Cost Reduction of Energy in Industrial Enterprises through the Implementation of RES Technology

Proposal of actions for enterprises

Warsaw, May ‘2024

Who we are?

Institute for Renewable Energy Ltd. (IEO) was founded in 2001 as an independent research group. IEO possesses the necessary knowledge and 22 years of experience to undertake tasks, particularly with a team possessing deep understanding of integrating RES with power and heating networks, starting from energy policy and law, economic and financial analysis from the entire RES area, and ending with technical and project issues. IEO has extensive experience in developing technical solution concepts, functional-use programs, feasibility studies, business plans, and also participates in author supervision in the practical implementation of investments in the renewable energy sector (all types of RES, including weather-dependent sources, heat and electricity storage, as well as in microgrid design processes and energy management within them). IEO has participated in the implementation of several international projects related to forecasting the development of RES and RES-based energy systems. The President of IEO is a member of the Scientific Committee of the National Distributed Energy Congress organized by AGH University of Kraków and a Member of the Board of the Polish Chamber of Energy Clusters and RES.

Experience and references

- **Polish Wind Energy Association** – Potential of industrial areas for the development of onshore wind energy (2023);
- **Grupa Norblin S.A.** – Analysis of legal and technical conditions for an RES project on 200 ha of land located in the Goleniów district (West-Pomeranian Voivodship) (2023);
- **PEC w Końskich sp. z o.o.** – Transformation of PEC Końskie (Heat Energy Company) to achieve the status of an effective heat system with 50% share of renewable and zero-emission energy sources, under the NCBiR project "Heat Plant of the Future" (2022);
- **Zakłady Górniczo-Hutnicze „Bolesław” S.A.** – Development of a concept for creating an integrated electricity management area in ZGH "Bolesław" S.A. (Mining and Metallurgical Plants "Bolesław") (2021 – 2022);
- **RAFAKO Innovation sp. z o.o.** – Feasibility study for the implementation of RES in the RAFAKO S.A. energy system, "Green Rafako" Project (2021 – 2022);
- **Grupa Azoty S.A.** – Technical-economic concept for the "Photovoltaic Power Plant in Grupa Azoty S.A." (2021);
- **OX2 AB** – Analysis of the photovoltaic potential in the business prosumer area in industry in the medium-term perspective (2021);
- **Polish Wind Energy Association** - Investment potential of onshore wind energy in Poland (2019);

- **Gaz-System S.A**. – Analysis of the potential use of renewable energy sources: photovoltaic panels, heat pumps, solar collectors in the natural gas transmission system, and designing a hybrid system (combining various RES technologies) to power the gas station in the Pruszcz Gd. district as an alternative to the network of gas reduction station power systems. (2013 – 2016).

