CENTER FOR THE STUDY OF DEMOCRACY

THE LOWEST HANGING FRUIT: WIND ENERGY POTENTIAL IN BULGARIA

Policy Brief No. 138, September 2023

The ambitious objective to fully decarbonise the European economy is facing strong headwinds from the ongoing energy price volatility, the supply deficits on electricity and gas markets, and the bottlenecks in accelerating the renewable energy investments – the backbone of the REPowerEU plan. At the center of the energy transition is the unlocking of Europe's wind energy potential. While Northwestern Europe has unleashed massive deployment of onshore and offshore wind power plants that have been eating away from the share of natural gas and nuclear generation facilities in the power market, the wind parks development in South East Europe has significantly lagged behind.

Wind-based power boasts high capacity factors and is less affected by seasonal factors, resulting in relatively low Levelized Cost of Electricity (LCOE). Furthermore, the implementation of wind projects depends less on land acquisition and offers synergies with other agricultural or economic activities. Wind energy development is crucial for balancing the power system during periods of limited sunlight, while in periods of excess supply of electricity, the additional power generation volumes can be harnessed for hydrogen production in industry.

The slow uptake of wind energy in Bulgaria is largely due to widespread governance deficits such as ad-hoc regulatory changes, technical and administrative bottlenecks before grid connection and access, the opposition from local communities, land use and environmental conflicts, and, more generally, a lack of political commitment to accelerate the investment process. There is also limited availability of evidence-based assessment of the technical-economic potential for wind energy, which feeds widespread disinformation narratives undermining the social acceptance of the deployment process.

KEY POINTS

- Wind energy remains an underutilized resource for electricity generation in Bulgaria, due to **legal and regulatory inconsistencies**, difficult grid access, opposition from local communities, environmental conflicts, and a lack of political will;
- There is **high potential for both on and offshore wind energy in Northeastern Bulgaria**, leading to strong regional competition for the available grid capacity;
- At least **10 GW of installed onshore and offshore wind capacity** with high utilisation factors and suitable land use and environmental conditions can be added in the Varna, Dobrich, Razgrad and Shumen districts;
- Around a third of the Bulgarian coastal area is considered **suitable for offshore wind deployment** with installed capacity potential of 176 GW;
- There is a need for significant **power grid expansion** to accommodate the current pipeline of projects, which are all located in areas with limited grid availability;
- The unlocking of the offshore wind energy development requires the adoption of an **enabling regulatory framework** and a National Maritime Spatial Plan with detailed mapping of prospective offshore wind energy zones;
- There is a need to **simplify the land use and construction permitting procedures** for wind energy projects and boost the capacity of local authorities to manage the process more effectively under a common central coordination body.

Based on the latest modelling assessment, conducted by CSD in cooperation with the Regional Center for Energy Policy Research (REKK), Bulgaria can add between 3,8 and 4,2 GW of new wind power capacity by 2030 and another 5 GW by 2040. To identify the overall feasibility of the wind energy sector expansion, the current study, led by the Austrian Institute of Technology, estimates the overall technically viable potential for wind power development in Bulgaria, and identifies key policy measures that are necessary to unlock it without compromising the security of power supply and respecting the highest land use, environmental and biodiversity standards.

Resource Availability Assessment

The study's first step has been to estimate the size of the total wind energy resources available both on -and offshore. First, a GIS-based processing of weather data was conducted. Comprehensive meteorological datasets on time-series of wind speeds for past weather years were processed via the open-source GIS software QGIS under a detailed geographical resolution (100m times 100m). The wind speed data, sourced from the high-resolution reanalysis system COSMO-REA6 for the 1995-2019 time period, served as the basis for identifying the unconstrained wind resource potential across Bulgaria.

The next step included the incorporation of distance rules and other spatial constraints, which also reflect social acceptance elements, such as whether the wind turbine will be located at least 1 kilometre away from the nearest urban zone. In addition, the assessment considered competing land use issues, as well as conflicts with nature protection, urban, agriculture, military use or other purposes that limit the suitability of specific zones for wind power generation, as well as related electricity grid expansion[1]. One example has been the conservatively restrictive approach to excluding all Natura 2000 protected areas as viable for wind energy investments.

