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Wind Energy in Latvia – Mismatch between the Potential and Reality

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***Abstract* – The process of wind energy development in Latvia, from conception to realization and operation, has been studied. It was concluded that in Latvia, both on the offshore and onshore, there is a great potential for wind energy due to favourable climatic conditions. During the research, the main obstacles, and risks for the development of wind energy were identified. Furthermore, the expected benefits for the Latvian economy were evaluated through a systematic analysis conducted. By performing modelling in the Energy Pro program, the amount of real electricity production of a wind power plant (WPP) in the Ventspils region was assessed. This evaluation considered not only the potential electricity generation based on climatic conditions, such as wind speed and direction, but also the anticipated operational limitations identified during the Environmental Impact Assessment (EIA) process (impact on local wildlife and habitats). The amount of capital investment and operating costs required for the WPP, as well as the payback time, considering the price of electricity, have also been calculated. Based on the analysis of the Latvian wind energy industry and the WPP projects, proposals have been made for organizing the development of the wind energy industry in the territory of Latvia.**

***Keywords* – Electricity production; renewable energy; wind farm in Latvia; wind.**

1. Introduction

Although limiting the global temperature increase to 1.5 °C above pre-industrial levels is increasingly challenging process, it is necessary to strive for sustainability in all sectors of the national economy. Renewable energy resources (RES) make an important contribution to achieving the transition and reducing global warming, so that in the framework of the goals of the Paris Agreement, RES should be approximately 70–85 % of the total electricity in 2050 [1]. The geopolitical situation in Europe has also resulted in the need for more RES capacities. Increasing RES capacities in Europe would promote energy independence and reduce the consequences of the current geopolitical situation [2].

Wind energy is currently one of the most profitable and economically efficient solutions to promote energy production from renewable energy resources (RES). Promoting the development of additional electricity production capacities, thereby reducing the electricity deficit in the Baltics and promoting Latvia's energy independence and the diversification of the electricity production portfolio. A balanced approach that includes a mix of various RES,

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such as solar, biomass, and continued use of hydropower, alongside wind energy, would be possible not only to achieve climate neutrality goals by producing green and environmentally friendly electricity. Possibly to reduce or stabilized energy production prices [3], [5], thus it is not only in the interests of wind power plant (WPP) developers, but also for the sustainability of society and the country in the interest of the question [4].

Despite quite similar climatic conditions and available natural resources to produce electricity from RES, there is a difference in the installed capacities of wind energy production in the three Baltic countries (Estonia, Latvia, and Lithuania). Unlike the rest of the Baltic countries, support for wind energy in Latvia has not been sufficient to achieve significant production abilities from this energy type. At the beginning of 2023, a total of WPPs with a capacity of 137 MW have been installed in Latvia [6], which is almost six times less than in Lithuania (800 MW) and almost four times less than in Estonia (500 MW) [7]. This discrepancy is attributed to factors such as inadequate funding, bureaucratic hurdles, and less favourable regulatory conditions in Latvia compared to its Baltic neighbours. Additionally, Latvia has the highest share of hydropower among the Baltic countries, which may have influenced its lower investment in wind energy development [8].

There are currently three large WPP in Latvia, but an ambitious new strategy has been rapidly developed to build at least 120 wind turbines, which would produce additionally 30 % of Latvia's total electricity consumption. This strategy has two main directions – SIA "Latvijas vēja parki", a joint venture between AS "Latvenergo" and AS "Latvijas valsts meži", was established in order to speed up the construction of WPPs [9]. At the same time, AS "Latvenergo" has also signed a memorandum with the German energy giant RWE AG on the development of offshore WPPs [10]. If both projects move forward as planned, Latvia will likely reach its goal by 2030, increasing wind power capacity to 800 MW. While Latvia is trying to catch up with neighbouring countries, Estonia and Lithuania continue to invest in wind energy [7].

Domestic electricity production in Latvia by source can be seen in Fig. 1. Annual wind energy is only 4 % of the total electricity production in Latvia, which is low, considering due to favourable climatic conditions.

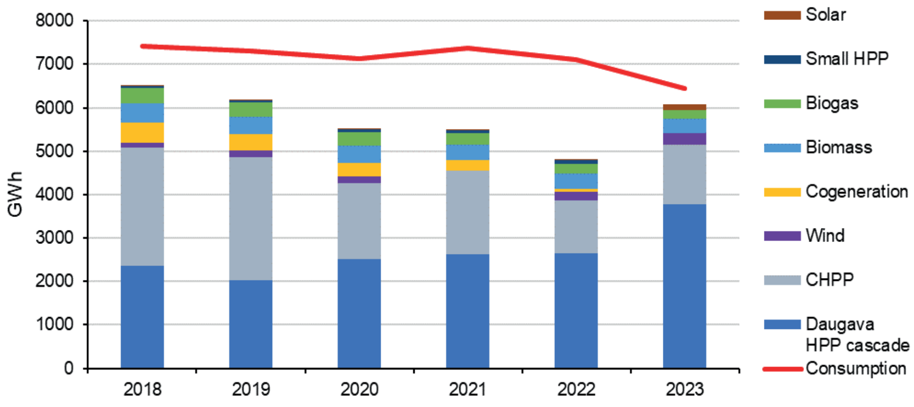

Fig. 1. Electricity production and consumption in Latvia [11].