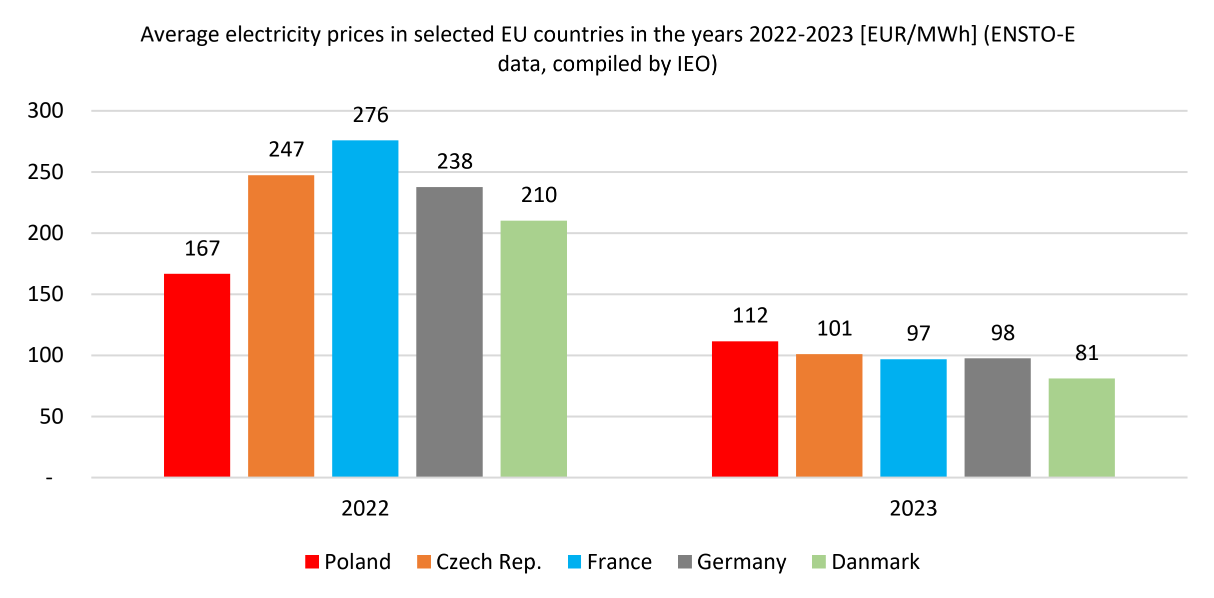
Why does the Industry need Renewable Energy Sources?

The offer is a response, among other things, to the CSRD directive. It concerns corporate reporting in the context of sustainable development. In Poland, initially about 4-5 thousand entities will be subject to these regulations. This is a significant step towards increasing corporate responsibility for environmental and societal impact. Preparing for these changes is crucial both for maintaining competitiveness and meeting stakeholder expectations. Adapting companies to the new requirements of the CSRD Directive will be crucial, as failure to meet ESG requirements, including a high carbon footprint in the supply chain, will result in a lack of creditworthiness and loss of competitiveness in both the domestic and European markets. Furthermore, competitiveness depends on energy intensity, particularly on the share of electricity in the industry's sold production, which is high (table below), energy prices for industry in different countries, and the so-called carbon footprint.

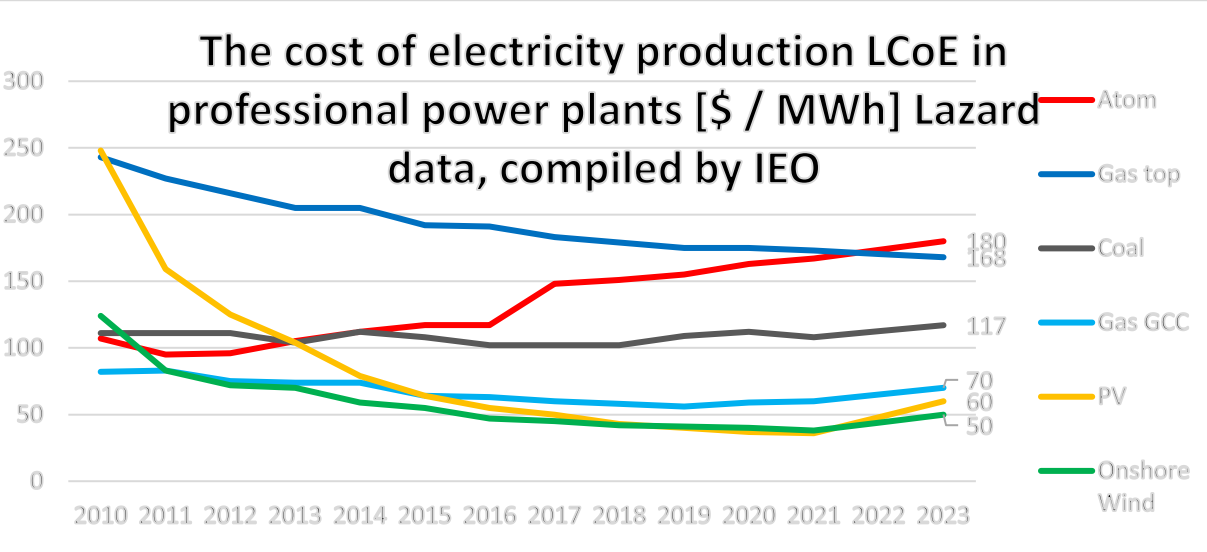
The energy intensity index of industrial production (electricity consumption per 100 PLN of sold production) for sectors according to the Statistical Yearbook of Industry (data for 2021)	The electricity consumption in kWh per 100 PLN of sold production
TOTAL	6,2
Mining and quarrying	13,6
Industrial processing, including:	
• Manufacture of starch and starch products	8,6
• Production of wood, cork, and straw products	9,2
• Paper and paper product manufacturing	10,4
• Manufacture of pulp, paper, and paperboard	18
• Chemical and chemical product manufacturing	10,6
• Manufacture of chemicals, fertilizers, and plastics	15,7
• Production of chemical fibers	14,5
• Manufacture of non-metallic mineral products	10,8
• Production of ceramic building materials	13,8
• Manufacture of cement, lime, and gypsum	23,8
• Metal production	10,7
• Generation of electricity, steam, and hot water	14,6