Usability factors were assigned to the various categories of global land use classifications under consideration. Assumptions vary from 0% to 40% usability based on the type of land. Natura 2000 areas were assumed to have 0% usability, and the same was assumed for areas of water bodies, urban areas, construction sites and infrastructure including airports, ports, roads and rail. Forests, wetlands and sand dunes were assumed to have a 10% usability factor, while various crop lands, including olive groves, vineyards and rice fields were a assigned a factor of 40%.

Furthermore, sensitivity assessments were performed for critical input parameters, including factors such as distance regulations, wind turbine designs, and economic constraints. For calculating the potential in terms of installed capacity and electricity generation, state-of-the-art wind energy equipment was considered. This involved a 4,95 MW class turbine for onshore wind, an 8 MW class turbine in the case of offshore wind. The site potential evaluation was measured in full-load hours (FLH) at a height of the rotor of 150 meters.

Box 1. Land Use Allocation Principles

The potential assessment has used two main approaches to evaluate the land use contraints linked to the development of new onshore wind projects:

- **Balanced approach:** Here the assumption was taken that land use constraints, i.e. upper limits concerning the average share of land suitable for wind power development, e.g. 10% in case of forest areas or 40% for agricultural areas, are homogenously distributed within each region, independent of the wind power site qualities.
- **Least-cost approach:** Here the assumption was taken that, among all land use categories suitable for wind power developments, these constraints differ within each region and land use category. This implies that best sites are primarily used, which means that a higher wind power density is achieved than the average. There is a higher concentration of wind farms feasible within certain (more windy) parts of a region compared to the average.

[1] The data sources for the land use were taken from the CORINNE land cover database as of 2021.

