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Analysis of economic efficiency of wind farm and photovoltaic installation operation in a cable pooling system in Poland

Paweł Włoch, Magdalena Lazarek - Janowska

Abstract: Wind farms and photovoltaic installations aligns with the concept of distributed energy sources. For many years, the "Achilles' heel" of implementing such investments was obtaining the ability to connect to the power grid. One issue raised by operators was the actual level of usage of the granted connection capacity by users. To truly enhance efficiency through the idea of combining wind and photovoltaic sources into a single connection, the concept of cable pooling emerged. To verify the validity of this assumption, it became necessary to study the cooperation of these generating units over time. The purpose of this study is to evaluate the profitability of projects implemented in a shared connection arrangement using cable pooling. The article employs the NPV method (Net Present Value) and IRR(Internal Rate of Return) to assess investment efficiency.The source data representing national generation from wind sources and photovoltaic installations were obtained from the Transmission System Operator. Structured into time series, they can be considered exemplary, representing the dynamics of variability in generation from these types of generating sources in the Polish geographic area.

Key words: cable pooling, economic efficiency, wind farm, photovoltaic installation.

Introduction

The development of renewable energy in Poland plays a crucial role in the transformation of the national power system towards sustainable development. Two key technologies driving this transformation are wind power plants and photovoltaic installations. The wind power sector has been growing rapidly, reaching over 10 GW of installed capacity in 2023. Meanwhile, photovoltaic energy, which gained momentum after 2017, is approaching 18 GW of installed capacity. Despite their significant potential, both technologies share a common characteristic – energy generation is dependent on weather conditions. Wind power plants operate at maximum efficiency primarily during the autumn and winter months, while photovoltaic panels reach their peak generation during the spring and summer periods, under optimal sunlight and moderate temperatures.

Given the limited connection capacity in the National Power System (KSE), the challenge lies in the efficient use of the available network infrastructure. Data from 2022 indicates that 90% of applications for new generation units were rejected. At the same time, existing renewable energy sources are not fully utilizing their connection capacity, causing losses for both investors and system operators. One solution to this problem is the concept of shared connections, known as cable pooling. This involves combining two different generation sources – a wind farm and a photovoltaic installation – into a single grid connection, while maintaining a limit on the maximum power fed into the network. By leveraging the complementary operation

of both technologies, it is possible to increase the efficiency of using connection capacity and reduce investment costs through shared infrastructure.

The aim of this study is to analyze the economic efficiency of implementing the "cable pooling" project within the context of the Polish power system. The article uses data on national energy generation from wind power plants and photovoltaic installations, published by Polskie Sieci Elektroenergetyczne S.A. (PSE) and the Energy Market Agency (ARE). The analysis is based on time series data, which allows for estimating the reduction in generation levels and assessing the project's profitability using NPV and IRR indicators.

This paper provides answers to the question of whether combining two different renewable energy sources into a shared grid connection is an economically viable solution in the context of Poland's energy sector and what benefits could arise from its implementation.

