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PROPOSAL FOR PUBLIC POLICIES TO PROMOTE AND ENCOURAGE THE GROWTH OF WIND ENERGY GENERATION IN THE UNITED STATES.

PROPUESTA DE POLÍTICAS PÚBLICAS PARA LA PROMOCIÓN E INCENTIVO DEL CRECIMIENTO DE LA GENERACIÓN DE ENERGÍA EÓLICA EN ESTADOS UNIDOS.

PROPOSTA DE POLÍTICA PÚBLICA PARA PROMOVER E INCENTIVAR O CRESCIMENTO DA PRODUÇÃO DE ENERGIA EÓLICA NOS ESTADOS UNIDOS.

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Abstract

This paper proposes novel public policies aimed at incentivizing wind energy generation in the United States. In response to the imperative of transitioning to sustainable energy sources, the study explores innovative approaches to promote and accelerate the adoption of wind power. Furthermore, the research employs the LEAP (Long-range Energy Alternatives Planning) software for energy planning to simulate the forecasted impact of these proposed policies on the wind energy supply in the USA. By integrating policy recommendations with simulation results, this study provides a comprehensive analysis to guide policymakers and stakeholders in fostering the growth of wind energy as a pivotal component in the country's renewable energy landscape.

Keywords: Wind energy, public policies in US, Renewable energy, Sustainable energy, Energy transition

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Resumen

Este documento propone políticas públicas novedosas destinadas a incentivar la generación de energía eólica en Estados Unidos. En respuesta al imperativo de transición hacia fuentes de energía sostenibles, el estudio explora enfoques innovadores para promover y acelerar la adopción de la energía eólica. Además, la investigación emplea el programa informático de planificación energética LEAP (*Long-range Energy Alternatives Planning*) para simular el impacto previsto de estas políticas propuestas sobre el suministro de energía eólica en Estados Unidos. Al integrar las recomendaciones políticas con los resultados de la simulación, este estudio ofrece un análisis exhaustivo para orientar a los responsables políticos y a las partes interesadas en el fomento del crecimiento de la energía eólica como componente fundamental en el panorama de las energías renovables del país.

Palabras Clave: Energía eólica, políticas públicas En EE. UU., Energías renovables, Energía sostenible, Transición energética.

Resumo

O presente documento propõe novas políticas públicas destinadas a incentivar a produção de energia eólica nos Estados Unidos. Em resposta ao imperativo da transição para fontes de energia sustentáveis, o estudo explora abordagens inovadoras para promover e acelerar a adoção da energia eólica. Além disso, a investigação utiliza o software LEAP (*Long-range Energy Alternatives Planning*) para o planeamento energético, a fim de simular o impacto previsto destas políticas propostas no fornecimento de energia eólica nos EUA. Ao integrar as recomendações políticas com os resultados da simulação, este estudo fornece uma análise abrangente para orientar os decisores políticos e as partes interessadas na promoção do crescimento da energia eólica como uma componente essencial no panorama das energias renováveis do país.

Palavras-chave: Energia eólica, Políticas públicas nos EUA, Energias renováveis, Energia sustentável, Transição energética

1. Introduction

Wind power generation has become a pivotal constituent within the global energy paradigm, assuming a pivotal role in the transition towards renewable resources (Silva, W. K., et al., 2023) (Negrão, Ana Beatriz Gomes Rodrigues, et al., 2023) (De Souza Alves, Ana Carolina, et al., 2023). Against this backdrop, the United States has established itself as a pivotal actor, instituting public policies designed to incentivize and expedite the proliferation of wind power generation. This research undertakes an in-depth analysis of the ramifications of public policies implemented in the United States to catalyze wind power generation.

The contemporary energy milieu is intricately entwined with the imperative to address environmental and climate imperatives. In this context, wind energy emerges as an auspicious remedy, underscored by its capacity to sustainably generate electricity, mitigate greenhouse gas emissions, and enhance the diversification of the energy matrix (Qin, Meng, et al., 2022) (Joshi, Janak., 2021) (Li, Li, et al., 2022). The purview of this study will encompass a substantial temporal expanse, scrutinizing public policies spanning from the nascent stages to the most recent iterations, with the objective of delineating the trajectory of their impact on wind generation in the United States.

