THE POTENTIAL FOR WIND ENERGY DEVELOPMENT IN THE REPUBLIC OF MOLDOVA

Ion BEJAN

Department of Foreign Languages, Group ISER- 231, Faculty of Energetics and Electrical Engineering, Technical University of Moldova, Chişinău, Republic of Moldova

Corresponding author: Ion Bejan, ion.bejan@ie.utm.md

Coordinator: **Ala JECHIU**, university assistant, Department of Foreign Languages, TUM

Abstract. *Green energy is clean energy, it is produced from renewable sources. Currently, the Republic of Moldova faces numerous challenges in the energy sector, including dependence on electricity imports. The war in the neighboring country has shown how important energy independence is. In recent years, due to the accelerated development of renewable energy systems, there has been an increased interest in efficient technologies capable of producing large amounts of electricity. Like other European countries, Moldova has chosen the path of developing renewable energy with the potential of 11 unused territories that could produce up to 30% of electricity for the national energy system by 2030. Wind turbines do not occupy large areas and do not have a negative impact on the environment, the electricity generated is harmless to nature. I believe that represents a promising solution for our country would be the Danish-made V236-15.0 MW wind turbine. Wind energy involves generating electricity from the wind. Its future potential is limited only by the financial resources invested in obtaining this energy source. The money invested in wind energy can bring not only energy independence, but also the development of industry and technologies.*

Keywords: *energy independence, green energy, renewable sources, wind turbines*

Introduction

As the issue of electricity production remains a topical one in the Republic of Moldova, the integration of renewable energy sources into the national power system is of paramount importance. The benefits are clear – green and independent energy.

Like other European countries, Moldova has chosen the path of developing renewable energy. Only in 2021 we were able to provide 1% of electricity consumption from wind energy. In 2023 around 3%. The best areas for wind energy development are in the north and central parts of the country, where the wind speeds are highest. The average wind speed in Moldova is 3-5 m/s so it's enough to reach point at which the turbine starts generating electricity from turning. There are currently around 90 wind turbines installed in our country.

The Moldovan government has recognized the limitations of the current energy landscape and the urgency of transitioning towards renewable energy sources. The country's National Energy Strategy for 2030 sets ambitious targets for increasing the share of renewable energy in the national grid to 30% [1].

Moldova possesses a promising wind regime suitable for generating electricity through wind turbines. Wind data analysis and wind resource maps reveal favorable wind speeds across several regions in the country, particularly in the northern and central parts. These wind resources offer significant potential for generating clean electricity that can contribute to Moldova's energy needs.

1. Unveiling Moldova's Wind Resource Potential

The Republic of Moldova possesses a promising wind regime for electricity generation. Studies conducted by the International Renewable Energy Agency (IRENA) and the United States Agency for International Development (USAID) indicate a technical potential exceeding 1 GW for wind energy in the country. This translates to the ability to generate enough electricity to meet a significant portion of Moldova's current needs using wind turbines.

Understanding wind resource variability is crucial for successful wind farm development. Wind data collected over several years using meteorological masts or remote sensing techniques like LiDAR (Light Detection and Ranging) is used to create wind resource maps. These maps depict wind speed variations across the country, highlighting areas with optimal wind conditions for power generation.

Selecting optimal locations for wind farms involves careful consideration of several factors. Firstly, wind speed is a critical parameter. Areas with average annual wind speeds exceeding 4 meters per second (m/s) at a hub height of 80 meters [2], classified as Class 3 and Class 4 according to the International Electrotechnical Commission (IEC) standards, are generally considered suitable for commercially viable wind power generation.

Secondly, factors like land availability, proximity to the electricity grid, and environmental considerations also influence site selection. Large, unobstructed areas with minimal environmental impact and a nearby connection to the grid are preferred locations for wind farms.

Wind speed is a variable resource, fluctuating throughout the day and year. Understanding these variations is essential for predicting energy production and ensuring grid stability. The Weibull distribution, a statistical function, plays a crucial role in analyzing wind resource variability. By fitting the Weibull distribution to wind speed data, it is possible to estimate the probability of different wind speeds occurring at a specific location. This information is used to calculate the expected annual energy production (AEP) of a wind farm, which is a key metric for project feasibility studies.