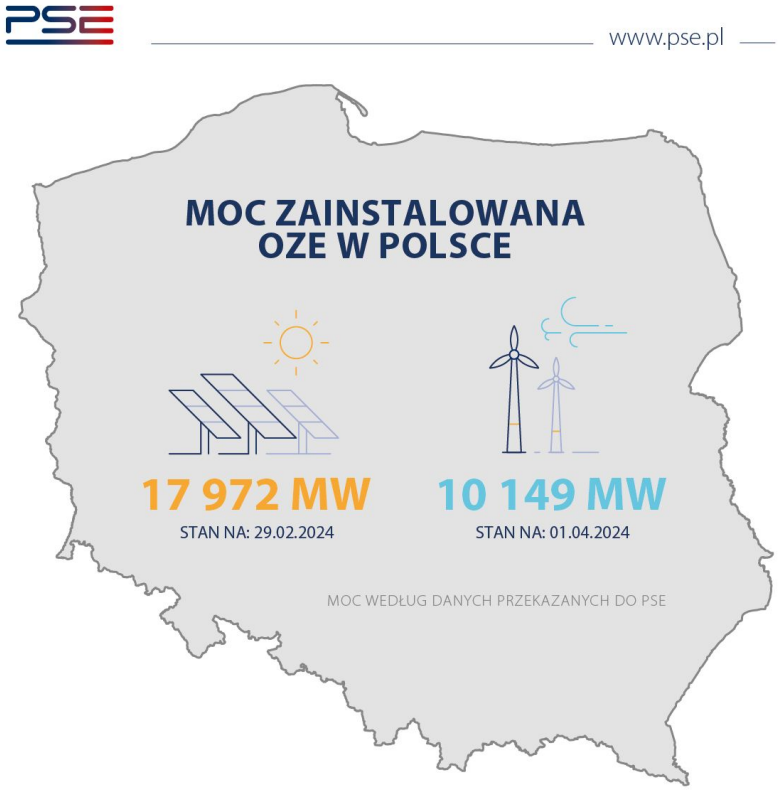
Wind and photovoltaic power in Poland

The development of the renewable energy market in Poland in the form of wind farms began in 2001 with the construction of the first wind farm in Barzowice with a capacity of 5 MW (Zimny, Laskowski M 2004: 57). Since then, the installed capacity of wind farms in Poland has exceeded 10 GW (based on data published by PSE S.A.).

Photovoltaic energy began its dynamic development in 2017, and the installed capacity in this technology is now close to 18 GW. Both sources are weather-dependent, with generation subject to variable weather conditions.

For example, the efficiency of wind farms achieves 2,566 MWh/year/MW (Gnatowska, Wąs 2015: 23-33) for a 3 MW power plant, representing an efficiency of 29%. In the case of photovoltaic power plants, the efficiency in Poland is 1,015 MWh/year/MW (Gradziuk, Gradziuk 2019: 125), representing an efficiency of 11.6%. However, this is the energy efficiency of photovoltaic modules, which, in the electrical system, are connected to inverters with lower power than the total module power. This is typically defined using the DC/AC ratio, which ranges from 1.15 to 1.35, resulting in an actual system efficiency of 9.6%.

Fig. 1. Installed capacity of wind power plants and photovoltaic panels in Poland



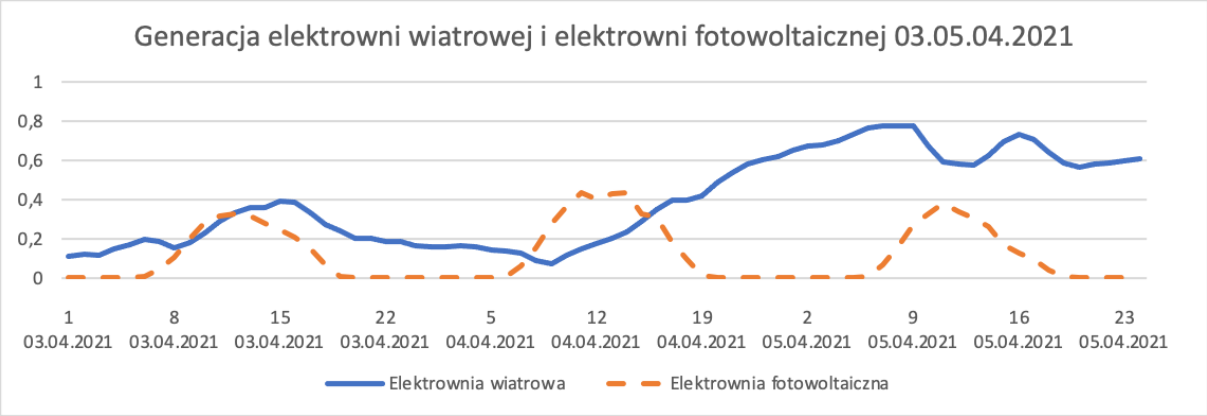
Source: www.pse.pl (access: 15.04.2024).

The operational characteristics of both generating sources share a common feature: their generation levels vary based on weather conditions, fluctuating between maximum power and zero (maximum power generation is rare for wind farms and does not occur for photovoltaics).

Photovoltaic generation is dictated by two factors: current sunlight and ambient temperature. The nominal operating temperature of the module, provided by the manufacturer, averages 25 degrees Celsius. During sunny summer days, when panels can heat up significantly above this temperature, they do not reach their maximum output. Therefore, photovoltaic peak generation is observed in the third decade of May, a month before the summer solstice when the sun is near its highest point of irradiation, but ambient temperatures are not yet as high as in the summer months.