The detailed analysis of these policies includes not only the policy and regulatory aspects, but also the interaction of key actors, such as companies in the sector, local communities and government agencies (White House, 2023) (United Nations Climate Change, 2023) (United Nations, 2013) (Executive order, white hose, 2023) (Energy, 2023) (Garratt, Anthony, Ivan Petrella, and Yunyi Zhang., 2023) (Worlbank, 2023) (World Economic Forum: present and future, 2023) (World Economic Forum, 2023). Through the evaluation of fiscal incentives, subsidies, renewable energy targets and other policy tools, this study will seek to discern patterns, identify lessons learned and propose recommendations for future policy design in this area (Limmeechokchai, Bundit, and Degeorge Dul., 2023).

A thorough understanding of the impact of public policy on wind energy generation in the United States will not only contribute to academic knowledge, but will also provide valuable insights for policymakers, energy sector companies, and any entity interested in transitioning to a sustainable and resilient energy future.

2. Methodology

This research will begin with a comprehensive assessment of electric power generation from renewable sources in the United States, using U.S. state government sources (White House, 2023) (United Nations Climate Change, 2023) (United Nations, 2013) (Executive order, white hose, 2023) (Energy, 2023) (Garratt, Anthony, Ivan Petrella, and Yunyi Zhang.,

2023) (Worlbank, 2023) (World Economic Forum: present and future, 2023) (World Economic Forum, 2023). A special focus will be placed on wind power, considering its current contribution to the nation's energy mix and exploring state data to understand regional variations in the adoption of renewable technologies.

Similarly, a comprehensive collection of statistical data related to renewable energy generation in each U.S. state was conducted (Limmeechokchai, Bundit, and Degeorge Dul., 2023) (BP, 2023) (KPMG, 2023) (International Energy Agency, 2023) (Li, Li, et al., 2022) (Energy, 2023). This included information on installed wind farm capacity, annual wind energy production, and the proportional share of wind energy in state electricity consumption. Analysis of these data will identify specific patterns and challenges in each region.

Subsequently, based on the analysis of current policies and lessons learned from past experiences, specific recommendations will be formulated for new public policies to boost the expansion of wind power generation. These recommendations will address identified challenges and seek to optimize the integration of wind energy into the energy matrix.

A detailed model will then be developed in LEAP software that will reflect the current U.S. energy infrastructure (Handayani, Kamia, et al., 2022) (Cai, Liya, et al., 2022) (He, Bin, et al. 2023) (Cai, Liya, et al., 2023). The model will incorporate state-specific data, considering variability in wind resource availability and transmission infrastructure. In addition, proposed policies will be integrated to simulate their impact on wind power generation through 2038. Figure 1 shows the diagram of the methodology used in this study.