2. The Advantage of Vestas V236-15MW Turbines

The Vestas V236-15MW wind turbine represents a significant advancement in wind energy technology [3]. With a colossal rotor diameter of 236 meters and a blade length exceeding 115 meters, this behemoth dwarfs traditional wind turbines. This immense size translates to a significant increase in energy capture potential. Each Vestas V236-15MW turbine boasts the capability of generating a staggering 15 megawatts (MW) of electricity, enough to power approximately 18,000 homes annually.

The benefits of the Vestas V236-15MW extend beyond sheer capacity. These turbines incorporate cutting-edge technologies that enhance efficiency and performance. One key feature is the swept area, the area covered by the rotating blades. The V236-15MW boasts a swept area exceeding twice the size of its predecessors, allowing it to capture more wind energy even at lower wind speeds.

Furthermore, these turbines feature advanced aerodynamic designs that optimize energy capture across a wider range of wind conditions. Additionally, innovations in materials science have led to the development of lighter and stronger turbine components, contributing to improved efficiency and reduced operational costs.

The integration of Vestas V236-15MW turbines into Moldova's wind energy sector offers several compelling advantages. Firstly, the high capacity of these turbines allows for the generation of significant amounts of electricity from a smaller number of installations compared to traditional models. This translates to a reduction in the land footprint required for wind farms, minimizing potential environmental and social impacts.

Secondly, the improved efficiency and performance of the V236-15MW turbines contribute to a reduction in the levelized cost of energy (LCOE) for wind power. The LCOE represents the average total cost of generating electricity over a given period and is a crucial metric

for evaluating the economic viability of renewable energy projects. With lower LCOE, wind energy becomes more competitive with traditional fossil fuel-based generation.

Finally, the Vestas V236-15MW turbines have the potential to significantly contribute to Moldova's energy security by reducing dependence on imported fossil fuels. By harnessing its own wind resources, Moldova can achieve greater energy independence and mitigate the risks associated with volatile global energy prices.

3. Economic and Environmental Benefits of Wind Energy Development in Moldova

Moldova's current energy landscape is heavily reliant on imported fossil fuels, primarily natural gas. This dependence exposes the country to several vulnerabilities, including price fluctuations in the global energy market and geopolitical instability in gas-producing regions [4]. By developing its wind energy potential, Moldova can diversify its energy mix, reducing dependence on external sources and bolstering energy security.

Wind energy offers a clean and domestic energy resource, mitigating reliance on imported fossil fuels. Harnessing its own wind resources allows Moldova to reduce its exposure to price volatility and potential supply disruptions in the international energy market. This diversification strengthens the country's energy independence and provides greater control over its energy future.

The development of wind energy in Moldova presents a multitude of economic benefits. The construction, installation, and maintenance of wind farms create new job opportunities in various sectors. These jobs span the engineering, construction, logistics, and operations fields, contributing to economic growth and development.

The construction phase of wind farms requires skilled labor in areas like civil engineering, electrical engineering, and project management. Additionally, the installation of wind turbines necessitates expertise in specialized lifting equipment and rigging techniques. These jobs provide valuable income opportunities for skilled professionals within the Moldovan workforce.

Furthermore, the operation and maintenance of wind farms create ongoing employment opportunities. Technicians are needed to monitor turbine performance, conduct regular maintenance, and address any technical issues. These jobs require specialized training but offer long-term career prospects within the renewable energy sector.

Beyond direct job creation, wind energy development can also stimulate the growth of related industries. The establishment of local manufacturing facilities for wind turbine components, such as towers, blades, and nacelles, can further contribute to economic growth. This not only creates additional job opportunities but also fosters technological advancements and expertise within the country.

Wind farm development can revitalize rural areas by injecting valuable income into local communities. Landowners who lease their land for wind turbine installation receive lease payments, providing a steady source of income. These payments can contribute significantly to the economic well-being of rural communities, especially in areas with limited economic opportunities.

Additionally, wind farm developers often establish community benefit programs that support local development initiatives. These programs can include infrastructure upgrades, educational scholarships, or investments in healthcare facilities. By addressing local needs and fostering social development, wind energy projects can build positive relationships with communities.

Wind energy offers a significant environmental advantage over traditional fossil fuel-based power generation. Unlike coal or natural gas power plants, wind turbines do not produce greenhouse gas emissions or air pollutants during operation. This clean energy source contributes to a healthier environment and reduces Moldova's carbon footprint.