In Figure 2, an example of 3 days of operation for wind power plants and photovoltaic panels is shown.

Fig. 2. Generation of wind and photovoltaic power plants during the period 03 – 05.04.2021



Source: Own elaboration, based on data from PSE S.A.

This operational nature suggests that these generating units inefficiently utilize the connection, i.e., they use the assigned connection capacity to the National Power System to a low degree. This issue is critical for the further development of the energy system.

In 2022, nearly 90% of new generating unit connection requests were denied compared to submitted applications. This situation is confirmed by initial cases observed in the network, where there is temporary overproduction of energy and transmission network overloads (Włoch 2023: 68).

Considering this, it should be noted that on one hand, granting new connection capacities for new installations is impossible, while on the other hand, approximately 28 GW of power with poor connection capacity utilization efficiency has been connected to the network.

To conduct a comparative analysis, it was necessary to analyze the efficiency of installations working in a shared connection arrangement, known as "cable pooling." This involves connecting two generating units, a wind farm and a photovoltaic farm, to a single connection agreed upon with the power system operator and not exceeding the defined connection capacity.

For the theoretical analysis, this involved building and operating two generating installations, each with a capacity of 30 MW, under the condition of not exceeding a maximum power of 30 MW for energy fed into the network. This is practically done using automation control systems to ensure the maximum power agreed with the network operator is not exceeded. An important economic aspect is that such an investment involves creating a single connection and incurring the related investment costs.

Investment Evaluation Criteria. Assessment of Common Generation Reduction

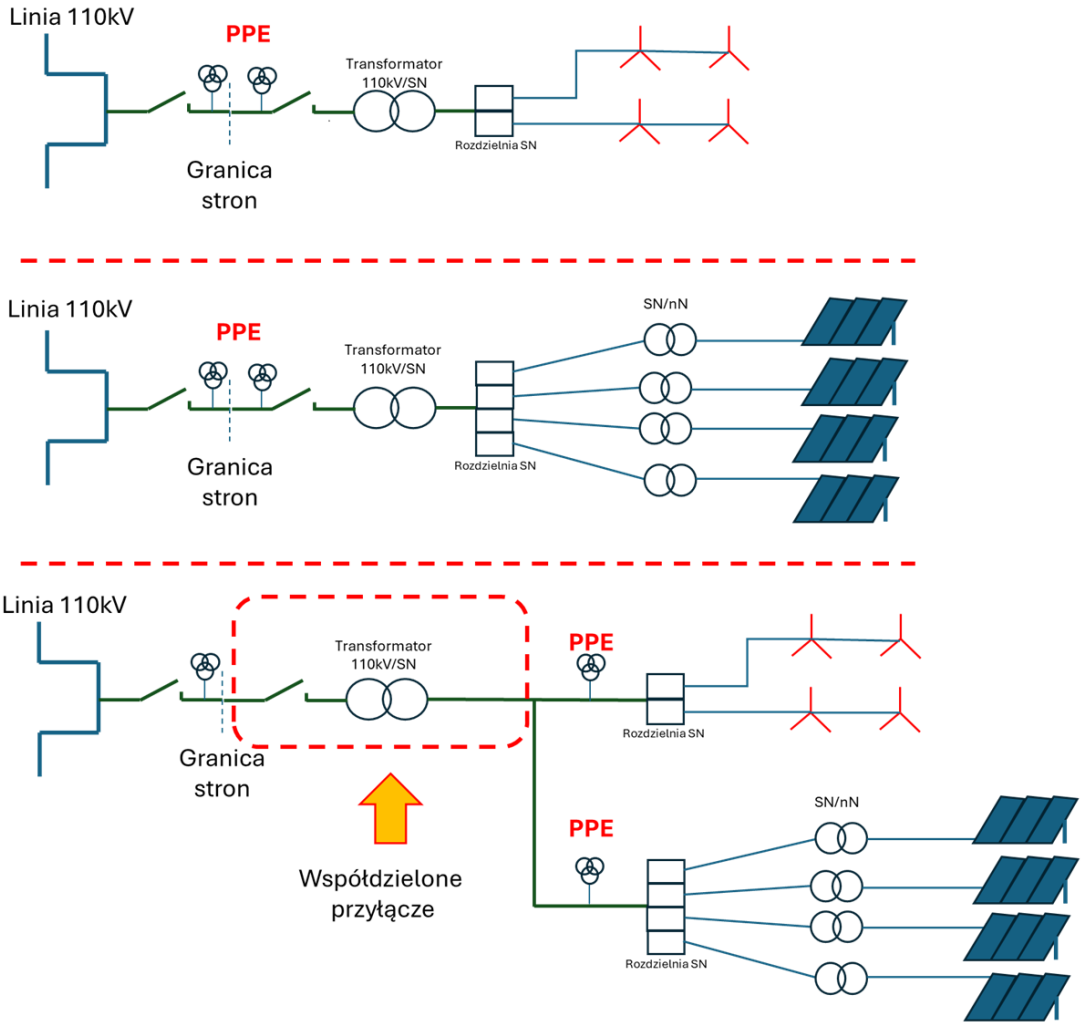
To evaluate the efficiency of two generating installations with a maximum power limit, an analysis was conducted on time series representing the generation of wind and photovoltaic power plants for a one-year calendar period. Time series were based on data from national power generation, published by Polskie Sieci Elektroenergetyczne S.A. and the Energy Market Agency S.A. regarding installed power in the national power system. Time series were developed based on data from January 1, 2021, to December 31, 2021. The subject of the analysis was a theoretical object consisting of a 30 MW wind farm and a 30 MW photovoltaic farm, working on a shared connection with a maximum power limit of 30 MW.

