

# A Comparative Study on the Development Strategies of Renewable Energy Industries in China and the United States Based on an Innovation Perspective

Yifei Xu

Shanghai Pinghe School, Shanghai, 201206, China

xuyifei@shphschool.com

**Abstract.** This paper conducts a comparative study on the development strategies of renewable energy industries in China and the United States, highlighting the challenges in transitioning to renewable energy and underscoring the importance of political will. It aims to elucidate the differences in approaches between the two countries to inform future policy innovations. In China, the focus lies on fostering innovation in green energy technologies, with significant investments in research and development, disruptive technologies, and ambitious renewable energy capacity targets. Conversely, the United States is transitioning towards decarbonization through regulatory measures, financial incentives, and innovative financing mechanisms to accelerate the adoption and deployment of existing renewable energy technologies. While both countries are expanding their renewable energy sectors, China emphasizes innovation and government-led initiatives, whereas the USA relies more on market mechanisms, state roles, and private capital. These differences reflect the unique economic, political, and technological contexts of each nation, shaping their respective approaches to renewable energy development. Moving forward, policymakers can draw insights from these comparative analyses to enhance their renewable energy strategies. By leveraging the strengths of each approach and addressing challenges collaboratively, both countries can advance towards a more sustainable energy future.

**Keywords:** Development Strategies; Renewable Energy Industries; China; United States; Innovation.

## 1. Introduction

### 1.1. Research Background

In the face of escalating global energy demands and environmental concerns, the development of renewable energy industries has become an essential direction for many nations.

However, this transition is not without its challenges. The biggest barriers to renewable energies are often political, not technological or financial. The report by Carbon Tracker suggests that the main obstacle to a more sustainable world is not money, technology, or space but sheer lack of political will. This highlights the need for strong political commitment and policy support for renewable energy development. Comparative surveys such as those conducted by Muhammed and Tekbiyik-Ersoy have shown a significant positive relation between the number of patents and the total renewable energy installed capacity in the three nations studied using linear regression analyses [1].

Renewable electricity production from sources such as wind power and solar power is often criticized for being variable or intermittent. This variability can pose challenges to the reliability of energy supply, sparking debates about the feasibility and strategies of large-scale renewable energy deployment.

These gaps and controversies highlight the complexities involved in energy transition and the need for innovation in policy and strategy development. Renewable energy policies significantly influence the development of nations' renewable energy capacity, with varying effectiveness based on the type

of policy instruments used and the specific context of each nation. Therefore, comparative studies are crucial for understanding these dynamics and informing future policy innovations.

## **1.2. Research Objective**

This paper aims to conduct a comprehensive comparative study on the development strategies of renewable industries of the world's two largest economies - China and the United States.

From an innovation perspective, this research paper will dive deep into the approaches and methods adopted by China and the USA in their field of renewable energies. It will explore how innovation, as a driving force, has accelerated the growth of these industries under different economic and political contexts.

The primary objective of the research is to evaluate how political commitment and policy support influence the development and adoption of renewable energy technologies in both nations. Also, it is required to understand how different policy instruments can influence the industry in each nation and identify the most effective innovations to be made in strategies.

The second objective is to examine how innovative practices and technologies can contribute to the growth and performance of the renewable energy industry in each nation.

Through this research, we aim to provide a thorough understanding of the renewable energy industries in China and the United States, shedding light on the strategies that have driven their success and the role of innovation in shaping these industries. This study will serve as a valuable resource for policymakers, industry professionals, and researchers in the field of renewable energy.