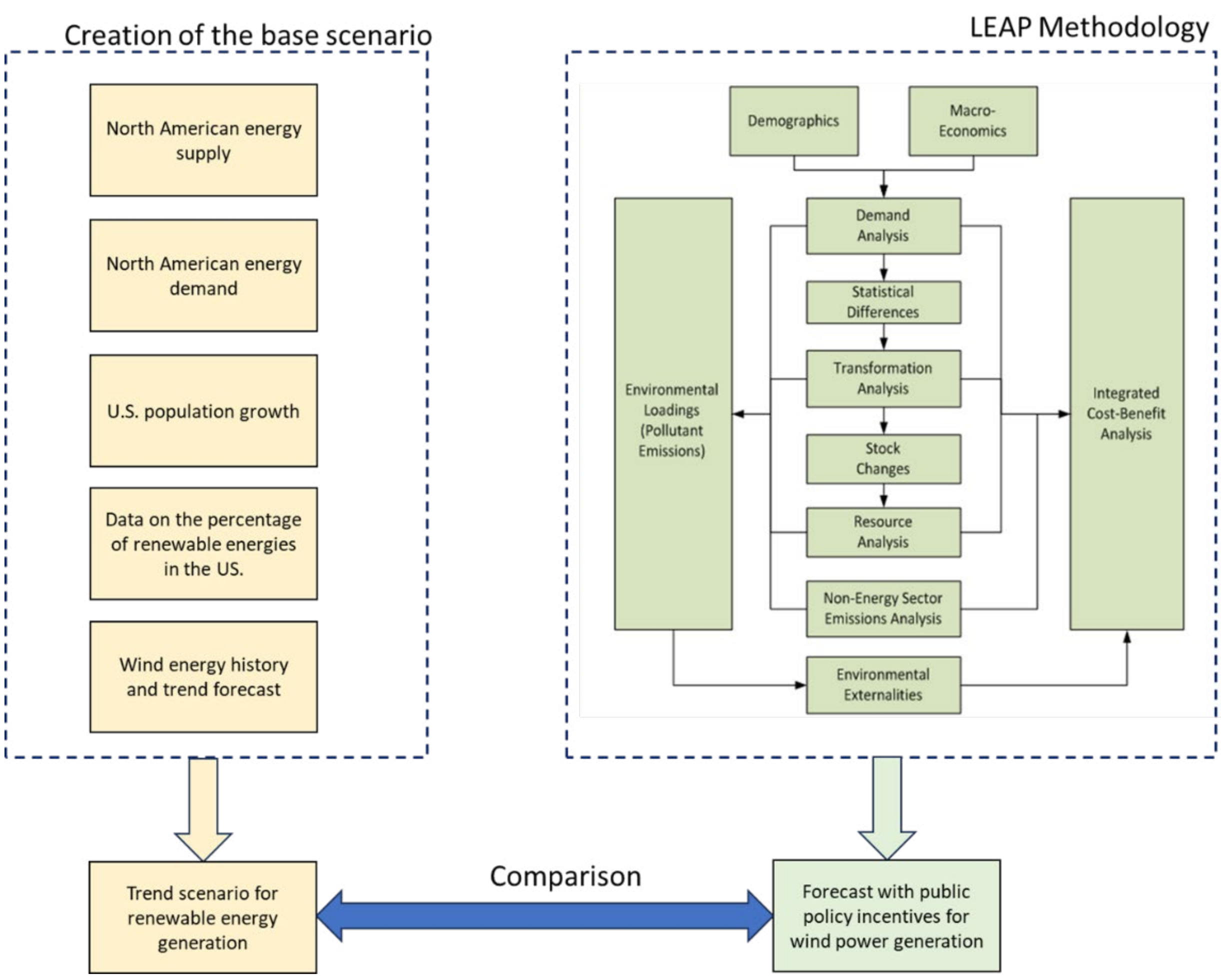

Figure 1. Methodology used for the creation of the forecast and comparison with the baseline.
Source: Adapted by (Leap, 2023).

A validation of the model will be performed by comparing its results with actual wind power generation data from previous years. Any discrepancies will be addressed through adjustments to the model parameters to ensure its accuracy and relevance in predicting future power generation scenarios.

Finally, the simulation results will be analyzed in detail, assessing the impact of proposed policies on wind power generation at the national and state level. Future scenarios will be explored, identifying potential challenges and opportunities, and providing a comprehensive view of the contribution of wind energy through 2035.

3. Results and Discussions

3.1. A Current Analysis of U.S. Wind Energy Status and Legislation

According to the U.S. Energy Information Administration (EIA), in 2020, installed wind generation capacity in the country reached 122 gigawatts (GW), representing approximately 9% of total electric generation capacity (Energy Information Administration, 2023). This increase in wind capacity is attributed to the continued installation of both onshore and offshore wind farms. Wind energy in the United States has been concentrated primarily in regions with significant wind resources, such as the Midwest and Central Plains. Texas has been a leader in wind power generation, standing out as the state with the largest installed capacity (Energy Information Administration, 2023) (Singh, Upma, et al., 2022) (Elmallah, Salma, and Joseph Rand, 2023).

Similarly, the following incentives currently exist for wind energy generation, first and foremost, the Tax Credits (PTC and ITC): The Production Tax Credit (PTC) and Investment Tax Credit (ITC) have been crucial extensions to encourage investment in wind projects. These credits provide tax benefits to wind project developers and owners, which has been a significant driver of growth in the sector (Celsa, Matthew, and George Xydis., 2023) (Parker, Matthew E., 2023) (Min, Yohan, et al., 2023) (Aldeman, Matthew R., Jonghwan Kwon, and W. Neal Mann., 2023).

Also, State and Local Support, where many states have implemented their own incentive policies, which may include additional tax credits, renewable energy purchase programs, and grants for specific projects. These incentives vary by location and may complement federal programs (Urpelainen, Johannes, and Alice Tianbo Zhang., 2022) (Stanitsas, Marios, and Konstantinos Kirytopoulos., 2023).

In turn, Power Purchase Programs (PPAs), which seek long-term Power Purchase Agreements (PPAs) between wind project developers and power purchasers, such as corporations and utilities, have been instrumental in ensuring the financial viability of projects (Stanitsas, Marios, and Konstantinos Kirytopoulos., 2023) (Mesa-Jiménez, J. J., et al., 2023).

