovacool et al., 2015;), providing financial incentives, and leveraging public-private partnerships to attract capital for renewable energy projects, especially in the developing countries (Mignon and Bergek, 2016). The review also highlights the potential of innovative financing mechanisms such as green bonds and crowdfunding. Even more, the main focus is on the environmental and social impacts. While renewable energy sources are generally considered environmentally friendly, they can still have certain environmental and social impacts. The literature discusses the need for comprehensive environmental assessments and stakeholder engagement to mitigate potential negative impacts such as habitat disruption, land use conflicts, and community displacement. Competitiveness is matters most when discussing about the challenges in terms of the renewables business model (Kim and Park, 2016). Job creation and economic opportunities remain at the core of the renewables business model in terms of explaining the sustainability and value creation in different societies (Marques and Fuinhas, 2012, p. 111). The transition to renewable energy has the potential to create new job opportunities and stimulate economic growth. Some leading authors underline (Romano et al., 2017; Apergis and Eleftheriou, 2015; Ackah and Kizys, 2015; Zeb et al., 2014; Pfeiffer and Mulder, 2013; Zhao et al., 2013; Marques and Fuinhas, 2012, p. 111), the importance of workforce development and training programs to ensure a skilled workforce for the renewable energy sector. Additionally, the review identifies the potential for local economic development through the establishment of renewable energy industries and supply chains. In this regard we have review as case study the KWF bank in Germany. At last but not least, energy access and equity is what can distinguish a good or poor performance renewables business model. Renewable energy can play a crucial role in providing access to clean and affordable energy for underserved populations. The literature emphasizes the need for targeted policies and initiatives to address energy poverty and ensure equitable distribution of renewable energy benefits (Baldwin et al., 2017; Pfeiffer and Mulder, 2013; Brunnschweiler, 2010; Carley, 2009). The review also highlights the potential of decentralized renewable energy systems to provide energy access in remote and off-grid areas. Muzho (2020) argues that different countries pay significant role to policy and regulatory frameworks, grid integration, technological advancements; financing, environmental and social impacts, job creation, and energy access are identified as key areas of focus. Addressing these challenges and capitalizing on the opportunities can accelerate the transition to a sustainable and low-carbon energy future. Further research and collaboration among stakeholders are essential to overcome these challenges and unlock the full potential of renewable energy. Our aim is to find out the criteria for the social and political perspectives and success story in terms of CSR (Geng and Ji, 2016; Cheon and Urpelainen, 2013; Popp et al., 2011).

To achieve this objective, we involved a literature review approach to identify the criteria and involved in the process. In the second phase we included a validation from a case study reviewcomparing how the criteria are influencing the whole process towards the opportunities and tackling the challenges with the renewables in different countries.

Theoretical background: The current state of the renewable energy landscape is promising and rapidly evolving.

Comparison analysis in the EU, China and United States of America

Policy measures

To complete the overview of the empirical frameworks used in the relevant literature with regards to policy measures in the European Union (EU), China, and the United States (USA) I found that they play a crucial role in promoting the development and deployment of wind and solar renewable energy.

Here are some key policy measures implemented in each region: European Union (EU):

1. Renewable Energy Directive (RED): The EU has set binding targets for renewable energy consumption through the RED. The directive requires member states to achieve a 32% share of renewable energy in final energy consumption by 2030. It also establishes national renewable energy action plans and support mechanisms to incentivize the deployment of wind and solar energy.

2. Feed-in Tariffs (FiTs): Many EU member states have implemented FiTs, which guarantee a fixed price for electricity generated from renewable sources, including wind and solar. FiTs provide long-term contracts and stable revenue streams, encouraging investment in renewable energy projects.

3. Renewable Portfolio Standards (RPS): Some EU countries, such as Germany and Spain, have implemented RPS, which require a certain percentage of electricity to come from renewable sources. RPS create a market demand for wind and solar energy and stimulate their development.

4. Auction Mechanisms: Several EU countries, including Denmark and the Netherlands, have introduced auction mechanisms to allocate support for renewable energy projects.

These competitive bidding processes ensure cost-effective deployment of wind and solar energy by awarding contracts to projects with the lowest bids.