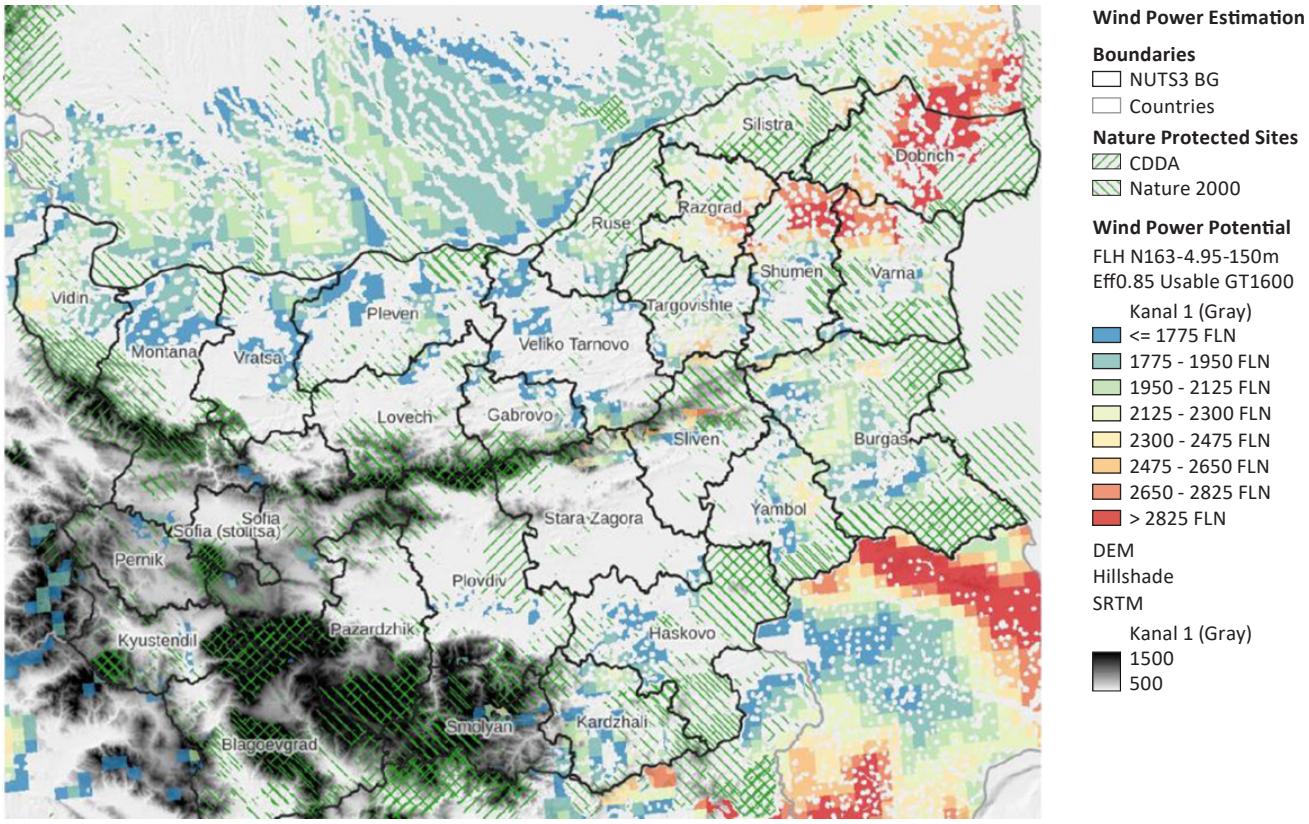
Prospective Areas

The study found that there is a total of 14 891.78 square kilometres of usable area across all Bulgarian regions, which ignores any land use constraints. When estimating the total power generation capacity of each region with assumed land use constraints, the study draws out two main scenarios. The least cost scenario assumes that projects would be implemented in areas with a higher FLH potential, while the balanced scenarios assumes lower average FLH levels.

The districts (NUTS-3 level) of **Dobrich (2893 FLH), Varna (2458 FLH), Shumen (2381 FLH) and Razgrad (2343 FLH) have the highest values for full load hours under a balanced scenario,** and therefore offer the best potential for wind energy development in the country in terms of generation volumes and economic efficiency. Even when land use constraints are considered, these territories continue to show some of the highest potential for capacity addition and power generation potential. In Dobrich, under a balanced scenario, a total of 3.3 GW of wind power generation capacity can be installed, which will operate at very high FLHs. In Varna, the potential for generation capacity is estimated at 2.4 GW under a balanced scenario, while in Shumen and Razgrad, the estimate is for 2.4 GW and at 2.2 GW , respectively. On the other hand, there are districts such as Sliven (2062 FLH) and Silistra (2112 FLH) where wind-based power can be generated very efficiently due to the high FLHs but the serious land use constraints due to Natura 2000 restrictions can delay and significantly hamper the project implementation process.

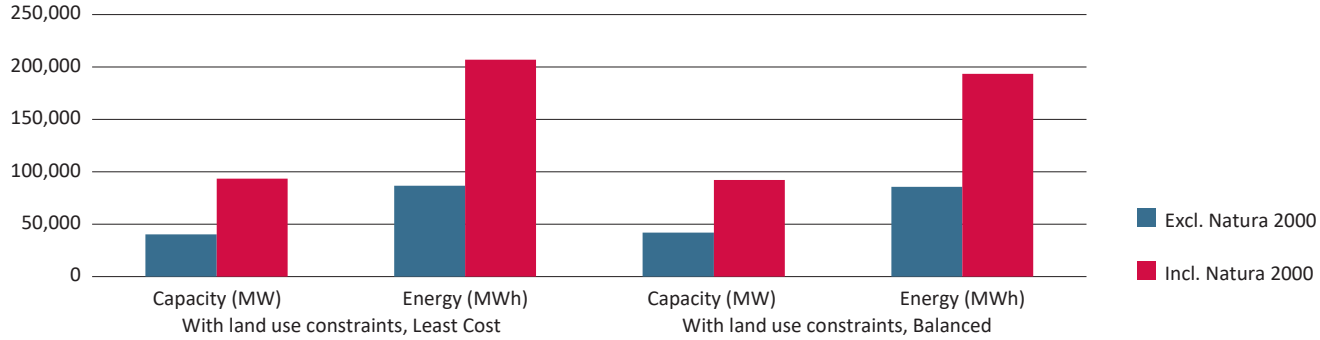
The study shows that a total of 40-42 GW of wind power generation capacity can be installed at an average FLH of 2040 when Natura 2000 areas are completely excluded. The inclusion of Natura 2000 areas expands the potential generation capacity under a balanced scenario by 120% and the total expected power production – by 126%. In summary, **the areas with the best wind potential (>2300 FLH) can house up to 10.23 GW of wind power generation capacity**, which can produce 26.2 TWh of electricity per year, or more than 2/3 of the current power demand in the country.