## **1.3. Structure and Research Methods**

The study will be structured around five key research directions, aiming to conduct an in-depth comparative study of the renewable energy industries in China and the USA. First of all, the policies and regulatory framework that have been implemented by both China and the USA to promote renewable energy industries. This includes incentives for innovation, subsidies, tax benefits, and more. In addition, the technological advancements that have been made in the renewable energy sector in both countries dive deep into specific technologies like solar, wind, hydro, and others. Furthermore, the market dynamics of the renewable energy sector in both countries include supply and demand trends, competition, and pricing. Similarly vital are the investment and financing strategies adopted by both countries to boost growth in the renewable energy industry. Last but not least, assessing the socio-economic impact of the growth of the renewable energy sector in both countries, which means the macro impacts such as job creation, impact on GDP, or environmental benefits.

The research methods will include mainly the literature research method and quantitative research method, both based on comparative analysis. The former includes searching and evaluating relevant literature and writing a literature review that analyzes, synthesizes, and critically evaluates to give a clear picture of the state of knowledge. The latter is a systematic investigation that collects and analyzes numerical data to find patterns and averages, make predictions, and test causal relationships.

## **2. Description of the Development Strategies of Renewable Energy Industries in China and the United States**

### **2.1. Development Strategies in China**

China has achieved remarkable growth in its installed renewable capacity over the last two decades, far outpacing the rest of the world [2]. The Chinese government is now implementing an innovation-driven development strategy, building a system that nurtures innovation in green energy technologies and upgrading energy technologies and equipment in an all-round way [3]. China has strengthened basic research on energy, innovation in generic and disruptive technologies, and original and integrated innovation. China's focus on strengthening basic research on energy is noteworthy. The

country is investing heavily in the development of generic and disruptive technologies, with a particular emphasis on original and integrated innovation. These efforts are aimed at revolutionizing the energy sector and positioning China as a global leader in renewable energy technologies. In 2020, China made a bold pledge to reach 1,200 gigawatts of renewables capacity by 2030, more than double its capacity at that time [4]. This target underscores China's commitment to accelerating its transition to renewable energy.

## **2.2. Development Strategies in the USA**

The United States is moving towards decarbonization, with states and their leaders playing a crucial role in achieving net zero emissions [5]. The country is trying to achieve a combination of regulatory measures and financial incentives to expedite the manufacturing, deployment, and adoption of existing technologies that are available today, such as solar, wind, batteries, electric vehicles, and highly efficient appliances and equipment, as well as an expanded transmission network to support more renewable energy and electrification [6]. The USA is also exploring innovative financing mechanisms to attract investments from both public and private capital. These efforts are aimed at closing investment gaps and ensuring the availability of sufficient funds for the development and implementation of green energy technologies [7].

## **3. Comparative of Development Strategies in China and the USA**

While both countries are committed to expanding their renewable energy sectors, their approaches reflect their unique economic, political, and technological contexts. China's strategy is characterized by a strong emphasis on innovation and a top-down approach, with the government playing a leading role in driving growth and setting ambitious targets. The USA, in contrast, relies more on market mechanisms and financial incentives and emphasizes the role of states and private capital in driving the transition to renewable energy.

### **3.1. Policy Preferences**

China's approach to innovation policy in the renewable energy sector is characterized by a "supply-side policy" [8]. This approach is evident in the smart grid industry, where utilities are investing heavily due to increased electricity demand and aging infrastructure. The Chinese government has been actively promoting innovation through policy tools such as subsidies, tax incentives, and direct government investment.

In contrast, the USA leans towards an "environmental-side policy" [8]. This approach prioritizes environmental considerations and encourages innovation through regulations that promote clean energy and reduce greenhouse gas emissions. The USA's policy tools include renewable portfolio standards, tax credits, and research and development funding.

### **3.2. International Competitiveness**

The USA has strong overall international competitiveness in renewable energy products. This competitiveness is driven by its advanced technology, abundant resources, and good infrastructure. The USA has a particular strength in wind and solar energy products.

China shows rapid growth in the renewable energy sector, with a focus on wind and solar energies [9]. Despite starting from a lower base, China's renewable energy product competitiveness has grown rapidly in the past decade due to its large economic volume, increasing technological innovation, abundant resource endowment, and improving infrastructure.