Against the background of the European Union, Latvia is already a green country, much greener than Lithuania and Estonia, because historically 40–60 % of the electricity in Latvia is produced by hydroelectric power plants (HPP) (see Fig. 1.), which are classified as RES. On the other hand, there are no such large HPPs in Lithuania and Estonia, so Lithuania and

Estonia have focused on the development of wind energy much faster than Latvia. Latvia is currently above the European Union (EU) average RES level of 37.5 %, while Estonia with 30 % and Lithuania with 20 % are below this level [12].

The main obstacles to the development of WPPs in Latvia so far are the limited land area - due to biodiversity and residential building restrictions in legal acts, as well as the long and difficult permit process [13]. To develop a WPP, the project must be economically profitable. This study addresses the gap in literature on wind energy development in Latvia by examining specific barriers, such as land use, permitting and operational limitation, and conducting an economic analysis of their impact. It aims to provide insights and recommendations to enhance wind energy capacity and support Latvia's renewable energy targets.

2. Materials and Methods

To assess the real possible potential of a WPP, it is important to analyse WPPs projects (which completed EIA process) to obtain the most accurate cost estimate possible, as well as to evaluate the possible obstacles of the project from a technical, administrative, and environmental point of view using publicly available information. Thus, the analysis of this case focuses on the coastal region of the Baltic Sea – Ventspils, where there is the greatest potential for wind energy development [15], [19]. The analysis assumes that the lifetime of the WPPs will be 25 years, with a total number of installed turbines up to 15 and a capacity of up to 100 MW (see Table 1). It is important to emphasize that the purpose of the study is to find what costs, limitations and benefits are expected from the implementation of a project of this scale, evaluating them at the local and national level. The planned production capacity adopted in the analysis are based on the practical experience of real WPP projects that have been developed or currently are in the EIA stage in Latvia.

TABLE 1. WPP ANALYSE PARAMETERS

Criteria	Value
Planned area of activity	Ventspils region
Planned number of turbines	15
Nominal turbine power, MW	5–8
Total power, MW	to 100
The period of operation of the WPP, years	25

The economic analysis of the WPP project will be carried out according to the scheme found in the Fig. 2. By performing the following sequence of steps:

1. Searching for the location of the WPP using publicly available information on restrictions related to natural values, Natura 2000 areas, buildings, and access to the public electricity grid.
2. Placement of turbines in the intended WPP, using the turbine power curve and wind speed data, the planned electricity generation is modelled in Energy Pro.
3. Based on the literature available prediction of the electricity price, capital investment (CAPEX) and operating expenses (OPEX), the profit of the WPP is calculated.
4. The real WPPs project EIA reports are analysed to determine operational restriction, after which WPP is remodelled in Energy Pro including operational restrictions and economic viability of the WPP is re-evaluated.
5. Comparing modelled scenarios and analysing obstacles and benefits in WPP development.