Increasingly diverse electricity prices and varying carbon footprints (as well as the level of subsidies for energy-intensive industries) have become an extremely limiting factor for industrial competitiveness. After high, but relatively low electricity prices in Poland in 2022, the situation for the Polish industry significantly worsened in 2023 - Poland became a country with one of the highest wholesale electricity prices in the EU (after Italy).

The chart below illustrates how Poland's competitive position has changed compared to countries with strong industrial processing.



One of the reasons for high energy prices in Poland is still the relatively low share of the cheapest RES energy sources (wind and solar) in the Energy Mix, and a high share of coal, along with the risk of rising energy prices due to planned massive investments in nuclear energy (more expensive than coal energy). The chart below illustrates how the costs of energy from newly built power plants have changed in subsequent years.



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The cheapest energy comes from newly built RES - they have become the cheapest for investments in wind and photovoltaic farms carried out respectively in the years 2012-2025. The costs of energy from these sources are twice as low as the costs of coal energy. In a situation where there are too few wind and photovoltaic farms built after 2015, the best way to reduce energy supply costs (and reduce the carbon footprint) is to build its own wind or PV sources. Ideally, these sources should be located on the premises or in the vicinity of the industrial plant and connected to the plant's own network, chosen to ensure full energy self-consumption in the auto-producer model. The connection capacities of RES to the internal networks of industrial plants (often Distribution Network Operator not directly connected to transmission network - OSDn) currently have greater potential than the current possibilities of connection to the national energy grid (distribution and transmission networks).

The main obstacle in locating the cheapest wind sources (which also have a favourable generation profile from the industry's point of view), also in industrial areas, has been the regulations of the wind farm investment law known as the 10H principle and the requirement to change the local spatial development plans (under the spatial planning law). Last year, these regulations changed favourably for industry needs.

The amendment to the spatial planning law allows the implementation of wind farm investments (as the so-called main investment) together with accompanying investments (usually infrastructural) within the framework of the Integrated Investment Plan (IIP), adopted by the resolution of the municipality. The IIP becomes a form of local spatial development plan. The 10H principle has been changed to the 700m principle (minimum distance of wind turbines from residential buildings). As a result, the potential and possibilities of wind farm investments in industrial areas have significantly increased. Annex 1 presents an example of spatial analysis assessing the potential for wind energy investments in an industrial enterprise in current legal conditions (after the liberalization of the "10H principle"). The analysis confirmed that after the liberalization of the regulations, wind farms with a capacity of 9 MW can be located on the company's own premises, and with buffers, even up to 220 MW, depending on the size of the buffer.

The following proposal for assessing the possibilities of implementing RES technologies has been developed with comprehensive support for companies in adapting to the current reality. In our analysis, we pay particular attention to increasing the competitiveness of companies by effectively using cheaper renewable energy. The feasibility of the RES project is thoroughly verified in terms of technical and economic aspects, enabling decision-making based on solid data and forecasts. Our offer includes an analysis of various economic scenarios, allowing the energy strategy to be adjusted to changing market conditions.