Finally, there are Government Funding Programs and Renewable Portfolio Standards (RPS), where the federal government and some states offer funding programs that support research and development of wind technologies, as well as the implementation of large-scale projects (Feldman, Rachel, and Arik Levinson., 2023). In addition, Many states have established renewable portfolio standards (RPS), which require a specified percentage of energy generated to come from renewable sources, including wind energy. Meeting these standards can trigger financial and regulatory benefits for developers (Barbose, Galen L., 2023).

3.2. Public Policy Proposals to Encourage the Use of Wind Energy in the United States.

Each of the public policies to promote the supply of wind energy in the United States is described below. It is worth noting that each of these policies is an input for the simulation in the LEAP *software*.

3.2.1. International Collaboration and Energy Diplomacy Relations

The United States should promote international collaboration in the development of wind technologies and the expansion of renewable energy. Sharing knowledge and best practices can accelerate progress and strengthen global partnerships in clean energy. Additionally, actively seeking trade partnerships and preferences can enhance the development of such technology.

Global cooperation in research, technology, and energy policy facilitates the exchange of knowledge and best practices. By actively participating in international agreements, the United States not only benefits from the accumulated experience in wind energy worldwide but also contributes to technological advancement and the strengthening of global regulations.

3.2.2. Promotion of Storage Technologies

Incentivize the research and adoption of energy storage technologies that complement the intermittency of wind energy. These incentives could accelerate the implementation of large-scale storage solutions. It is important to note that energy storage is one of the most challenging issues in the energy industry. Addressing this problem would boost renewable energy, especially wind energy, in the United States.

3.2.3. Financial Incentives for Local Communities

Create specific financial incentives for local communities to participate in wind energy projects. This may include tax benefits, equity participation programs, and community development funds. At the same time, it generates employment in the region and provides qualifications in the area to more and more people, promoting qualified personnel for wind energy.

Incentives promote acceptance and active participation in the development of these facilities. Programs that share the financial benefits generated by wind energy, such as taxes and royalties, contribute to strengthening the relationship between the renewable energy sector and local communities.

3.2.4. Public Sector Power Purchase Programs (PPAs)

Promote long-term power purchase programs (PPAs) for the public sector at the federal, state, and local levels. Government commitments to purchase wind energy can provide financial stability to projects and demonstrate leadership in the transition to renewable sources.

These programs signify a strategic commitment by government entities to purchase electricity generated from wind sources. By establishing long-term agreements for energy purchase, financial stability is provided to wind projects, encouraging investment and the development of new installations.

3.2.5. Education and Job Training

Implement education and job training programs to enhance the specialized wind energy workforce. This will ensure the availability of qualified professionals and strengthen the industry nationwide. It’s important to note that the goal is to train nearly 900,000 new workers by 2035. Therefore, these programs should gradually increase enrollment and impact in regions conducive to wind energy generation.

As the wind industry experiences significant growth, it is crucial to cultivate a skilled and specialized workforce. Educational programs and training opportunities enable engineers, technicians, and industry professionals to acquire the specific skills needed to efficiently design, construct, and maintain wind facilities. Moreover, education fosters research and development in advanced wind technologies. By investing in technical skills development, the United States not only promotes skilled jobs but also ensures a successful transition to a more sustainable and advanced energy infrastructure.

3.2.6. Incentives for Offshore Wind Energy

Establish specific policies and incentives for offshore wind farm development. These incentives could include grants, tax credits, and permitting facilitation to encourage the expansion of wind energy in coastal areas.

Correspondingly, the United States is in a unique position to capitalize on the significant potential for offshore wind generation. The vast expanses of territorial waters along the Atlantic and Pacific coasts offer an environment conducive to offshore wind farms. This potential is supported by technological advances that have improved the efficiency and economic viability of wind energy in offshore environments. Offshore wind energy not only diversifies the country’s energy matrix, but also promotes employment and contributes to emission reduction targets. With continued commitment and a progressive approach, the United States can lead the expansion of offshore wind energy, establishing itself as a pioneer in the transition to more sustainable and resilient energy sources.

3.2.7. Transmission Infrastructure Development

Prioritize planning and developing transmission infrastructure to efficiently connect wind-rich regions with demand centers. This facilitates the seamless integration of wind energy into the national grid, reducing energy losses.

This integration allows for the efficient distribution of wind-generated energy throughout the country. Connecting regions with favorable winds to consumption centers optimizes the use of wind energy, enhancing the stability and reliability of the electricity supply. Moreover, this interconnection eases compensation for variations in generation, ensuring a continuous flow of clean and sustainable energy.