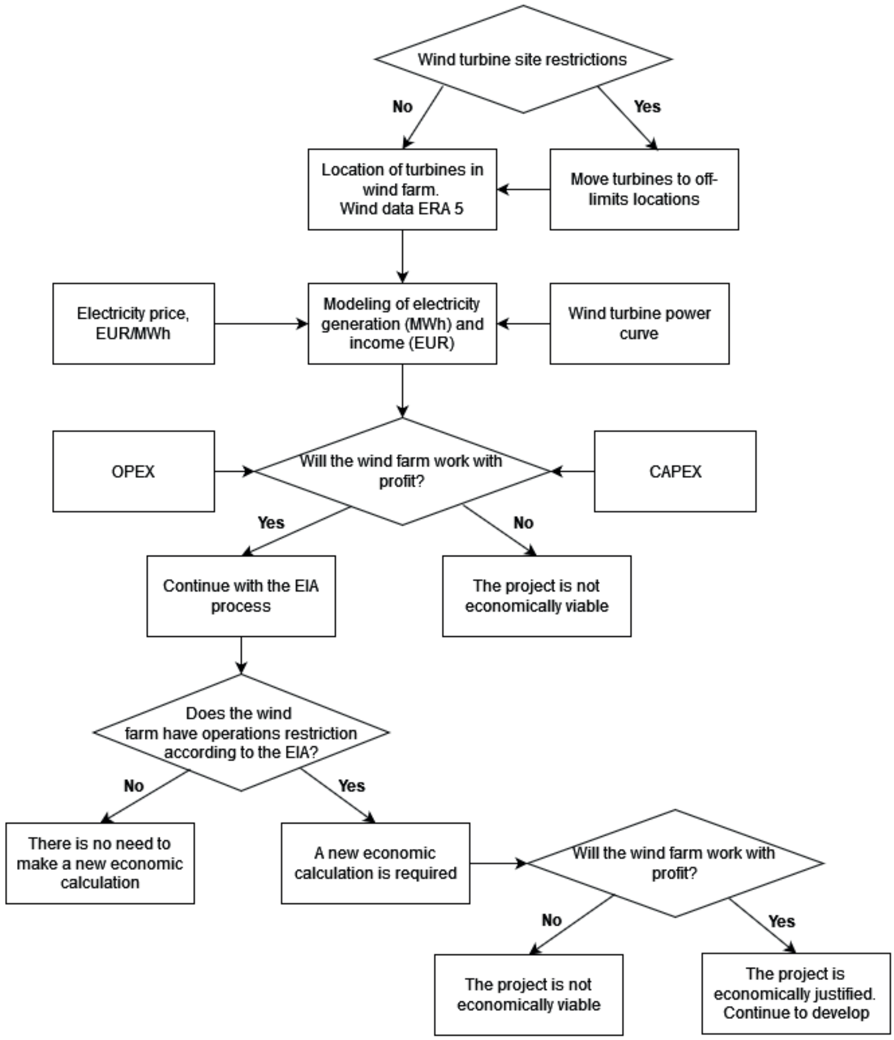

Fig. 2. Simplified scheme of economic analysis of a WPP project.

Wind conditions in the planned area of WPPs is the primary circumstance that the developer must consider when choosing both the location and the wind power plant models and manufacturer for the construction of the WPP. For the detailed analysis of wind conditions in the Ventspils region, the data of the model ERA5 [14] developed by the European Centre for Medium-Term Weather Forecasts (ECMWF) for the period from 2018 to 2023 were used. Hourly average wind speed data are available in the ERA5 database. The *Energy Pro* software developed by *AS EMD International* is used for processing ERA5 data, which allows obtaining calibrated long-term observational data on wind conditions at a certain height and add operational restriction in specific time of the day (bat and bird activity to decrease a collision risk). As part of the analysis of this wind potential, data on the wind speed at a height of 160 m have been used.

To estimate the production of the turbines at a specific wind speed, the power curve of each wind turbine was entered into the *Energy Pro* program. By adding historical wind data from the ERA5 model, the program calculated the annual electricity production of WPP. By adding bird and bat restriction time second model with operational restriction was made.

Using publicly available data on the production potential of wind turbines of various manufacturers at a specific wind speed [16]–[18], the calculation of the average annually capacity factor (C_p) at Ventspils region was made. A higher C_p shows better performance and more effective energy production at the chosen location. The calculation was made according to shown in Eq. (1).

$$C_p = \frac{E_{net}}{P_{max} \cdot t} \cdot 100\% \tag{1}$$

where

C_p	capacity factor of a wind turbine, %;
E_{net}	electricity produced, MWh;
P_{max}	maximum power of the wind turbine, MW;
t	electricity generation time, h.

3. Results and Discussion

3.1. Selection of Wind Turbines

In analysis was concluded that the most suitable wind turbine would be Siemens Gamesa 5X series turbines (6.6 MW, hub height 165 m), so further calculations of the electricity production potential will be based on the use of Siemens Gamesa 5X series 6.6 MW turbines (see Fig. 3).

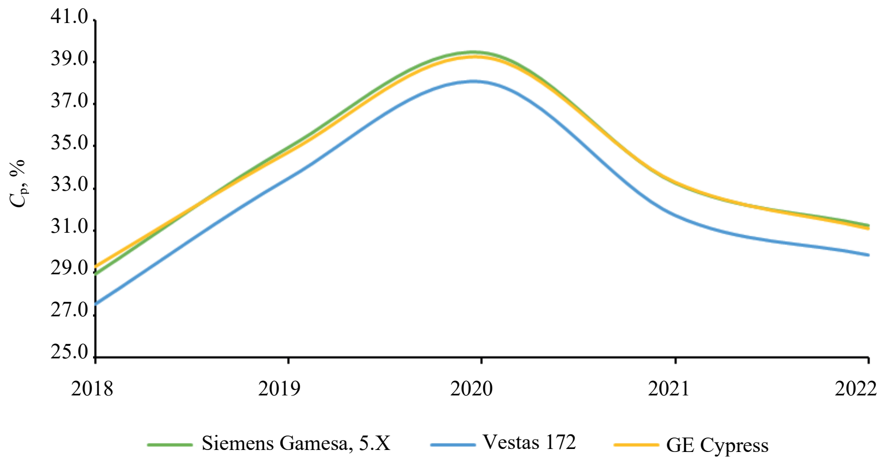

Fig. 3. Average annual capacity factor of wind turbines.