Figure 1. Detailed Map of Available Areas for Onshore Wind Project Development in Bulgaria with FLH



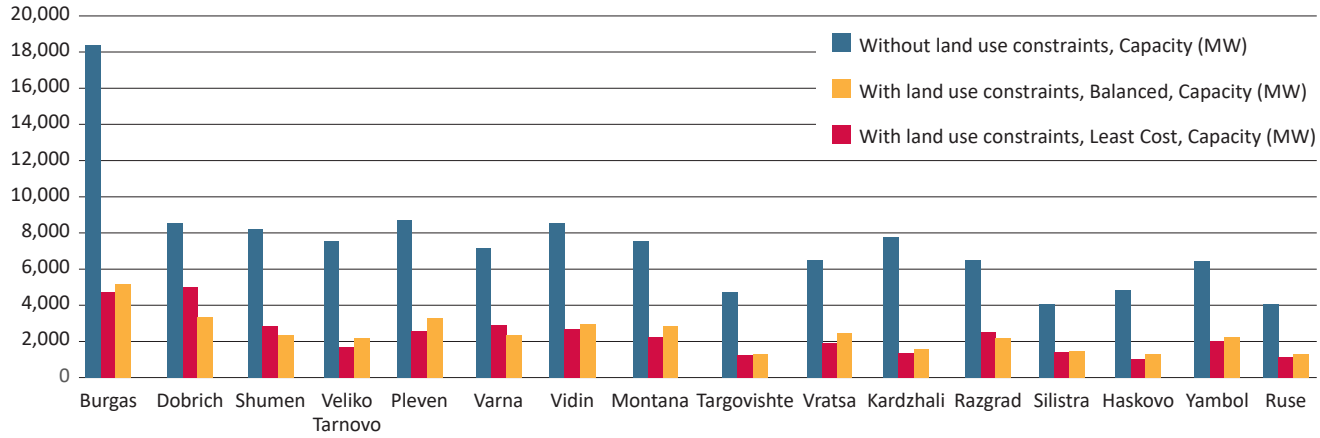
Source: *GIS-based assessment conducted by the Austrian Institute of Technology.*

Figure 2. Total Capacity and Power Generation Potential Excluding and Including Natura 2000 Areas



Source: *CSD based on GIS-based assessment conducted by the Austrian Institute of Technology and the review of land use and environmental constraints.*

Figure 3. Usable Onshore Area and Wind Power Potential per District



Source: *CSD based on GIS-based assessment conducted by the Austrian Institute of Technology and the review of land use and environmental constraints.*

Zooming in on the offshore wind energy potential, the data shows that FLH increase both with water depth and distance from shore. The lowest FLH values are found in areas with water depths of 40 m or less, 12-24 nautical miles (nmi) from the shore (2,075 h/a), while highest FLH values are found in areas with water depths of over 120 m, more than 24 nmi from the shore, (2,772 h/a). 34.5% of Bulgarian coastal area is considered suitable for offshore wind deployment, of which a large majority is 24 nmi or more from the shore. In total, the suitable area has installed capacity potential for 176 GW offshore wind power at FLH of 2593. The high potential both in terms of onshore and offshore wind generation, is concentrated in Northeastern Bulgaria, which creates high competition for the limited available grid capacity between the potential project developers.

A previous study developed by CSD of the technical-economic potential for offshore wind energy reveals that there is 116 GW of technical wind potential, 26 GW of which can be utilized in accessible territories with the currently available technological solutions[2]. The then-analysis considered four potential areas for offshore wind farm development where capacity factors in the range of 40-48% could be achieved. The average cost per megawatthour of electricity generated by fixed wind installations near the coastline is estimated to be between €62 and €90 per MWh. Due to the considerably higher intensity of capital investments in floating installations in depths of more than 60m, the average cost per unit of energy produced is estimated in the range of €120-158 per MWh.

[2] Trifonova, M. and Vladimirov, M., *The Energy Security and Innovation Nexus: Towards a New Regulatory Framework for Offshore Wind Energy Development in Bulgaria*, Sofia: Center for the Study of Democracy, 2022.