### **3.3. Impact of Trading and Mergers and Acquisitions (M&A)**

Mergers and acquisitions (M&A) have emerged as a significant driver of innovation in the renewable energy sector. In particular, US firms have been able to leverage M&A activity to enhance their

technological innovation, outpacing their Chinese counterparts significantly. This can be attributed to the fact that M&A activities provide firms with access to new technologies, markets, and resources, thereby fostering innovation.

In the study by Lu et al., cross-border M&As have been found to have a greater impact on innovation than domestic ones [10]. This could be due to the broader range of resources and capabilities that are accessed through cross-border M&As, which can stimulate more diverse and novel ideas.

Another key finding is that firms' prior research accumulation positively affects post-merger innovation. This suggests that firms with a strong foundation in research and development (R&D) are better positioned to integrate and leverage the new resources and capabilities acquired through M&As.

Environmental policy stringency also plays a significant role in post-M&A innovation among Chinese and European companies. This highlights the importance of regulatory frameworks in shaping firms' innovation strategies and outcomes.

Given these findings, policymakers should focus on facilitating cross-border M&As through increased public R&D efforts, improving intellectual property protection systems, and enhancing national innovation levels post-M&A transactions. These measures can help create a conducive environment for M&A-driven innovation in the renewable energy sector.

### **3.4. Lead Markets**

Lead markets play a crucial role in driving competitiveness in the renewable energy sector. These markets, characterized by early adoption and diffusion of innovations, can stimulate first-mover advantages, providing firms with a competitive edge.

Domestic demand is a key factor that fosters the development of national renewable energy industries. By developing competence building, firms can develop and refine their technologies, products, and services, thereby enhancing their competitiveness.

China has dominated the wind power market due to factors such as economies of scale despite using lower-quality turbines. This underscores the importance of market size and cost efficiencies in shaping competitiveness in the renewable energy sector.

Policy support for environmental innovation can significantly impact competitive advantage within lead markets for renewable energy technologies like wind power. Such support can take various forms, including financial incentives, regulatory standards, and public procurement policies, among others.

Understanding the different factors contributing to renewable energy innovation is vital for designing effective policy mixes. By aligning policies with the specific needs and characteristics of the renewable energy sector, policymakers can enhance competitiveness globally. This, in turn, can accelerate the transition towards a more sustainable energy future.

While their policy approaches differ, both countries recognize the importance of renewable energy in addressing climate change and ensuring energy security. As they continue to invest in renewable energy technologies and improve their competitiveness in renewable energy products, both countries will play crucial roles in the global transition to a sustainable energy future.

## **4. Suggestions**

### **4.1. China**

For China, the success of the "supply-side policy" underscores the importance of continuing strong government support for the renewable energy sector. This entails maintaining or even increasing subsidies, tax incentives, and direct government investment. These measures have played a pivotal role in driving the rapid growth of renewable energy in the country.

While China has made significant strides in renewable energy deployment, there is a pressing need to focus on enhancing the quality of renewable energy products to ensure their long-term sustainability and competitiveness. This involves investing in research and development to improve technology and manufacturing processes, as well as implementing stricter quality control measures.

Additionally, cross-border mergers and acquisitions (M&As) have emerged as a crucial driver of innovation in the renewable energy sector. Therefore, policies should be formulated to facilitate such M&As, including easing regulatory restrictions and providing financial incentives for cross-border collaborations. By encouraging international partnerships and knowledge exchange, China can further accelerate innovation and technology transfer in the renewable energy industry.

Moreover, fostering a conducive business environment for renewable energy companies is essential. This includes streamlining administrative procedures, reducing bureaucratic hurdles, and providing support for startups and small to medium-sized enterprises (SMEs) in the renewable energy sector. Creating a favorable ecosystem for innovation and entrepreneurship will attract more investments and talent to the industry, driving its continued growth and development.