Let's shed light on the case of China:

1. Renewable Energy Law: China's Renewable Energy Law sets targets for renewable energy consumption and establishes a legal framework for its development. The law requires grid companies to purchase all electricity generated from renewable sources, including wind and solar, at guaranteed prices.

2. Feed-in Tariffs (FiTs): China has implemented FiTs for wind and solar energy, providing fixed tariffs for electricity generated from these sources. FiTs have been instrumental in driving the rapid growth of wind and solar installations in China.

3. Renewable Portfolio Standards (RPS): China has introduced RPS at the provincial level, requiring a certain percentage of electricity to come from renewable sources. RPS create market demand and incentivize the development of wind and solar energy projects.

4. Subsidies and Incentives: The Chinese government provides various subsidies and incentives to promote wind and solar energy, including financial support for project development, tax benefits, and low-interest loans.

These measures help reduce the upfront costs and attract investment in renewable energy projects.

The third case study comes from the United States (USA):

1. Production Tax Credit (PTC) and Investment Tax Credit (ITC): The USA offers federal tax credits for wind and solar energy projects. The PTC provides a per-kilowatt-hour tax credit for electricity generated from wind, while the ITC offers a tax credit based on the investment in solar energy projects. These incentives have been instrumental in driving the growth of wind and solar installations in the USA.

2. Renewable Portfolio Standards (RPS): Many states in the USA have implemented RPS, requiring a certain percentage of electricity to come from renewable sources. RPS create market demand and provide a policy framework for wind and solar energy development.

3. Net Metering: Net metering policies allow residential and commercial customers to receive credits for excess electricity generated from their solar installations. This encourages the adoption of rooftop solar and promotes distributed generation.

4. State and Local Incentives: Various states and local governments in the USA offer additional incentives for wind and solar energy, such as grants, rebates, and property tax exemptions. These incentives vary by jurisdiction and aim to support the growth of renewable energy at the regional level.

It is important to note that policies and incentives in each region are subject to change and may vary across different countries or states within a region. Additionally, this is not an exhaustive list of all policy measures, but rather highlights some key measures implemented in the EU, China, and the USA for wind and solar renewable energy.

To compare the declining costs and technological advancements of renewable wind and solar energy in the USA, China, and the EU, let's examine the following factors:

1. Declining Costs:
   - USA: The cost of wind and solar energy has been declining in the USA due to technological advancements, economies of scale, and policy support. According to the U.S. Department of Energy, the levelized cost of electricity (LCOE) for onshore wind has decreased by around 70%

since 2009, while the LCOE for utility-scale solar has decreased by about 90% during the same period.

- China: China has also experienced significant cost reductions in wind and solar energy. The country's manufacturing capabilities and economies of scale have contributed to lower costs. The LCOE for onshore wind in China has decreased by approximately 30% since 2010, and the LCOE for utility-scale solar has decreased by around 80% since 2010.
- EU: The EU has seen declining costs in wind and solar energy as well. The LCOE for onshore wind in the EU has decreased by about 30% since 2010, and the LCOE for utility-scale solar has decreased by approximately 80% since 2010. The EU's strong policy support and investments in renewable energy have helped drive down costs.

2. Technological Advancements:
   - USA: The USA has been at the forefront of technological advancements in wind and solar energy. The country has made significant progress in developing more efficient wind turbines and solar panels, improving their performance and reducing costs. Innovations such as taller wind turbine towers, longer blades, and advanced tracking systems have increased the capacity and efficiency of wind energy. In solar energy, the USA has made advancements in the development of thin-film solar cells, bifacial modules, and improved manufacturing processes.
   - China: China has also made substantial technological advancements in wind and solar energy. The country has become a global leader in wind turbine manufacturing and has developed larger and more efficient turbines. China has also invested in research and development of advanced solar technologies, including high-efficiency solar cells, floating solar farms, and integrated solar-wind hybrid systems.
   - EU: The EU has been at the forefront of wind energy technology, with several countries leading in wind turbine manufacturing and innovation. The EU has made advancements in offshore wind technology, including larger turbines, floating platforms, and advanced grid integration systems. In solar energy, the EU has focused on improving the efficiency of solar cells and developing innovative solar panel designs.