Based on the analysis, the level of common generation reduction was determined at 2.05% of operating time. The total generation of both generating sources without limitation was 102,411.6 MWh/year. Due to the 30 MW power limit, total generation was reduced to 101,838.78 MWh/year. The limitations occurred over a total of 180 hours, representing 2.05% of the operational time in one calendar year.

Assessment of Shared Investment Costs

For a unit capacity of 30 MW, connection to the network would involve connecting to a 110kV line field at an existing power station, with the cost of connection estimated at 3 million PLN net. For connection to be possible, appropriate infrastructure must be built on the investor's side. Given that wind turbines generate energy at medium voltage (6 to 33 kV) and photovoltaic modules generate energy at low voltage (48V), it is necessary to construct a network infrastructure with voltage transformation to 110 kV. Figure 3 shows a conceptual diagram presenting the connection infrastructure for each of the considered implementations.

Fig. 3. Conceptual scheme of connection and shared connection implementation



Source: Own elaboration.

According to legal regulations, the object connected to the network is defined by the so-called PPE point, or energy consumption point. An energy meter assigned to this point determines the amount of energy consumed or fed into the network. For generating installations, this is done through dual metering, both on the operator's side and the investor's side. As illustrated in Figure 3, sharing the connection can divide investment costs between two installations (shared infrastructure marked with a red dashed line).

Shared connection components may include:

1. Connection fee based on the connection agreement,
2. Cost of constructing the power line to the connection point,
3. Cost of constructing the 110kV/MV transformer station.

When connecting a wind farm and a photovoltaic farm as independent projects, each investment would bear 100% of the connection costs. Shared connection installations involve building the infrastructure once, splitting the costs between two investments.

When connecting at the 110 kV level, the connection fee associated with constructing a 110 kV line field is estimated at 3 million PLN net, while constructing a 110kV/MV transformer station with a capacity of 33 MVA is estimated at 10 million PLN net. The cost of underground 110 kV lines depends on individual location and distance from the generation infrastructure to the connection point. For the analysis, it was assumed that the installations are directly adjacent to the connection point.

Based on these assumptions, a financial analysis was conducted for three installations:

1. Construction and operation of a 30 MW wind farm,
2. Construction and operation of a 30 MW photovoltaic farm,
3. Construction and operation of a 30 MW wind farm and a 30 MW photovoltaic farm, operating in a shared connection arrangement, known as "cable pooling."