3.2. Electricity Production Potential of the WPP

Windless days (wind speed < 3 m/s at the height of the gondola) in the planned WPP area are from 9.7 to 14.5 % per year, when wind turbines will not work due to low wind speed. Analysing the opinions of the Environment State Bureau (ESB) on the EIA and the expected construction and operation restrictions. The main wind turbine operational restrictions are due to the activity of birds and bats [20]–[22].

In the case of bats, restrictions are expected on summer nights, when the wind speed is less than 5–7 m/s or the air temperature is higher than +6 to +10 °C, depending on the characteristics of the area. Analysing the WPP in the Ventspils region and the expected operational restrictions due to bat activity, it was assumed that the turbines will be stopped:

1. From June 1 to September 30, at least the first seven hours after sunset or until sunrise in summer, when the length of the night is less than seven hours, the following criteria are met: the wind speed at the height of the gondola is 6 m/s or less.
2. Air temperature is higher than +6 °C.

Shutting down turbines during bat activity decrease from 1 % to 3 % of annual electricity generation. On the other hand, during the affected months, it represents 5 % to 9 % of the month total electricity generation The obtained modelling results correspond to the information found in the literature [23], [24].

On operational restrictions on birds, the opinions of the ESB that turbines must be equipped with camera and radar systems. In the analysis of EIA reports concluded that one of the main reasons for shutting down turbines is bird migration at certain times of the year [20]–[22].

Bird migration takes place in spring, summer, and autumn. The Latvian Sea coast is characterized by an intensive movement of birds wintering in the Baltic Sea and the Gulf of Riga (see Fig 4). The greatest degree of activity is observed in the following periods [25]:

– March to early May (spring migration).
– End of August to end of October (autumn migration).
– July to August (summer migration).

Bird migration (or movement) at different times of the year can be affected by weather conditions [26]. Bird migration is one of the main constraints that could cause a reduction in WPP electricity production, as the turbines may have to be shut down. Currently, no information is available on the reduction in electricity production when wind turbines are stopped due to bird strikes, as radar and camera systems are a relatively new solution. In Latvian conditions, they could be stopped due to the intensity of migration and the movement of certain species near the park (black stork, lesser spotted eagle, etc.).

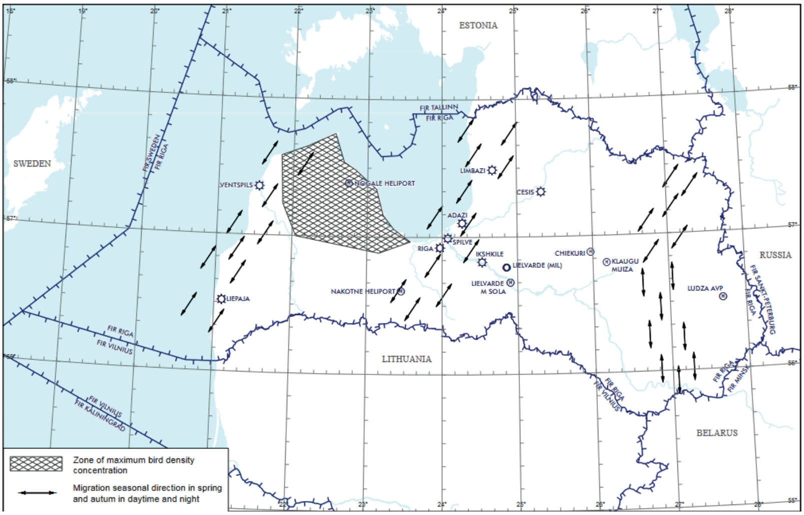

Fig. 4. Birds migration routes in Latvia [26].

The spring migration of birds takes place on a wide front across the whole of Latvia. The most dangerous time with the maximum density of bird migration is: 1–2 hours after local sunset and 1.4–7 hours after local sunrise.

The summer migration of birds takes place in a wide front over the whole of Latvia with large concentrations along the Baltic coastal areas and over the Baltic internal waters Most dangerous time in the 24-hour period with the maximum migration density: 1–4 hours after the local sunrise and 1–2 hours before the local sunset. Restrictions partially overlap with bat restrictions, and stations are often off during the summer night.