The transition to wind energy plays a crucial role in combating climate change. Climate change poses a significant threat to Moldova, with potential impacts on agricultural productivity, water resources, and extreme weather events. By reducing its reliance on fossil fuels and increasing

its share of renewable energy, Moldova can contribute to global efforts in mitigating climate change and building a more sustainable future.

Furthermore, wind energy development can also have positive ecological impacts. By using wind as a resource, wind farms eliminate the need for fossil fuel extraction and transportation, which can have detrimental environmental consequences.

4. Challenges and Considerations for Wind Energy Development in Moldova

While the potential benefits of wind energy in Moldova are significant, several hurdles need to be overcome to ensure successful and sustainable development. Here are some key challenges and considerations [5]:

Financial Considerations: Upfront Costs and Investment Incentives

One major challenge lies in the initial investment required for wind farm development. Wind turbines are complex technological marvels, and constructing wind farms necessitates significant capital expenditures. These costs encompass purchasing and installing turbines, grid connection infrastructure, and transmission lines.

Attracting investment to overcome this financial hurdle is crucial. The government can play a vital role by implementing effective financial incentives. Feed-in tariffs, which guarantee a fixed price for electricity generated from wind farms, provide investors with a predictable revenue stream and reduce project risks. Production tax credits, offering tax breaks based on electricity production, further incentivize investment.

Furthermore, innovative financing models can unlock additional capital. These models could involve public-private partnerships, where the government collaborates with private investors to share costs and risks. Additionally, green bonds, which are debt instruments specifically earmarked for financing renewable energy projects, could attract investment from environmentally conscious investors.

- Grid Modernization and Integration:

Moldova's existing electricity grid may not be adequately equipped to handle the fluctuating nature of wind power generation. Wind farms inject electricity into the grid intermittently, depending on wind availability. This variability necessitates grid modernization and integration solutions to ensure efficient and reliable power delivery.

Strengthening transmission lines is a crucial step. Robust transmission infrastructure ensures efficient transfer of electricity generated by wind farms from remote locations to population centers. Additionally, energy storage solutions, such as battery storage systems, can play a critical role in managing the variability of wind power. These storage systems absorb excess electricity generated during high wind periods and release it back into the grid during times of low wind availability, contributing to grid stability.

- Environmental Considerations and Mitigation Strategies:

While wind energy offers a clean energy source, there are potential environmental impacts that require careful consideration. The placement of wind turbines needs to be meticulously planned to minimize their impact on wildlife and local ecosystems. Conducting thorough environmental impact assessments is essential for identifying potential risks and developing mitigation strategies.

One major concern is the impact on birds. Collisions with wind turbine blades can cause bird mortality. Strategies such as using bird-friendly turbine designs, strategically locating turbines to avoid bird migration routes, and radar-based bird detection systems can mitigate this risk.

Additionally, the visual impact of wind farms on landscapes needs to be considered. Careful planning and engagement with local communities can help ensure that wind farms are integrated visually into the landscape in a way that minimizes disruption. Responsible wind farm development requires striking a balance between maximizing energy production and protecting the environment.

Conclusion

Moldova possesses a promising wind resource with the potential to revolutionize its energy landscape. Vestas V236-15MW turbines offer a leap forward, maximizing energy production. Wind energy development fosters economic growth, creates jobs, and reduces dependence on fossil fuels. However, overcoming financial hurdles, modernizing the grid, and prioritizing environmental considerations are crucial. Collaboration between people and our foreigen partners is key to harnessing the power of wind for a secure, sustainable, and prosperous future for Moldova.

References:

[1] [Online] https://energy-wind.md/studiul-usaid-r-moldova-poate-reduce-dependenta-de-moldgres/
[2] Average wind speed in Chişinău [Online]. Available: https://weather-and-climate.com/average-monthly-Wind-speed,chi-in-u,Moldova
[3] V236-15.0MW™ [Online]. Availble: https://www.vestas.com/en/products/offshore/V236-15MW
[4] "Republic of Moldova Energy Profile" by INTERNATIONAL ENERGY AGENCY [Online]. Available: https://iea.blob.core.windows.net/assets/a6dd7ac3-8955-41f9-8971-d7c09ccff6d9/MoldovaEnergyProfile.pdf
[5] Gr. Pirtac and Gh. Mosneaga, "The challenges to national security of the Republic of Moldova in the context of regional crisis". Acta Universitatis George Bacovia. Juridica, 2023, Vol 12, Issue 2, pp 87. ISSN 2285-0171.