3.2.8. Research and Development (R&D) Promotion

Increase investment in research and development programs for wind energy. Encourage collaboration among government agencies, academic institutions, and industry to advance technologies, increase efficiency, and reduce costs.

Investment in research drives innovation, enabling the design of more efficient and cost-effective wind energy technologies. This support not only accelerates the adoption of advanced solutions but also strengthens the global competitiveness of the U.S. wind industry. Additionally, increased investment in research and development opens the door to improvements in managing wind power variability, enhancing its effective integration into the national power grid.

3.2.9. Extend and enhance tax credits while creating Federal Renewable Portfolio Standards (RPS).

Propose the ongoing extension and enhancement of existing tax credits, such as the Production Tax Credit (PTC) and the Investment Tax Credit (ITC), to provide certainty and stimulus to wind project developers. Regular reviews of these incentives will enable adjustments based on the evolving needs of the sector and advancements in technology.

Additionally, establish a Federal-level Renewable Portfolio Standard (RPS) that sets ambitious targets for wind and other renewable energy generation. These mandatory standards could establish a consistent, national framework for sustainable energy growth.

3.3. Impact of public policies on the supply of wind power generation: LEAP simulation.

The Figure 2 provides a clear overview of the exponential growth of renewable energy in the United States, with a specific focus on the sustained rise of wind power.

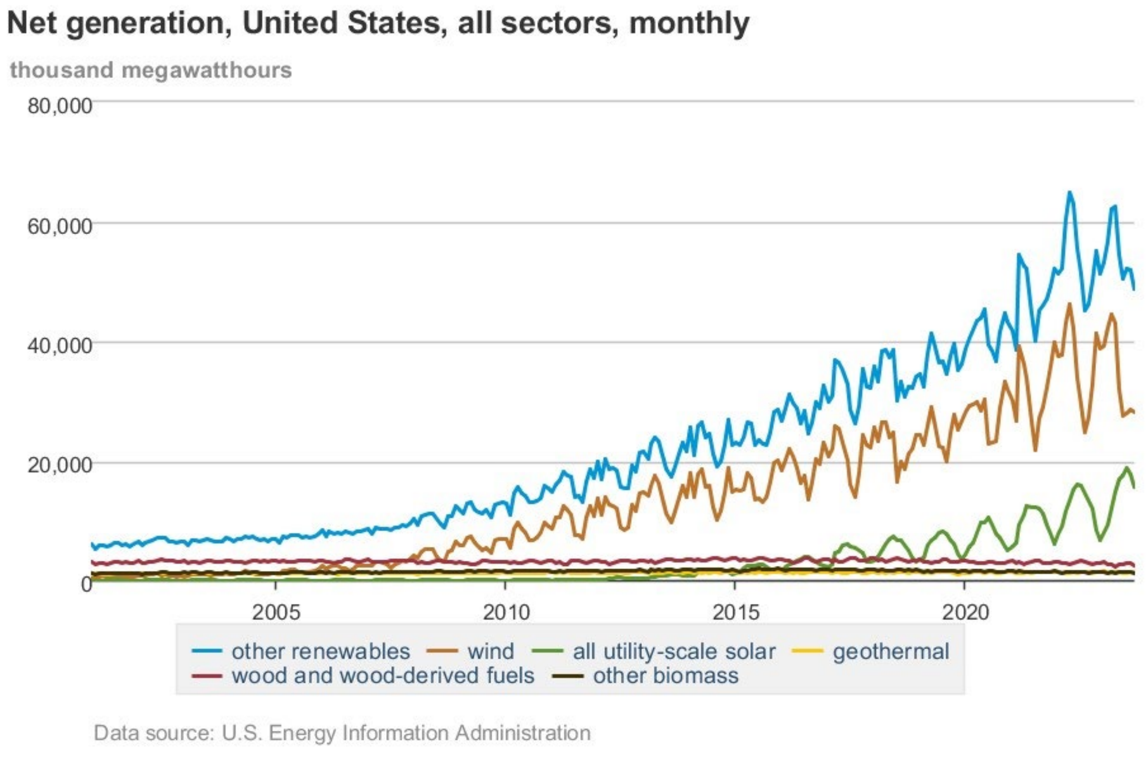

Figure 2. Growth of renewable energy generation in the U.S. Source: Generated by EIA.

Figure 3 presents a graphical visualization highlighting the exponential growth of wind power generation in the United States during the turn of the century. The horizontal axis represents time, with annual subdivisions, while the vertical axis shows power generation in thousands of megawatt-hours (MWh).