The autumn migration of birds takes place on a wide front across the whole of Latvia. It is visible both during the day and at night, with an increased density of migration along the Baltic coast (5–10 km inland). The most dangerous time in a 24-hour period in Latvia, when the density of bird migration reaches its maximum, is 1–4 hours after the local sunset and 3–5 hours after the local sunrise. Also, in August and September, when the intensity of bird migration is higher, the restrictions overlap with the bat restrictions for stopping the turbines.

Several methods are available to reduce wind turbine collisions with birds. Solutions that do not affect the production of electricity are changing the colour of the turbine parts - the rotor blades and the tower. As well as short-term turbine shutdowns based on the response of cameras and radar systems. Considering that in Latvia, the EIA and construction process of WPPs must be coordinated with the Latvian Air Traffic and the Civil Aviation Agency, there may be restrictions on the practical application of the methods mentioned in Table 2.

TABLE 2. COMPARISON OF MITIGATION METHODS [27]

Method	Effort	Effectiveness	Impact on annual production
Colouring blades	Low	High	No
Tower painting	Low	High	No
Temp. shut-down	Medium	High	Yes

Assuming that some of the restrictions related to stopping the turbines due to birds during the summer period overlap with the restrictions caused by bats, then according to the author, the impact on electricity production in specific months due to bird migration in spring and autumn could be up to 3 % taking account both migration periods. Based on this assumption, the reduction in electricity production in 15 turbines WPP at Ventspils region is shown in Fig. 5. On average, annually 5851 MWh of electricity is lost due to operational restrictions of 15 turbine WPP, which in financial terms amounts to losses of up to 520 000 EUR/year and more.

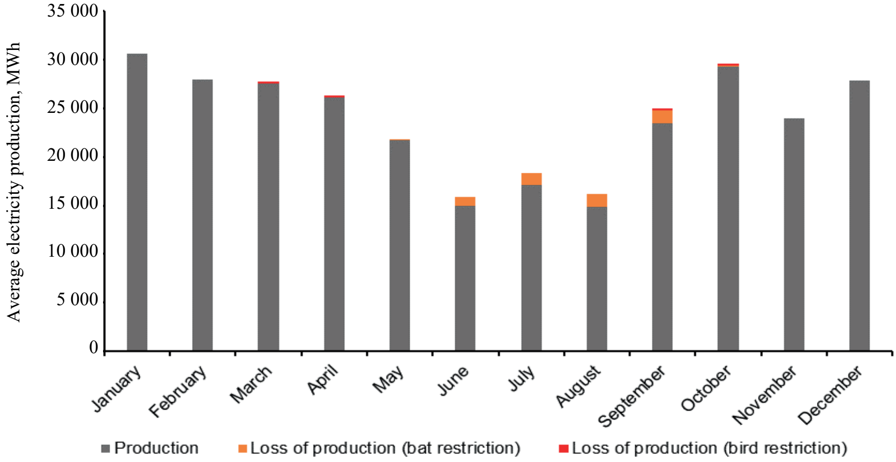

Fig. 5. Bird and bat restriction impact on annual energy production in 15 turbines WPP at Ventspils region.

3.3. CAPEX, OPEX and Revenue

Comparing the 2022 capital investments in different European countries, the cheapest onshore WPPs were in Norway 1 200 000 EUR/MW, while in Sweden and Poland their costs were approximately 1 300 000 EUR/MW. Differences in onshore wind costs between different European countries are determined by two factors: available land and existing constraints, as well as market maturity. Therefore, the lowest costs are usually with the most mature market, where the supply is defined, and the rules are clear. Countries with tight permitting and land restrictions, and little history of wind energy development, need more investment to see new onshore wind projects [28]. Latvia is also in the category of these countries, but there are also examples of other European countries like France with 1 500 000 EUR/MW and the Netherlands with 1 600 000 EUR/MW. Therefore, according to the Author, the capital investments needed for Latvia would be equivalent to the Netherlands – 1 600 000 EUR/MW. It is not expected that even in countries where the market for the development of the wind industry is mature, the value of CAPEX will decrease, it can only increase due to the increased price of natural resources, as well as due to inflation and higher prices of supplies [29], [30].

The expenses of the WPP do not arise only from its construction. Throughout operation, every year the WPP is budgeted for OPEX which can vary between projects as they depend on the location of the park, as most WPP parts are delivered via sea routes. In the literature, it is found that the planned and unplanned maintenance and production costs amount is up to 41 000 EUR/MW [31].

By performing a cost-benefit analysis of the project with non-operational restrictions and the project with operational restrictions, in both cases projects are economically profitable, and the payback period of the project is approximately 10–11 years (see Table 3).