Acting in the context of new economic challenges, we consciously strive to develop an analysis that will not only meet current requirements or satisfy needs but also prepare your company for potential future changes. We are convinced that our experience and professionalism can become a key support in the process of adapting your company to the new energy reality.

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Staged collaboration formula

Stage I – Initial assessment of potential and qualification of the enterprise; Confirmation of wind power potential expressed in RES capacity

The client will be asked to fill out a survey, based on which the preliminary potential for reducing energy costs in the industrial enterprise through the implementation of RES technology will be evaluated, including:

• Analysis of addresses provided by the client of facilities or plots along with the surrounding environment in terms of the amended wind farm investment law.

Timeline: **2 weeks**

Stage II – Verification of the feasibility of the RES project for the enterprise

This involves a comprehensive assessment of the feasibility (technical, logistical, and legal) of the RES implementation project on potential investment areas. Expert analysis will identify potential challenges and determine the optimal solution, ensuring the effective implementation of the project.

a) Study visit to industrial facilities:

As part of the initial visit, the following actions will be taken:

- Meeting with the Management of the enterprise and personnel responsible for energy management and embedding the project concept in the company's energy supply optimization strategy
- Initial assessment of the location and its surroundings for the potential use of RES
- Establishing contact with local government authorities regarding local spatial planning conditions

b) Identification of areas/places for RES investments:

Conducting potential analysis for various RES technologies within the available investment area on the enterprise's premises and in the "buffer zone" (e.g., using direct lines). At this stage, geospatial analysis tools will be used, utilizing data on land cover, terrain relief, soil classes, building suitability for RES installation, distances from residential and industrial buildings, as well as other terrain obstacles and protected areas.

c) Description of technical conditions:

Assessment of technical conditions (including network conditions) along with the location of equipment in the field and analysis of the productivity of individual RES technologies translates the potential of a given area into real proposals for installing RES solutions along with the volumes of energy generated by a given technology (or configuration of several RES solutions). The analysis will be conducted using professional simulation tools (PV*Sol, WaSP, etc.) considering meteorological and topographical data.

d) Legal conditions assessment:

It includes a description of the formal and legal procedures required to effectively implement RES investments, considering currently applicable national, European, and local regulations. Due to potential locations extending beyond the enterprise's land, the ownership structure of the land and the possibility of installing facilities and establishing direct lines between the RES installation and the production plant will also be verified.

e) Logistical conditions assessment:
Primarily concerns wind energy. Key elements of the assessment include effective transport of heavy turbine components, ensuring access to qualified staff, and proper management of temporary storage areas. A detailed assessment is possible through IEO's collaboration with technological partners.

Timeline: **8-12 weeks after completion of Stage I**

Stage III – Technical-economic analysis with summary and recommendations

The final stage involves an economic analysis, including a detailed and realistic cost estimate of the investment, ROI forecast, and the possibility of using available investment financing programs. The aim is to provide clear information regarding the project's profitability and cost optimization possibilities through the following tasks:

a) Integration of RES and energy storage with the enterprise's energy system and simulation of the modernized system's operation:
- Configuration of variants for the most attractive technological solutions, including reference variants (usually PV and Wind with their hybrids) and alternative ones (using so-called enabling technologies - energy storage, electrolysers, etc.)
- Verification of analysis assumptions considering the results of stages I and II,
- Assessment of potential RES investment costs and economic benefits, such as savings related to energy cost reduction in the overall operation balance of the enterprise, along with potential financial support.

b) Investment economic analysis including:
- Wholesale electricity price forecasts (indices at which energy is sold to the grid) and tariffs (components of charges on which the investor saves on energy purchases) up to 2040;
- Analysis of the technology suppliers and installers market and recommendation and determination of average CAPEX, OPEX costs;
- Recommendation of three technological solutions and proposal for selecting the optimal variant with determining the investment's profitability using commonly used investment assessment indicators - LCoE - Levelized Cost of Energy (or NPV);
- Presentation of available support instruments and opportunities for obtaining financial resources for the investment.