Overall, all three regions (USA, China, and the EU) have experienced declining costs and significant technological advancements in wind and solar energy. The USA has been a leader in technological innovation, while China has excelled in manufacturing and scaling up renewable energy installations. The EU has also made substantial progress in wind energy technology and has been driving down costs through policy support and investments. These advancements have contributed to the increased deployment of wind and solar energy in all three regions and have made renewable energy more competitive with conventional sources of energy.

Discussion and results

The intermittency of renewable sources, the need for grid infrastructure upgrades, and the reliance on government policies and incentives are some of the obstacles that need to be addressed for further growth in the renewable energy landscape.

Comparing the intermittency of wind and solar energy in the EU, China, and the USA, with a focus on the outlook towards 2030, involves considering the following factors:

• Wind Energy Intermittency:

- EU: The EU has a significant amount of installed wind capacity, both onshore and offshore. While wind energy is intermittent, the geographic diversity of wind resources in the EU helps mitigate intermittency to some extent. By connecting different wind farms across countries through a well-developed grid infrastructure, the EU can balance the intermittent nature of wind energy and ensure a more consistent supply of electricity.

- China: China has also invested heavily in wind energy, becoming the world's largest wind power producer. However, the country faces challenges related to wind intermittency, particularly in certain regions with less consistent wind resources. To address this, China has been working on improving grid infrastructure and implementing advanced forecasting and control technologies to better integrate wind energy into the grid.

- USA: The USA has abundant wind resources and has experienced significant growth in wind energy installations. While wind energy is intermittent, the USA has been addressing this challenge through the development of advanced grid systems, energy storage technologies, and improved forecasting techniques. These measures help optimize the integration of wind energy into the grid and ensure a reliable electricity supply.

• Solar Energy Intermittency:

- EU: Solar energy is also intermittent, as it depends on sunlight availability. The EU has been investing in solar energy, with several countries experiencing rapid growth in solar installations. To address intermittency, the EU has been working on improving grid flexibility, implementing energy storage systems, and promoting the use of smart grid technologies. These measures help balance the intermittent nature of solar energy and ensure a stable electricity supply.

- China: China has become a global leader in solar energy deployment. While solar energy is intermittent, China has been working on integrating solar power into the grid through advanced grid technologies, energy storage systems, and demand-side management. The country has also been investing in concentrated solar power (CSP) plants with thermal energy storage, which can provide dispatchable power even when sunlight is not available.

- USA: The USA has seen significant growth in solar energy installations, particularly in states with abundant sunlight. To address intermittency, the USA has been investing in energy storage technologies, such as batteries, to store excess solar energy and release it when needed. The country has also been implementing advanced grid systems and demand response programs to manage the intermittent nature of solar energy.

Looking towards 2030, it is expected that the intermittency of wind and solar energy will continue to be addressed through technological advancements and improved grid integration. The development of advanced forecasting techniques, energy storage systems, and flexible grid infrastructure will help mitigate the challenges associated with intermittency. Additionally, the increased deployment of renewable energy across a wider geographic area and the use of hybrid renewable energy systems (combining wind and solar) can further enhance the reliability and stability of renewable energy supply.

It is important to note that the specific strategies and approaches to address intermittency may vary within each region (EU, China, and the USA) based on their unique energy systems, grid infrastructure, and policy frameworks. Additionally, advancements in energy storage technologies and grid flexibility will play a crucial role in managing intermittency and ensuring a reliable and sustainable energy supply from wind and solar sources.

Recommendations

No doubts, the potential for renewable energy production will be enlarged in the years to come. It is one of the prerequisites of the Sustainable development programs of the EU and the UN. However, the escalation of the war conflicts in Ukraine and the Middle East leads to further complications in the energy sources supply to the EU and elsewhere. That is why, the nuclear energy is gaining momentum in many countries, including Bulgaria. This type of energy has proven its cost efficiency and reliability regardless of the climate conditions and other natural factors supporting the thesis that sustainable development is a most needed prerequisite for maintaining the competitiveness at national and corporate level (Gechev, 2011). I share the understanding that both nuclear and renewable energies are rather mutually supportive than mutually exclusive. There is venue for future discussion especially on the *"mission-oriented programs for innovation policy"* as stated by Mazzucato (2018) in the energy sector. This interdependence will be a focus in my next study.

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