For each case, investment costs, operating costs, and revenue from electricity sales were determined. Based on these values, financial modeling was performed to conduct an indicator analysis, i.e., determining the Net Present Value (NPV) and the Internal Rate of Return (IRR).

Tab. 1. Assumptions for financial analysis of discussed installations

Installation	**Wind Farm**	**Photovoltaic Farm**	**Wind + PV (cable pooling)**
Capacity (MW)	30 MW	30 MW	30MW + 30 MWp
CAPEX/MW	€ 1 500 000	€ 750 000	
Connection Cost/MW	€ 100 000	€ 100 000	€ 50 000
OPEX/MW	€ 50 000	€ 5 000	€ 55 000
Production (MWh/year/MW)	2566 MWh	1015 MWh/847MWh*	----
Production (MWh/year)	76 980 MWh	30 450 MWh/25 431 MWh	101 838,78 MWh
Energy Price	€ 85,00		
Inflation	2,50%		
Discount Rate	9%		

Source: Own elaboration.

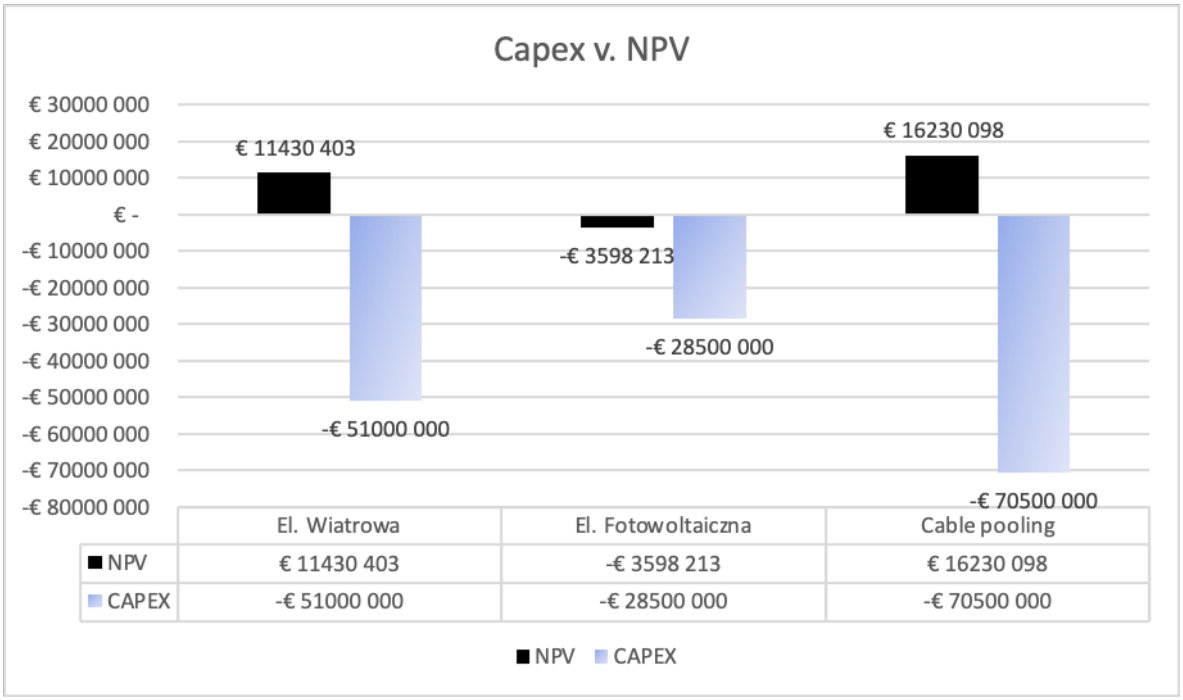
In the analysis, revenue and operating costs were adjusted based on the inflation rate. The analysis was conducted for a 25-year operational period of the facility.

Tab. 2. Results of ratio analysis

Facility	Wind Energy	Photovoltaic Energy	Cable pooling
NPV	€ 14 430 403,07	€ -599 264,91	€ 16 230 097,75
IRR	12,13%	8,74%	11,42%

Source: Own elaboration.

Chart 1. Comparison of investment expenditures and NPV values for the analyzed installations



Source: Own elaboration.