The growth curve exhibits a sharp increase between the years 2017 and 2019, reflecting a rise of just over 100,000 megawatt-hours in wind generation during that period. This substantial growth suggests strong momentum in the adoption of wind power as a significant part of the country's energy mix.

Additionally, the figure highlights two key states in this phenomenon: Iowa and Texas. Consistent and notable growth in wind power generation is observed in both states, underscoring their prominent role in contributing to the overall increase in U.S. wind capacity. This consistent pattern reaffirms the commitment and success of these states in promoting and developing wind energy as a major source of electricity.

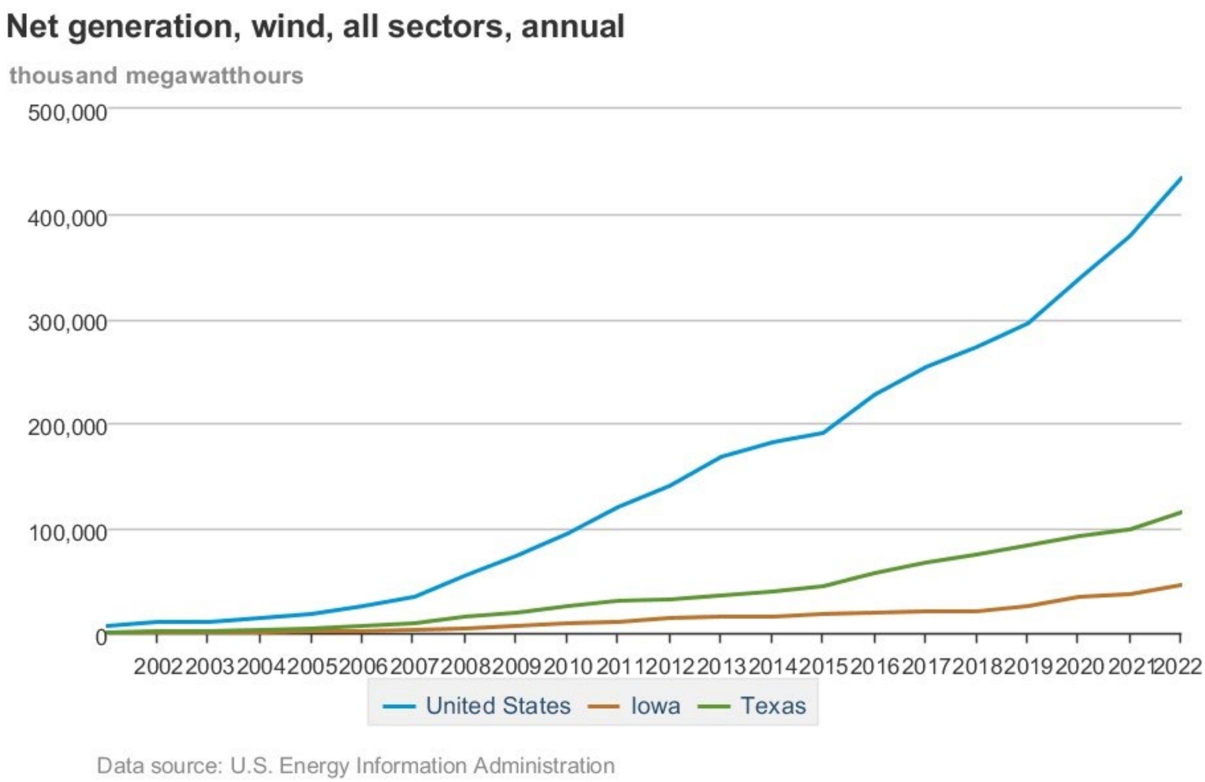

Figure 3. Net generation in Wind Sector, US, Iowa and Texas. Source: Generated using EIA.org tool.

Subsequently, the simulation was performed in LEAP software, which incorporates data on generation capacity, energy demand, government policies, and other relevant factors. With this information, LEAP facilitates the simulation of different scenarios and evaluates the impact of specific energy policies on system expansion and operation.

The Figure 4 presents two distinct lines visualizing wind power generation in the United States. The baseline represents the current trend of wind power generation growth, reflecting installed capacity and production in megawatt-hours (MWh) over time through 2035. The second line, derived from the forecast, projects wind power generation to 2035, considering the implementation of specific public policies proposed in the article.