c) Summary and recommendations:
Based on the gathered data, analysis, and assessments, a detailed report containing conclusions, recommendations, and potential implementation scenarios for RES in the enterprise will be prepared. Additionally, throughout the cooperation period, the IEO team is open to consultations with the Company's management team to obtain acceptance and discuss potential adjustments to the current and long-term enterprise strategy.

Timeline: **4-8 weeks after completion of Stage II**

Total project execution time: **from 13 to 22 weeks**

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Estimated Costs of Project Implementation

Preparing a project for renewable energy development in an industrial enterprise, including technical and economic analysis, is a unique undertaking that can be likened to "tailoring." The costs of preparing the project will depend on several factors and will be adjusted to the specific needs of the client. Considerations include:

a) The size and complexity of the area, as well as the number of enterprise facilities covered by the analysis and assessment.
b) The possibility of constructing renewable energy installations on the enterprise's premises, including an analysis of terrain and technical conditions.
c) The need to prepare a system for managing the energy generated by the enterprise, along with any associated implementation costs.
d) The enterprise's interest in energy storage, including consideration of various forms and periods of storage, which may entail additional costs.

Therefore, project costs will be determined flexibly after gathering all necessary information and understanding the client's needs.

For any further questions, please feel free to contact Piotr Dziamski at the provided email address or phone number.

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Attachment - Example of preliminary spatial analysis regarding the assessment of potential for wind energy investment in a large energy-intensive industrial enterprise

Spatial analysis of renewable energy (RES) locations using the IEO methodology is demonstrated here with the example of areas belonging to a selected energy-intensive enterprise, focusing on the potential for wind turbine locations (the cheapest source of electrical energy) based on legal regulations (in this case - 700m from residential buildings) and planned regulations (a proposed law allows for 500m), as well as justified buffers due to distance (at the expense of cable line construction).

Similar analyses are conducted for photovoltaics (here - with soil class analysis) and identification of areas suitable for seasonal underground heat storage, hydrogen, or battery storage.

A representative industrial facility specializing in metal production and processing was selected. The organizational structure of the analysed enterprise includes a metallurgical plant and an adjacent post-production waste landfill.

The main objective of the study is to assess the potential for implementing onshore wind energy solutions in the structure of the enterprise among energy-intensive companies in areas close to the enterprise. The following figure presents an illustrative map showing the locations of the enterprise.

Figure 1. Overview map of the analysed energy-intensive enterprise

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Spatial analysis

Defining two buffers with radii of 5 km and 3 km from the location of the main plant of the analysed enterprise allows for estimating areas optimal in terms of wind potential in two cases: first, when the enterprise is within an industrial development zone (OSDn) or operates within an energy cluster, analysed for a 5 km buffer; second, when the enterprise operates outside such structures, with a 3 km buffer. The following figure presents an overview map with designated buffer areas.