TABLE 3. COST BENEFIT ANALYSE

	No restriction	**Only bat restriction**	**Only bird restriction**	**Bat and bird restriction**
CAPEX, EUR	–158 400 000			
OPEX, EUR	–103 950 000			
Income from electricity, EUR (over 25 years, if the price of electricity is 89.97 EUR/MWh)	+654 853 603	+643 500 915	+653 022 366	+641 693 784
Revenue, EUR	+392 503 603	+381 150 915	+390 672 366	+379 343 784
LCOE, EUR/MWh	36.04	36.68	36.15	36.78
Payback period, years	10.02	10.19	10.04	10.22

An analysis of the price of electricity was also conducted. Between 2018 and 2023, the price of electricity was in the range of 34–89 EUR/MWh, but in 2022 it experienced a rapid increase of 156 % compared to 2021 due to the geopolitical condition (see Fig. 6 blue line) [32]. The average price of electricity in the last six years is 89.97 EUR/MWh (see Fig. 6 orange line), which is more than 2 times higher than the calculated levelized cost of energy (LCOE) of the Ventspils WPP, which currently guarantees that even if the production of the WPP decreases, the LCOE will be lower than the price of electricity in Nord Pool, which will contribute to the WPP's profitability. The LCOE of a WPP varies depending on operational constraints, which also affect the payback time of the WPP (see Table 3). Even with a decrease in the price of electricity, it is not expected that the construction of WPP could be economically unprofitable, as the predicted average price range found in literature could remain within the range of 50–100 EUR/MWh [33], which means that the WPP will work profitably, as well as the LCOE will be below price level [34].

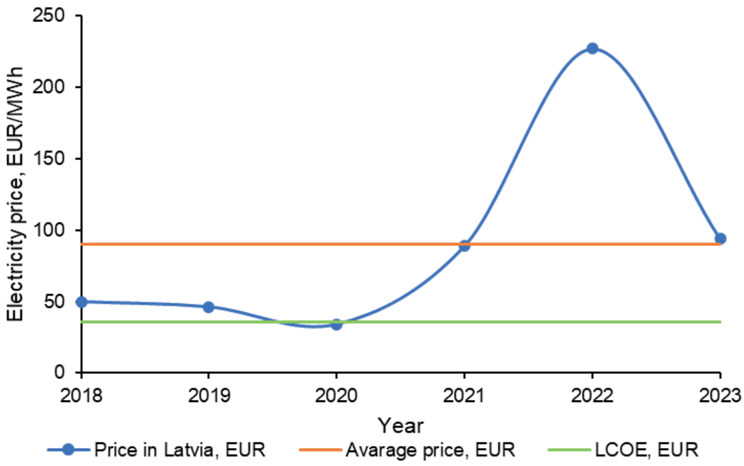

Fig. 6. Electricity price in Latvia from 2018 to 2023 and Ventspils WPP LCOE.

On the website of the ESB, information is available on wind farms that have undergone an environmental impact assessment process. Data are available from 2009. Until February 2024, in total, the decision on the EIA procedure of WPPs has been applied to 68 projects (see Fig. 7), of which the process has been completed only for 12 projects. Not all planned activities for which the EIA process has completed will be implemented because of project next steps and permits [35].

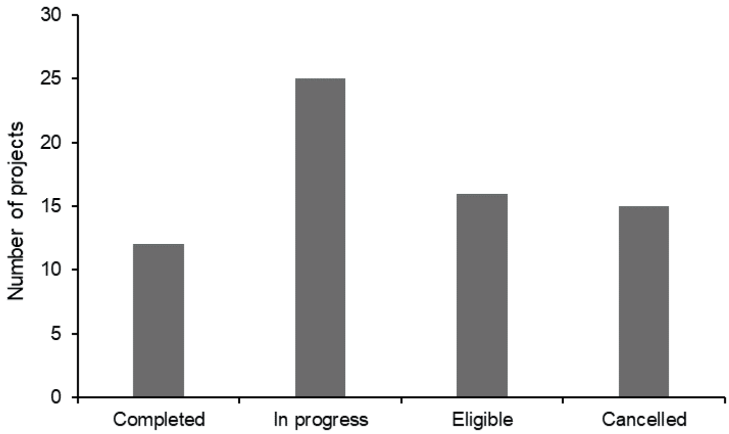

Fig. 7. Project statuses of environmental impact assessments for the construction of WPPs.

Considering the mentioned climatic condition and the calculated possibly economic profitability, there are still significant obstacles to the development of wind energy in Latvia, which is proven by the small number of completed EIA projects and installed wind power capacity, as well as the analysis of obstacles and risks for the development of WPPs in the territory of Latvia (see Table 4) [36].