Furthermore, promoting sustainable practices and environmental responsibility is critical for the long-term viability of the renewable energy sector. China should prioritize initiatives aimed at improving energy efficiency, reducing carbon emissions, and mitigating environmental impacts associated with renewable energy production and usage.

In conclusion, while China has made significant progress in the renewable energy sector, continued government support, efforts to enhance product quality, facilitation of cross-border collaborations, and promotion of sustainable practices are crucial for ensuring the sector's sustained growth and competitiveness in the global market. By addressing these key areas, China can further solidify its position as a leader in renewable energy innovation and deployment.

#### **4.2. USA**

The United States has effectively implemented an “environmental-side policy” that has spurred innovation in the renewable energy sector. To further advance progress in this area, the USA should continue to strengthen these policies, including regulations aimed at promoting clean energy and reducing greenhouse gas emissions. By maintaining a supportive regulatory environment, the USA can foster continued innovation and growth in the renewable energy industry.

In addition to regulatory measures, policies should also focus on stimulating domestic demand for renewable energy products. Domestic demand plays a crucial role in fostering the development of national renewable energy industries. Therefore, public education campaigns should be launched to raise awareness about the benefits of renewable energy and encourage consumers to adopt clean energy solutions. Financial incentives, such as tax credits or rebates, can further incentivize consumers to switch to renewable energy sources, driving demand and market growth.

Furthermore, US firms have demonstrated success in leveraging mergers and acquisitions (M&A) to enhance technological innovation in the renewable energy sector. To continue this trend, the USA should actively support M&A activities within the industry. This includes improving intellectual property protection systems to safeguard innovations and incentivize investment in research and development. Additionally, efforts should be made to enhance national innovation levels post-M&A transactions through collaboration between industry players, research institutions, and government agencies.

Moreover, fostering a conducive environment for innovation and entrepreneurship is essential for maintaining the USA's leadership in renewable energy technology. This involves providing support for startups and small to medium-sized enterprises (SMEs) in the renewable energy sector, facilitating access to funding and resources, and promoting collaboration between industry stakeholders. By nurturing a vibrant ecosystem for innovation, the USA can continue to drive advancements in renewable energy technology and maintain its competitive edge in the global market.

In conclusion, by strengthening environmental-side policies, stimulating domestic demand, supporting M&A activities, and fostering innovation, the USA can further accelerate the transition to renewable energy and solidify its position as a leader in the sector. These actions will not only drive economic growth and job creation but also contribute to the global effort to combat climate change and achieve a sustainable energy future.

### **4.3. Collaboration between the Two Countries**

Given the urgent global imperative of addressing climate change, collaborative efforts between countries are essential, particularly in the renewable energy sector. China and the USA, as leaders in the global energy transition, should actively seek opportunities for cooperation to accelerate progress towards sustainable energy solutions. Joint research projects, technology sharing agreements, and coordinated policy initiatives are key avenues for collaboration. By pooling resources and expertise, both countries can leverage their strengths to overcome shared challenges and drive innovation in renewable energy technologies.

Investment in research and development (R&D) remains crucial for advancing renewable energy solutions. Both China and the USA should continue to allocate significant resources to R&D efforts, including public funding for research institutions, tax incentives for corporate R&D, and initiatives to attract and retain top talent in the field. By fostering a supportive environment for innovation, both countries can spur technological advancements and maintain their positions as leaders in the renewable energy sector.

Policy support is also essential for creating conducive conditions for renewable energy growth. Both China and the USA should maintain robust policy frameworks that incentivize investment in renewable energy technologies. This could include financial incentives, regulatory standards, and public procurement policies that prioritize renewable energy sources. By providing clear signals to markets and industry stakeholders, governments can stimulate demand for renewable energy solutions and drive market growth.

Furthermore, efforts should be made to address specific challenges faced by each country in its renewable energy sectors. For example, China may focus on improving grid infrastructure and energy storage capabilities, while the USA may prioritize streamlining permitting processes and enhancing supply chain resilience. By sharing best practices and lessons learned, both countries can benefit from each other's experiences and accelerate progress toward a sustainable energy future.