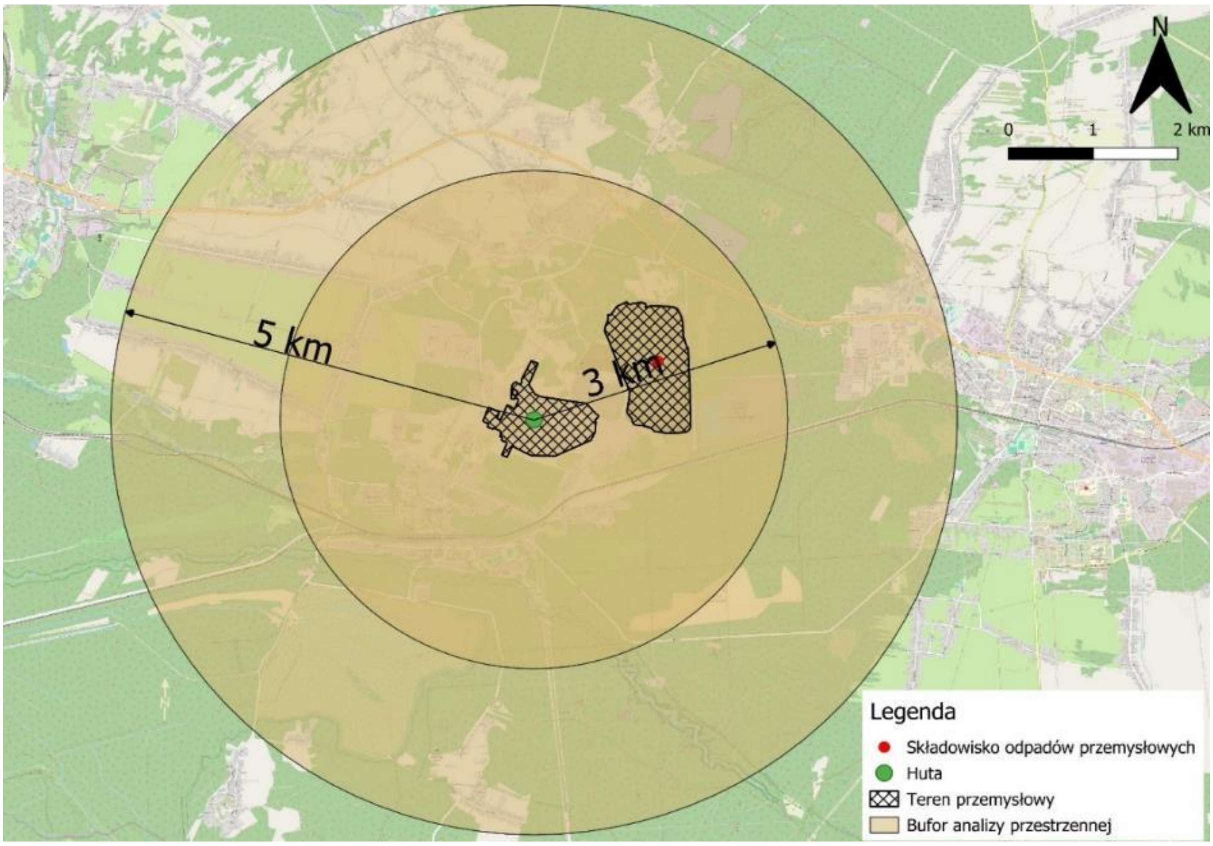

Figure 2. Distance buffers determining the scope of spatial analysis

Next, an exclusion zone was defined as a distance of 700 meters from single and multi-family residential buildings. The analysis results identified areas meeting the minimum distance requirements from residential buildings. The attached map below indicates, based on the 700m exclusion zone, the closest available areas for wind energy investment.