Figure 4. Available Areas for Offshore Wind Power Development in Bulgaria

Water depth (z, m)	Distance to shore (d, nautic miles)	Area potential (km^2)	Capacity potential (MW)	FLH (h/a)
-40 ≤ z	d < 12	0	0	
	12 ≤ d < 24	1717	25216	2075
	24 ≤ d	258	3797	2557
-80 ≤ z < -40	d < 12	0	0	
	12 ≤ d < 24	1131	16612	2445
	24 ≤ d	1925	28274	2639
-120 ≤ z < -80	d < 12	0	0	
	12 ≤ d < 24	116	1707	2539
	24 ≤ d	2174	31938	2662
z < - 120	d < 12	0	0	
	12 ≤ d < 24	9	135	2414
	24 ≤ d	4654	68367	2772

Source: *CSD based on GIS-based assessment conducted by the Austrian Institute of Technology and the review of land use and environmental constraints.*

Governance Bottlenecks for Unlocking the Wind Potential

Although there is no official national database of the wind power project pipeline, industry information data from business associations indicates that there are at least 5 GW of projects currently being implemented at different development stages. It is expected that at least 4 GW of these will successfully complete the administrative process and will come online until 2030. Almost all of the new wind parks will be located in the most prospective areas in Northeastern Bulgaria taking advantage of the high wind speeds and the relatively smaller land use limitations. The cumulative installed wind-based capacity is anticipated to surpass 11 GW by 2050, which will provide feasible balancing capacity to the abundant solar capacity, and thus be an important contributor to security of supply and grid stability[3]. To realise the important role to be played by the wind energy industry in the transition process, there needs to be a consistent policy strategy for overcoming the many governance bottlenecks blocking the development of projects.

Technical and Grid Constraints

The main prerequisite for the upscaling of wind energy investment is the availability of power transmission capacity. Any planned wind energy park would require connection to a high-voltage transmission grid. The current lack of reliable data on the available grid capacity is a serious barrier for the development of new energy projects. Based on recent assessments, the national transmission grid has the capacity to support the integration of up to 4 GW of new electricity production projects[4] in Northeastern Bulgaria, which would indicate the need for a significant upgrade of the transmission grid capacity.

In the National Recovery and Resilience Plan (NRRP), the Bulgarian government has included a specific project for the full digitalization of the national high and medium voltage grid to provide the necessary flexibility, security and reliability of the power system management in times of increasing deployment of intermittent renewable energy sources. One of the key impacts of the modernisation effort would be the expansion of the interconnection capacity with neighbouring coun-

[3] Vladimirov, M., Rangelova, K. and Aleksieva, R. *Decarbonising the Bulgarian Power Sector: Resolving the Coal Phase-Out – Security of Supply Conundrum,* Sofia: Center for the Study of Democracy, 2023.

[4] Trifonova, M. and Vladimirov, M. *Wind Power Generation in Bulgaria: Assessment of the Black Sea Offshore Potential,* Sofia: Center for the Study of Democracy, 2022.

tries by an additional 200 MW. As a result, renewable energy-based power producers would be able to sell their electricity generated abroad once the regional market coupling is completed.

In its 2022 ten-year infrastructure development plan the Bulgarian Transmission Systems Operator (ESO) points out the need for investment in new high voltage transmission capacity through the reconstruction and doubling of existing power lines, particularly in the Dobrich and Varna regions, due to the expected pipeline investments in new wind energy-based power generation. However, the Plan's estimates of the installed wind capacity by 2031 are only 343 MW, which does not accurately reflect investment plans and risks leaving the grid in a condition unable to meet the real demand for new projects. ESO also fails to consider the possible addition of offshore wind capacity in the Black Sea although the sector is considered a priority for future RES development in the NRRP. A special regulatory framework has also passed at first reading in the Bulgarian Parliament in September 2021, which envisions at least 3 GW of offshore wind power plants to be built or planned by 2030.

Due to the fact that the wind power potential is concentrated in Northeastern Bulgaria, where grid capacity is limited, wind power generation projects are often in competition with each other as well as with solar PV parks for network access. In the ongoing process of updating the national Renewable Energy Act, the government has indicated that it will include a BGN 50 000/MW (around EUR 25,000/MW) booking fee for capacity on the transmission network for future projects. The proposal envisages that the fee is paid at the earliest stage of the connection process when the investor applies for the ESO's evaluation of the available connection capacity.