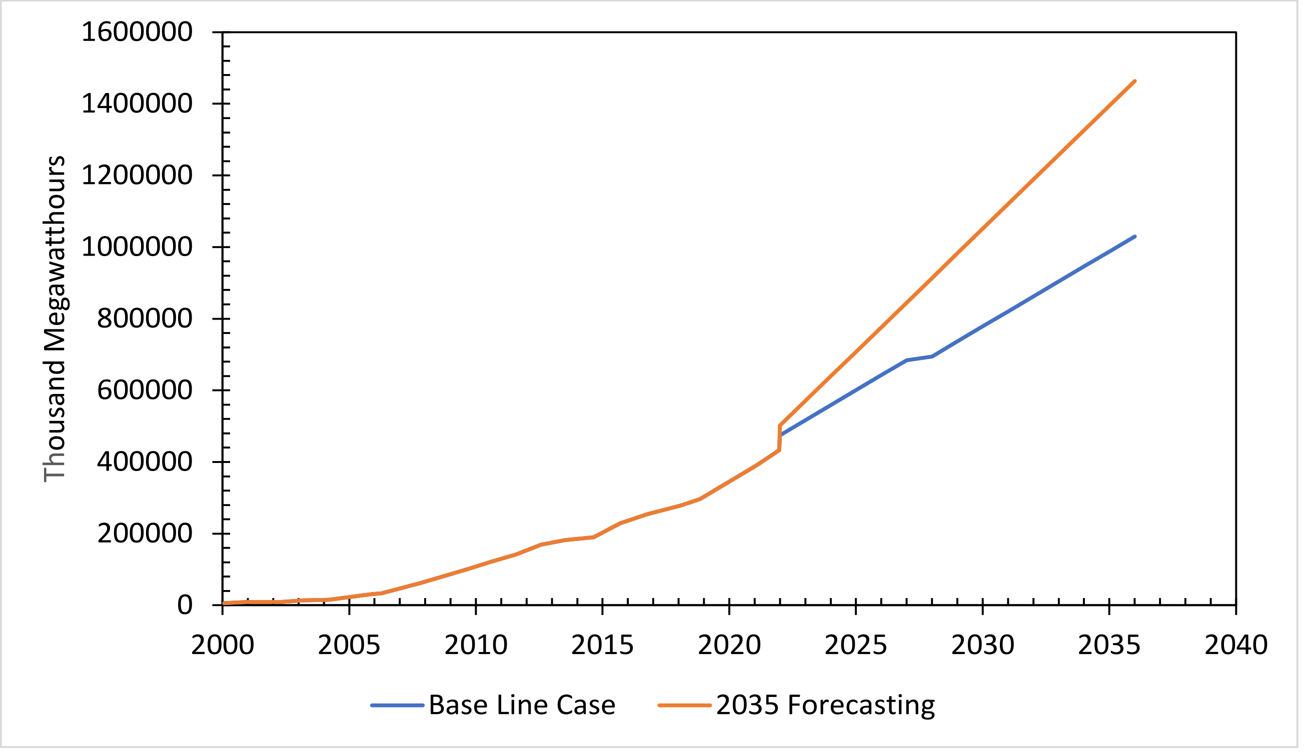

Figure 4. Forecast of electric power generation by 2035 with the use of public policies that encourage the generation of electric power. Source: The author

The implementation of strategic public policies, such as Transmission Infrastructure Development, Education and Job Training, International Collaboration and Diplomatic Relations in Energy, and the Promotion of Storage Technologies, proves essential for the sustained growth of wind power generation.

The first policy, Transmission Infrastructure Development, is reflected in a significant increase in transmission capacity, allowing a more efficient connection between regions rich in wind resources and demand centers. This translates into a significant improvement in the capacity to take full advantage of the country's wind potential.

Education and Job Training contributes to a steeper growth curve by ensuring the availability of a highly skilled and specialized wind energy workforce. Investment in the training of professionals paves the way for a more rapid and effective expansion of wind infrastructure. In turn, International Collaboration and Diplomatic Relations in Energy adds another significant boost to projected growth. Global cooperation and knowledge sharing accelerate the development of advanced wind technologies, allowing the United States to benefit from international advances in the field.

Similarly, the promotion of storage technologies plays a crucial role in managing the variability of wind generation. Successful implementation of storage technologies contributes to greater stability in power generation, consolidating wind energy as a reliable and consistent source.

Taken together, these public policies prove to be key elements in catalyzing a significant increase in wind power generation in the United States, supporting the projected forecast to 2035.