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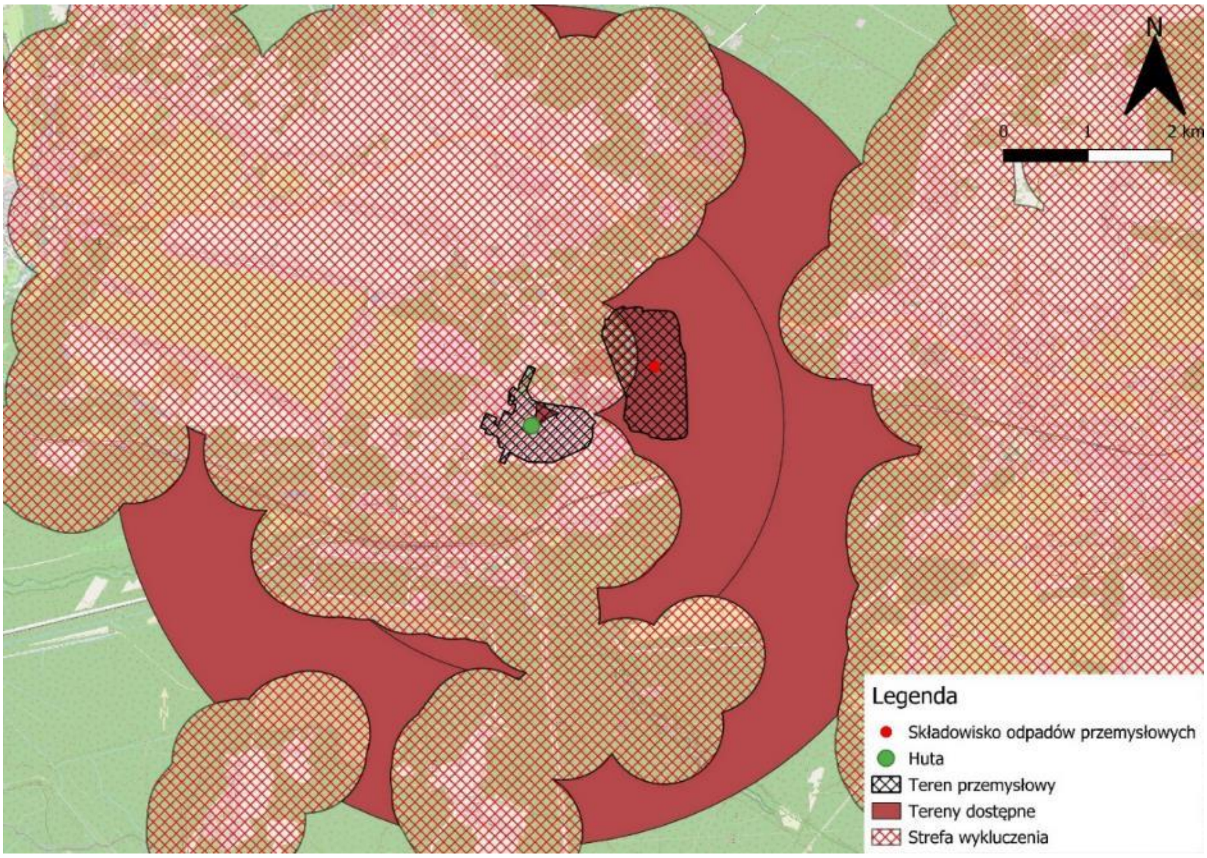

Figure 3. Exclusion zone of 700m from single and multi-family residential buildings in the vicinity along with available areas

To visualize the available surface area for the analysed case, an additional buffer analysis was performed considering setback requirements, with the “10H” distance set expertly at 1600 meters from residential buildings. The following figure illustrates the impact of the so-called "wind turbine law" on the exclusion of surrounding areas in the context of the analysed case.