The goal of the fee is to limit the potential speculative applications for grid access by companies looking to structure a project from an administrative, land ownership and regulatory perspective before selling it to an investor, who actually has the financial ability to implement the project. The Bulgarian TSO has announced that there are already 40 GW of renewable energy capacity booked in the system by investors and claims that only a fraction would be implemented. Only 7 GW of the projects with allocated capacity in the grid have signed a preliminary grid connection contract. Hence, the market impact of the fee is yet to be assessed in detail but it risks further disinsentivising investment in wind power generation due to the additional financial burden. It also risks giving an unfair advantage to projects with already signed preliminary contracts, if these would not be required to pay a reservation fee retroactively. There is a need for a financial incentive to select only commercially viable projects for grid connection but the guarantee should be provided only at a stage where there is a clear evidence that the project is mature and the investor is ready to complete it. This stage should be most logically the signing of the preliminary agreement but with clear provisions that the booking fee will be returned to the investor if the project fails to be completed for reasons beyond the control of the investor.

Regulatory Constraints

Another barrier to the development of wind energy projects is the time-consuming and administratively heavy procedure for grid connection examination and permitting, which each investor must undergo. Project developers encounter opaque procedures for allocating grid capacity. The absence of clear information regarding the available capacity at various grid connection points and a consistent methodology for assessing connection costs, as outlined in the Bulgarian renewable energy law (wherein investors are responsible for covering these costs but they are estimated by grid operators), creates uncertainty about the expenses related to grid connection. This uncertainty prompts project developers to submit requests for multiple grid connection points simultaneously and explore alternative options. Consequently, the applications submitted often do not truly represent investment decisions. ESO frequently prolongs the process or presents an inflated estimation of the grid connection expenses to be borne by the investor, without suggesting a mechanism for fairly distributing costs among all the facilities connected to a specific connection point.

Bulgaria is yet to develop a consistent long-term policy vision for the development of new wind power generation capacity. There is a lack of a transparent planning of grid capacity for the expansion of new renewable energy sources based on the adoption of auctioning mechanisms or a transparent connection cost allocation for all investors connecting to the same grid access point. This means that utility-scale investors in low-carbon energy cannot adequately estimate their investment costs and predict the net present value of their projects. Since 2019, any power trading deal with operators of renewable energy plants with a total installed capacity of 1 MW and above has to go through the Bulgarian power exchange. Moreover, wind energy power plants must

be connected directly to the electricity transmission grid preventing the option to sell electricity via long-term power purchasing agreements to nearby based large-scale industrial consumers.

Last but not least, the European energy crisis since 2021 that caused a sharp spike in electricity prices across the continent, led Bulgaria to implement a price cap on the power generated by renewable energy sources. In this way, the government would be able to provide financial assistance to vulnerable consumers, who were hard hit by the increase in prices. The cap was set at 300 Leva/MWh (about 150 EUR/MWh) for renewable energy projects without a premium compensation agreement. This move is in contradiction with electricity market liberalization efforts and is a further disincentive for investments in new wind power generation projects.

Environmental and Land Constraints

A significant challenge in onshore wind energy development revolves around addressing stakeholder apprehensions concerning its ecological and societal impact. These concerns encompass issues such as noise disturbance, wildlife effects, and the alteration of landscapes due to wind turbine installations. The administrative procedures linked to obtaining environmental and construction permits for new wind energy projects often result in project delays. These delays stem from deficiencies in institutional efficiency, interdependencies, and inadequate oversight. Key problems include:

- **Institutional Inefficiency:** Relevant institutions frequently fail to adhere to designated timelines due to limited administrative and professional capacity for processing applications.

- **Ambiguity in Legislation:** Existing legislation sometimes allows for multiple interpretations by competent authorities, often due to incomplete or vague frameworks and guidelines. Administrative officials may opt to postpone final decisions in such cases.

- **Paper-Based Processes:** Permitting procedures typically involve substantial paperwork, and the transition to fully digitalised processes remains incomplete. This further contributes to project postponements.