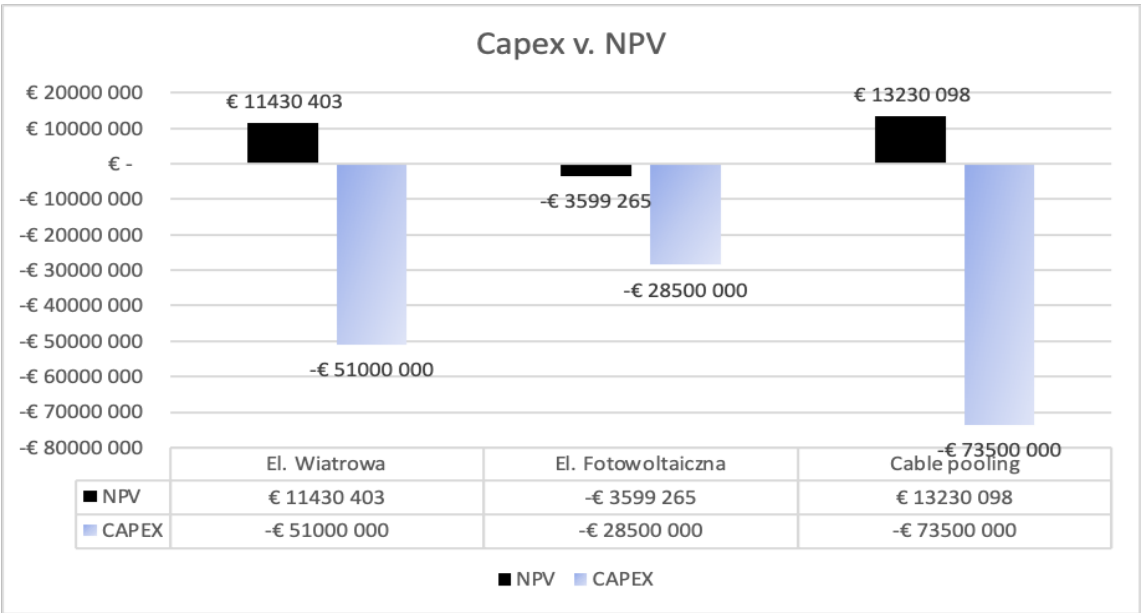
As part of the conducted analyses, a profitability study was carried out for facilities that additionally require laying a 10 km section of 110 kV cable line. For the analysis purposes, the construction cost of 1 km of underground MV line was assumed to be EUR 300,000. Table 3 presents the results of this analysis.

Tab. 3. Results of ratio analysis for facilities with a 10 km 110 kV power line

Facility	Wind Energy	Photovoltaic Energy	Cable pooling
NPV	€ 11 430 403,07	€ - 3 599 264,91	€ 13 230 097,75
IRR	11,36%	7,57%	10,91%

Source: Own elaboration.

Chart 2. Comparison of investment expenditures and NPV values for the analyzed installations



Source: Own elaboration.

An alternative investment approach involves assessing each facility independently, despite being interconnected through shared grid connection. In such a scenario, the connection cost is divided equally between each facility. The issue to determine is how to allocate the power generation constraints. Should they be borne entirely by the photovoltaic installation, the wind installation, or shared equally between both? The business strategy adopted by the investor plays a crucial role here. In practice, the structure of cable pooling can be implemented in three scenarios:

1. The investor owns a wind farm and plans to expand it with a photovoltaic farm.
2. The investor owns a photovoltaic farm and plans to expand it with a wind farm.
3. The investor intends to implement a project consisting of two generation sources.

In the first scenario, it seems justified to allocate the constraints to the photovoltaic installation. In the second scenario, the reduction in generation should be accounted for by the wind farm. In the third scenario, the reduction should be evenly split between both installations.

Table 4 presents the results of an analysis where the connection cost was split equally between both installations, but power generation constraints were allocated differently.

Tab. 4. Results of ratio analysis with varying power reduction strategies.

	Photovoltaic		Wind Energy	
	NPV	IRR	NPV	IRR
Reduction of Photovoltaic (PV)	€ 299 926	9,14%	€ 15 930 403	12,54%
Reduction 50/50	€ 600 331	9,27%	€ 15 628 946	12,48%
Reduction of Wind Energy	€ 900 735	9,41%	€ 15 327 490	12,41%

Source: Own elaboration.