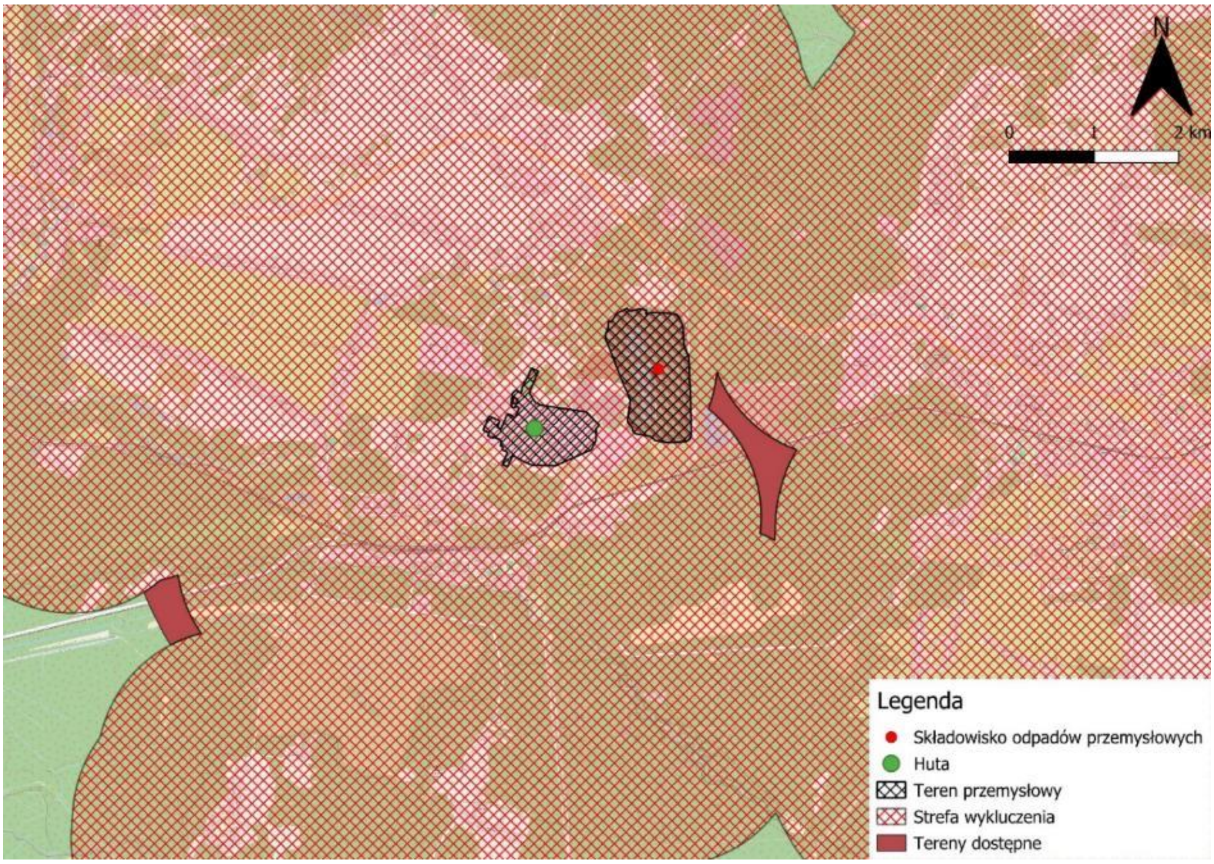

Figure 4. Available areas for a 10H distance from the analysed enterprise

Summary of the case study of spatial analysis of the analysed energy-intensive enterprise

Conducting spatial analysis allowed for identifying investment potential in areas around the analysed energy-intensive enterprise. The analysis also showed that areas belonging to the analysed enterprise - waste post-production landfill areas - were also qualified as available areas. Available areas in the vicinity of the analysed energy-intensive enterprise are summarized in the table below.

Results of analysis of available areas within the analyzed enterprise and neighboring areas within 3 km and 5 km distances

Distance from energy-intensive enterprise Enterprise	Own areas	Available nearby areas limited to 700m from residential buildings
Buffer 3 km	**Ca. 90 ha**	**655 ha**
Buffer 5 km		**2.203 ha**

For the 5 km distance scenario, a surface area of 2.203 ha was identified. For a distance of 3 km from the analysed enterprise, the available surface area was 655 ha. Precise determination of areas suitable for wind investments would require more detailed and individual analysis of the case study. Then it would be possible to unequivocally determine whether specific areas are suitable for carrying out wind energy investment projects. The final estimation of wind potential is summarized in the table below.

Summary analysis for the selected enterprise

	Maximum installed capacity [MW]	
	3 km	**5 km**
Total wind turbine capacity possible to install on the enterprise's own lands **under 10H conditions**	**0**	**0**
Total wind turbine capacity possible to install on the enterprise's **own lands, with a 700m distance from residential buildings**	**9**	
Wind turbines possible to install on adjacent lands, assuming a direct line and a **700m buffer**	**65**	**220**
Wind turbines possible to install on adjacent lands, assuming a direct line and a **10H buffer**	**5**	**8**

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