In addition, Natura 2000 areas, while not legally prohibited for wind power projects, often face refusals from responsible institutions due to a lack of clarity. This practice significantly reduces the potential for wind power generation, as highlighted by the GIS analysis results. In the case of offshore wind energy, harmonious coexistence with ecological, economic, and societal interests is vital to secure public approval for new investments. The National Maritime Spatial Plan (NMSP) aims to assess compatibility with various activities and ecosystems until 2035. However, the preliminary version of this document, released in February 2021, does not indicate forthcoming opportunities for offshore wind energy development. By not including offshore wind energy development in the NMSP, Bulgaria missed an unique opportunity to establish suitable zones for offshore wind development, with the next chance for revision of the strategic planning document not expected until 2024. The NMSP could play a vital role in coordinating future project planning to ensure compatibility with other marine activities and prevent conflicts.

Other significant challenges faced in wind project development pertain to property rights allocation and land use categorisation. Low capacity at the local government level results in extended periods for issuing necessary permits. Furthermore, there are significant disparities in procedures and interpretations of the legal framework between various regions and municipalities. Expected changes to the national Renewable Energy Law propose the removal of zoning requirements for solar PV projects but not for wind projects. The proposed changes outline:

- The establishment of a plan for zoning new projects.

- Limiting the capacity for the connection of new capacities.

- Development of priority sites for wind plants through inter-ministerial cooperation.

- The draft Amendment Act states that all Natura 2000 areas will be excluded from permitted areas, significantly restricting the potential for wind power project development.

Additionally, uncertainty surrounds the alignment of offshore wind investments with Bulgarian national concession laws, which govern the authorization of activities such as exploration, construction, installation, and operation of offshore wind farms in areas already allocated for other purposes like oil and gas exploration and production.

What's Next?

Bulgaria possesses significant untapped potential for wind energy development, both onshore and offshore. To fully leverage this potential and expedite the growth of wind energy, the following set of measures is a non-exhaustive list of short and long-term policy actions to accelerate this process. By implementing these policy measures, Bulgaria can unlock its wind energy potential, expedite the overall energy transition process, and contribute significantly to its decarbonisation efforts. These measures align with the broader European energy and climate security strategy, where wind energy will play a pivotal role.

- **Consistent regulatory and policy framework** is essential for promoting wind energy investments in Bulgaria. This framework should provide clarity, stability, and incentives for both domestic and international investors. Based on the research and benchmarking against international best practices in wind energy regulation, there needs to be close examination of successful case studies from countries with well-established wind energy sectors. Proven European regulatory models and policies should be adapted to and integrated into the Bulgaria's framework, considering the country's unique characteristics.

- Creation of a **national database** of existing and pipeline wind energy projects**,** and **available grid capacity** to paint a clearer picture of where future investments in wind energy production are possible.

- Significant **grid capacity expansion** is necessary with particular attention to Northeastern Bulgaria. This region boasts a convergence of high wind speeds and favourable land potential, making it a prime candidate for wind energy projects.

- Design and implementation of **onshore and offshore wind priority zones** that streamline the wind energy planning process. This approach would systematically identify areas suitable for wind energy transmission, **simplifying assessments for plant connections** during the investment planning phase. By doing so, the installation of necessary transmission infrastructure can be expedited.

- Bulgaria should also pave the way for offshore wind development. This requires the adoption of an **enabling regulatory framework** and a National Maritime Spatial Plan with detailed mapping of prospective offshore wind energy zones. Coordination with neighbouring Black Sea countries is essential to explore and develop jointly offshore wind parks.

- The study found that high wind speed and suitable land potential overlap mainly in Northeastern Bulgaria, including the coastal areas of the Black Sea close to the border with Romania. Planned investments in **upgrading the existing and building new additional grid capacity** will be an important pre-condition for the development of Bulgaria's full wind potential.

- Simplify the **land use and construction permitting procedures** for wind energy projects and boost the capacity of local authorities to manage the process more effectively under a common central coordination body, a one-stop-shop.

- To attract large-scale international investors, especially in the offshore wind subsector, Bulgaria should consider the introduction of **competitive auctions**. These auctions can help define project financing conditions and decrease the cost of capital. Additionally, offering economic incentives such as **contracts for difference** can secure **lower prices** for renewable energy-based power and potentially generate additional revenue for the state budget.