TABLE 4. OBSTACLES TO THE DEVELOPMENT OF WPPS IN LATVIA

Obstacles
Lack of political will, lack of understanding between national and local level policymakers, as well as non-observance of the legal principle of trust regarding the application of requirements
Long and difficult permitting process, especially environmental impact assessment
Lack of binding regulations for WPP research parameters in the environmental impact assessment process – landscapes, birds and other impacts
Limited building areas - rural homesteads, Natura 2000 areas, micro-reserves, high concentration of biological diversity and agricultural lands of local importance
Limited capacity of public officials and therefore availability for consultations, in particular the Environment State Bureau and the Nature Conservation Agency
Lack of motivation to open agricultural land of national importance for the development of WPPs
Lack of public-oriented communication from state-level structures about the advantages of wind energy and the current situation of the energy sector in general
Lack of renewable energy support schemes for developers
Resistance of local communities – only not in my yard effect (Nimby effect) and the dissemination of targeted myths by anti-wind interest groups and the initiation of various initiatives
Fear of impact on health and environment – a sharp reaction to anything new

According to the author, Latvian political planners can identify and define RES development goals, as defined in the Latvia National Energy and Climate Plan (NECP) but are unable to predict RES development scenarios and improve legislation so that the progress of RES projects is successful and fast. This fact is also confirmed by the European

Commission's 2022 report – "Technical support for the development and implementation of RES policy" [37], where Latvia's situation can be assessed as bad – in terms of location, application preparation, and obtaining permits for WPP.

TABLE 5. COMMUNITY BENEFITS FROM WPP DEVELOPMENT

	Benefits
1.	Revenues in the state and local government budgets from taxes, as well as from community payments
2.	Additional income for landowners from rent for building rights
3.	Reduction of the unemployment rate, increasing the number of jobs for specialists in various industries - builders, engineers, project managers, environmental experts, etc.
4.	Inflow of funding from foreign investors into the Latvian economy
5.	The overall energy independence of the country is promoted by diversifying and decentralizing sources of electricity production
6.	Electricity is exported at times when production is higher than consumption
7.	Development of local energy production will contribute to more efficient use of electricity; thus it can help reduce infrastructure, transmission and distribution costs in the future
8.	A lower electricity price (in periods of high electricity supply) will increase the demand for other technologies – heat pumps, electric transport, etc.
9.	Promotion of competition will reduce or stabilization of the price of electricity - cheaper electricity for Latvian consumers
10.	Reduction of greenhouse gas emissions
11.	Promoting the achievement of climate neutrality goals

To achieve the benefits mentioned in Table 5, for society and the country of Latvia as a whole, a solution to the obstacles and risks mentioned in Table 4 must be found. Energy companies are already ready to share their experience and point of view to prevent incorrect, hastily made decisions in the development of currently proposed and planned amendments to the regulatory acts, because the policymakers and lawmakers must understand that the developer will be affected the most through the scope of the created laws. Creating an effective legal system that will improve the safety, independence and competitiveness of Latvia's energy system in both the short and long term is only possible if all parties are involved. Such firmly established systems will not need to be abolished or changed after a short time, because the principle of sustainability will be applied [38].

The main improvements are needed in the national strategic documents and legislation, as well as in the education of the population (see Fig. 8).

While only 800 MW of new wind energy capacity can be found in Latvia's NECP, Lithuania has committed to increase it to 1322 MW by 2030 [39], but Estonia plans to build an additional 1200 MW [40]. The Estonian plan also includes goals for the use of accumulation methods to integrate RES more successfully into the electricity supply and to stabilize the impact of variable energy resources and the stability of the electricity grid. For Latvia to move forward more successfully when revising Latvian NECP, the following changes are necessary:

1. Integrating the requirements of Renewable Energy Directive (RED III), keeping a balance between the Convention on Biological Diversity.
2. Clearly defined wind energy development scenarios, foreseeing them in the case of onshore and offshore WPPs.
3. To define additional goals and scenarios related to the creation of energy storages along with the increase of RES capacities.

As mentioned, the restrictions are also related to the available areas for WPPs development. To solve it, it is necessary to decrease restrictions at the level of regulatory acts. There are several options for increasing the available area for wind energy:

1. It is possible to build WPP closer to buildings than 800 m if the owner's consent is obtained.
2. Compliance with the principles of the RED III directive regarding RES development.
3. "Softening" WPPs development requirements for biological diversity if modern technological solutions are used (cameras, radars, etc.) because collision risk decreases.
4. Determine the zoning of the territory, where accelerated RES development is possible.
5. Opening of agricultural lands for wind energy development.