Figure 5 shows the states that contribute the most wind energy to the country. With the public policies proposed in this document, there will be a sustained growth of generation in the states that generate 5 - 10 Terawatt hours. At the same time, there will be a sustained growth over time in the North American coasts that can capitalize on the mass of the air for the generation of electric power.

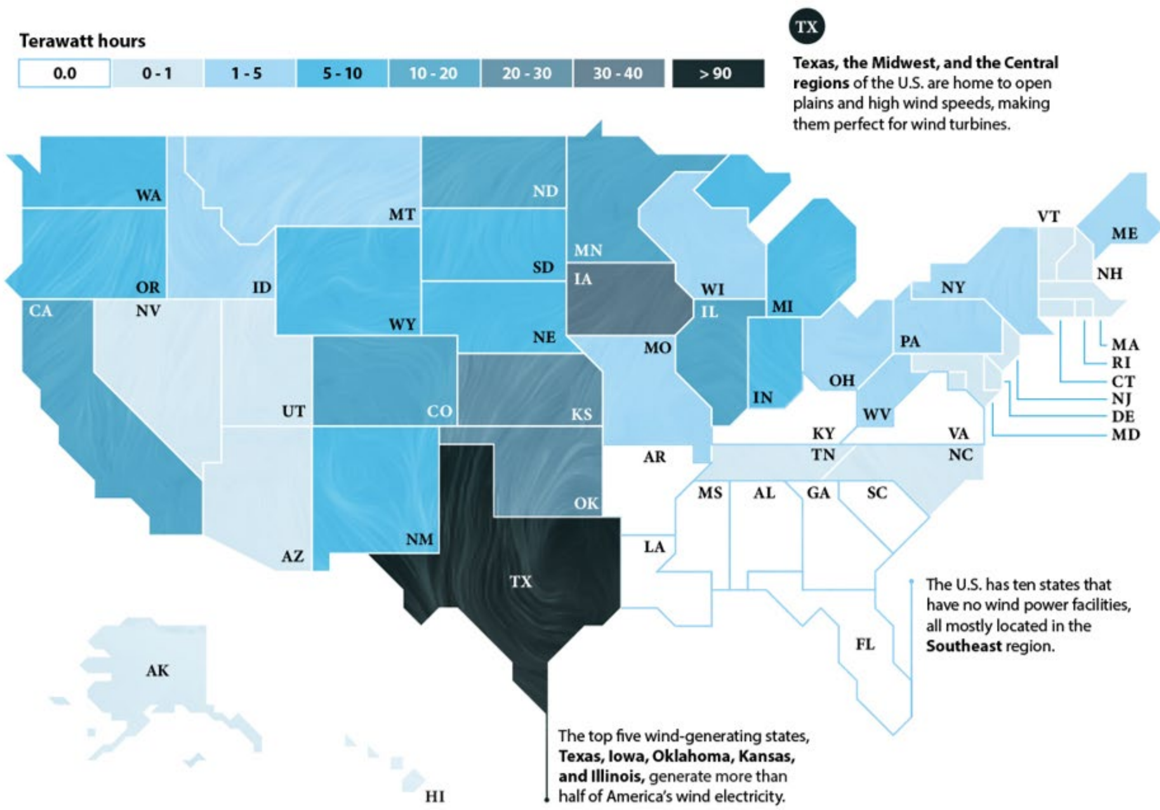

Figure 5. States contributing to wind energy generation. Source: (visualcapitalist, 2023)

4. Conclusions

The LEAP software proves to be a valuable tool for energy planning, incorporating importat data on generation capacity, energy demand, and government policies. The simulation, particularly Figure 4, effectively visualizes the current trend and the projected growth of wind power generation in the United States up to 2035.

The forecasted electric power generation up to 2035, considering the implementation of specific public policies, demonstrates a clear and positive impact on the growth of wind power. The proposed policies play a pivotal role in influencing the trajectory of wind energy expansion in the country.

Strategic public policies, including Transmission Infrastructure Development, Education and Job Training, International Collaboration, Diplomatic Relations in Energy, and Promotion of Storage Technologies, are identified as essential drivers for sustained growth in wind power generation.

The promotion of storage technologies is identified as a key element in managing the variability of wind generation. Successful implementation of these technologies enhances stability in power generation, establishing wind energy as a reliable and consistent source.

The proposed suite of public policies emerges as a comprehensive strategy to incentivize and bolster the generation of electric power, particularly focusing on wind energy, in the United States. Each policy addresses distinct facets Important for sustainable growth, collectively shaping a transformative landscape for the nation's energy sector.

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