In Table 5, the results of the analysis for facilities considering a 110 kV power cable line are presented, showing different scenarios of generation reduction.

Tab. 5. Results of ratio analysis for facilities with a 10 km 110 kV power line, with varying power reduction strategies.

	Photovoltaic		Wind Energy	
	NPV	IRR	NPV	IRR
Reduction of Photovoltaic (PV)	-€ 1 200 074	8,48%	€ 14 430 403	12,13%
Reduction 50/50	-€ 899 669	8,61%	€ 14 128 946	12,07%
Reduction of Wind Energy	-€ 598 213	8,74%	€ 13 827 490	12,00%

Source: Own elaboration

As observed in both scenarios of project implementation under shared power pooling, there is a positive impact on the financial outcomes of each independently analyzed project. However, the photovoltaic farm project does not always achieve the required rate of return.

Table 6 presents the analysis results for each installation, conducted as an independent entity and with different generation reduction strategies.

Tab.6. Results of ratio analysis for photovoltaic and wind farms, conducted independently and under shared grid connection with varying power reduction strategies

		IRR	NPV
	Independent Wind Farm	12,13%	€ 14 430 403
Ccable poo-ling	Cable Pooling - Reduced Wind Farm	12,41%	€ 15 930 403
	Cable Pooling - Wind Farm Co-reduced	12,48%	€ 15 628 946

	Cable Pooling - Wind Farm Unreduced	12,54%	€ 15 327 490
	Independent Photovoltaic Farm	8,74%	-€ 599 265
Cable pooling	Cable Pooling - Reduced Photovoltaic Farm	9,14%	€ 299 926
Cable pooling	Cable Pooling - Photovoltaic Farm Co-reduced	9,27%	€ 600 331
Cable pooling	Cable Pooling - Photovoltaic Farm Unreduced	9,41%	€ 900 735

Source: Own elaboration

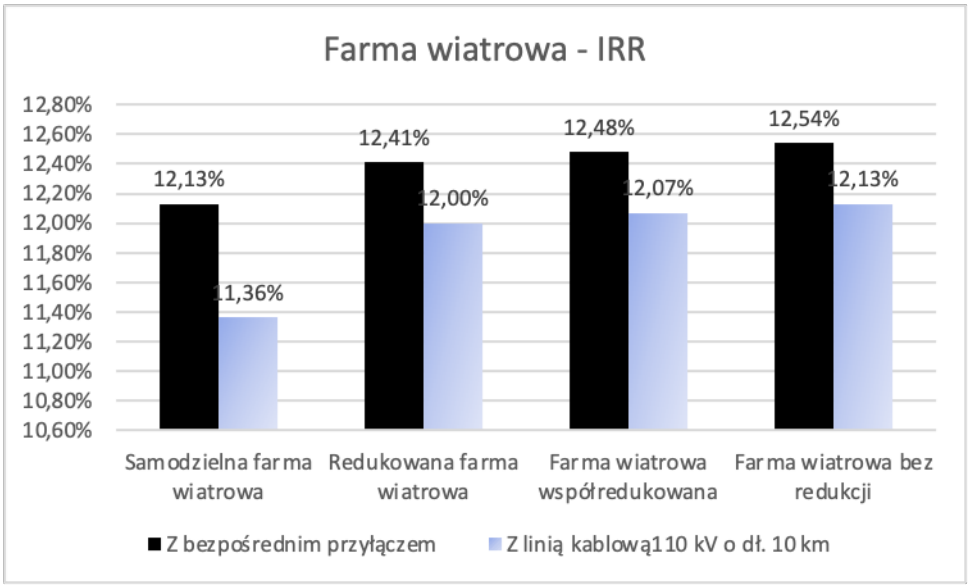
In Table 7, the analysis results are presented for each installation, assuming the construction of a 10 km 110 kV cable line, both as an independent entity and with different generation reduction strategies.