In conclusion, through collaborative research efforts, continued investment in R&D, and supportive policy frameworks, China and the USA can enhance their competitiveness in the renewable energy sector while contributing to global efforts to combat climate change. By working together towards common goals, both countries can play a leading role in driving the transition to a more sustainable and resilient energy system.

## **5. Conclusion**

China is placing a lot of attention on innovative disruptive technologies and establishing high goals for renewable energy capacity in order to foster innovation in green energy technologies. Through novel financing structures, financial incentives, and regulatory measures, the United States of America is rapidly accelerating the adoption and deployment of current renewable energy technology in order to achieve decarbonization. While the renewable energy industries in both China and the USA are growing, China places greater emphasis on government-led efforts and innovation, while the USA depends more on market mechanisms, governmental functions, and private money to drive the transition to renewable energy. The distinct political, technological, and economic environments of every country are reflected in these variations.

This study can conclude from the comparative study that policy support significantly influences competitive advantage within lead markets for renewable energy technologies. Meanwhile,

collaboration between countries or economies is crucial for driving innovation. Both nations should invest heavily in research and development.

The limitation of this study lies in its reliance solely on secondary data and literature analysis, lacking primary data. However, future research endeavors will aim to address this gap by incorporating primary data collection methods to enrich the depth and breadth of the research. Relying solely on secondary sources may restrict the study's ability to capture the full complexity of the phenomenon. Integrating primary data collection methods, such as surveys or interviews, will provide direct insights from stakeholders, enhancing the validity and reliability of the findings. By including primary data, researchers can explore new research questions and identify emerging trends not apparent through secondary data analysis alone. This comprehensive approach fosters a more nuanced understanding and robust analysis, contributing to the advancement of knowledge in the field.

## References

- [1] Gaafar Muhammed, Neyre Tekbiyik-Ersoy. Development of Renewable Energy in China, USA, and Brazil: A Comparative Study on Renewable Energy Policies. *Sustainability*, 2020, 12 (21), 9136.
- [2] Martinot Eric. Renewable power for China: Past, present, and future. *Frontiers of Energy and Power Engineering in China*, 2020, 4, 287-294.
- [3] Yang Xijn, Hu Jun, Tan Tianwei, and Li Jinying. China's renewable energy goals by 2050. *Environmental Development*, 2016, 20, 83-90.
- [4] The State Council Information Office, The People's Republic of China. Full text: energy in china's new era. White Paper, 2020.
- [5] You, Chengde, Shoukat Iqbal Khattak, and Manzoor Ahmad. Impact of innovation in renewable energy generation, transmission, or distribution-related technologies on carbon dioxide emission in the USA. *Environmental Science and Pollution Research*, 2022, 1-22.
- [6] White House Office of Science and Technology Policy, United States Department of Energy, United States Department of State. National innovation pathway of the united states. White House, April 2023.
- [7] Subtil Lacerda, Juliana, and Jeroen CJM Van den Bergh. International diffusion of renewable energy innovations: Lessons from the lead markets for wind power in China, Germany and USA. *Energies*, 2014, 7 (12), 8236-8263.
- [8] Lin Chenchun, Chia-Han Yang, and Joseph Z. Shyua. A comparison of innovation policy in the smart grid industry across the pacific: China and the USA. *Energy Policy*, 2013, 57, 119-132.
- [9] Jing Shuai, Yujia Zhao, Yilan Wang, Jinhua Cheng. Renewable energy product competitiveness: Evidence from the United States, China and India. *Energy*, 2022, 249, 123614.
- [10] Lu Qiao, Weijia Dong, Xin Lv. The heterogeneous impacts of M&As on renewable energy firms' innovation: Comparative analysis of China, the US and EU. *International Review of Economics and Finance*, 2023, 87, 306–323.