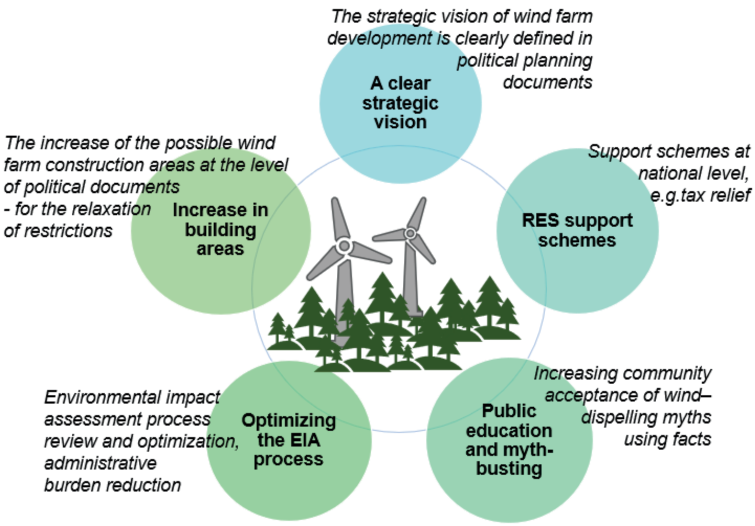

Fig. 8. Proposals for improving the situation for faster development of WPP projects in the territory of Latvia.

If zoning is determined for nature protection – new Natura 2000 territories, new micro-reserves are created to meet the requirements of European Union directives and conventions regarding biological diversity, increasing specially protected natural territories to 30 % of the total area of the country [41]. Then a similar zoning would also apply to the development of WPPs, which results from the requirements of the RED III Directive, where the latest amendments state that Article 15b, paragraph 1 of RED III is expressed in the following wording: "Until May 21, 2025, Member States shall carry out coordinated mapping of renewable energy resources for the deployment of energy in its territory, in order to identify the local potential and the available land surface, underground part and sea or inland water areas, which are necessary for renewable energy stations and their related infrastructure [...] to ensure at least the national contribution in Article 3, 1 of this directive. in the achievement of the general Union renewable energy target indicator for the year 2030 specified in paragraph" [42].

If Latvia can fulfil the requirements of the European Union in relation to biological diversity, then it would be equivalent to include the scenario of fulfilling the RED III requirements as well.

The last but one of the most important proposals is the optimization of the EIA process. If at least part of the above-mentioned proposals were taken into account, so that such WPP as the

Ventspils WPP proposed in this study could be successfully implemented, then the EIA process would have already become a little bit easier. But even with the previously expressed proposals, it is not enough to consider that the process is completely optimized, so additional recommendations for improvements should be taken into account:

- Reducing the administrative burden within the EIA process.
- Simplification of the EIA program.
- Unified system for nature research and monitoring.

Currently, each WPP EIA program is 15–20 pages long. It is necessary to review whether all the requirements of the EIA program really need to be evaluated in the first phase of the project or should be more precisely evaluated in the design phase, when more precise technological solutions and infrastructure layout are known.

The most complicated situation is with birds: in the case of birds, the saying “every expert has his own opinion” is applicable, because uniform approaches (guidelines) for nature research and monitoring are currently not available in Latvia, which means that research is carried out at a level of detail that corresponds to the expert’s opinion, as well as also the specified monitoring requirements. However, the Nature Conversation Agency certifies experts according to uniform rules, but this does not guarantee the WPP developer confidence that the certified expert they choose will be able to meet the requirements of the Nature Conversation Agency. Why is that? Each expert bases his opinion on scientific literature and studies of other countries but the decision on the relevance of the content of the expert’s opinion is made by the Nature Conversation Agency. A controversial question arises here – compliance with what? Or according to the principle, the stricter is better? The conclusion is one – the institution that issues expert certificates cannot evaluate expert opinions, because a conflict of interests arises.

4. CONCLUSIONS

The territory of Latvia has significant wind energy potential, especially in the coastal zone, so investments in wind energy projects could increase the country’s energy independence, promote the diversification of the energy sector, and contribute to the achievement of climate neutrality goals. Wind energy projects require large financial investments, which would be a positive contribution to the country’s economy, encouraging not only investment, but also job creation and other benefits.

The successful development of WPPs in Latvia requires the optimization of legislation and regulatory framework, the integration of the Renewable Energy Directive (RED III) into political planning documents and the regulatory framework of WPPs, considering it equally important with biological diversity.

This study offers a detailed economic analysis of a potential wind energy project in Ventspils region, including cost estimates, operational expenses, and payback periods. The integration of EIA results into the economic evaluation highlights how environmental factors impact project feasibility and economic outcomes. This comprehensive approach provides new insights into the economic and environmental sustainability of wind energy projects in Latvia, offering actionable data and strategic recommendations for the development of this sector. According to the study and modelled operational scenarios of a WPP, the investment payback period will be less than half life of WPP, which could be attractive to investors if there is an unchanged or more friendly legal framework and a stable electricity price.

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