Tab. 7. Results of ratio analysis for photovoltaic and wind farms with a 10 km 110 kV cable line, conducted independently and under shared grid connection with varying power reduction strategies

		IRR	NPV
	Independent Wind Farm	11,36%	€ 11 430 403
Cable pooling	Cable Pooling - Reduced Wind Farm	12,13%	€ 13 827 490
Cable pooling	Cable Pooling - Wind Farm Co-reduced	12,07%	€ 14 128 946
Cable pooling	Cable Pooling - Wind Farm Unreduced	12,00%	€ 14 430 403
	Independent Photovoltaic Farm	7,57%	-€ 3 599 264
Cable pooling	Cable Pooling - Reduced Photovoltaic Farm	8,48%	-€ 1 200 074
Cable pooling	Cable Pooling - Photovoltaic Farm Co-reduced	8,61%	-€ 899 669
Cable pooling	Cable Pooling - Photovoltaic Farm Unreduced	8,74%	-€ 598 213

Source: Own elaboration.

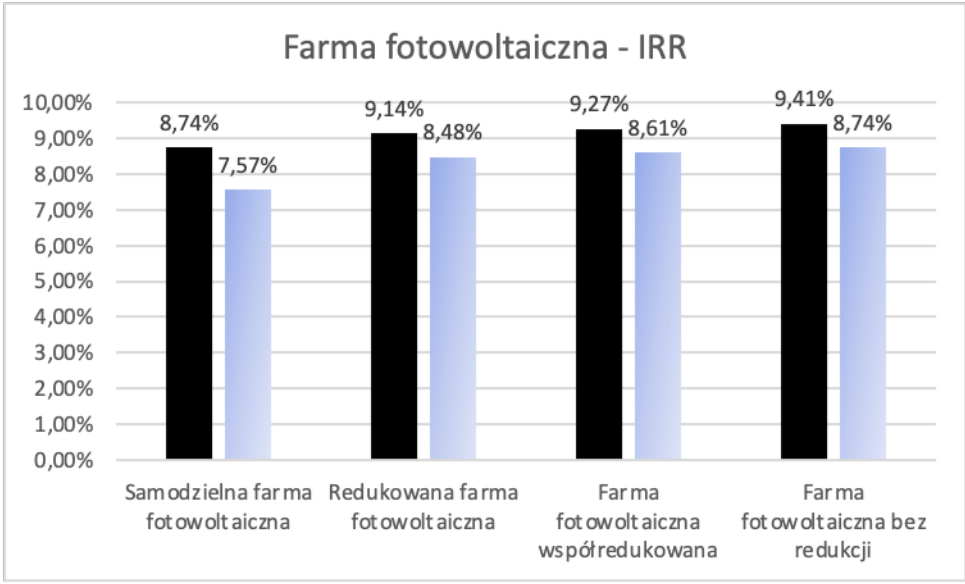
Chart 3. Comparison of IRR values for the wind farm with different implementation strategies



Source: Own elaboration.

As observed in Chart 3, expanding the wind farm project with an additional photovoltaic installation enhances the profitability of the initial investment. In the analyzed scenarios, whether as a standalone project or integrated with a necessary 10 km 110 kV cable line, the investment achieves a return well above the required threshold of 9%.

Chart 4. Comparison of IRR values for the photovoltaic farm with different implementation strategies



Source: Own elaboration.

Chart 4 presents the IRR results for various implementations of the photovoltaic farm. Each implementation under shared grid connection improves the investment outcome compared

to standalone implementation, although in most analyzed cases, the project achieved a return below the required threshold.

Conclusion

This study evaluated the profitability of projects implemented under shared grid connection. This approach is relatively new, regulated by the amendment to the Energy Law in September 2023. Shared grid connection requires connected installations not to exceed a specified maximum connection capacity. Under these conditions, it is possible for two different generating units to operate and share connection infrastructure.

The study assessed the impact of shared grid connection on investment profitability under different approaches. It evaluated the profitability of the entire project as a complete investment endeavor, generating a single combined result, and assessed the impact of sharing from the perspective of two independent projects by splitting connection costs (halving the connection cost) and reducing generation in relation to the specified maximum connection capacity.

In each analyzed case, it was demonstrated that implementing projects under the principle of shared grid connection positively impacts the profitability of both combined projects and each project individually. From an investment strategy perspective, this is an important finding as it opens up a new investment space in the context of very high investment risk for projects applying for new grid connection conditions (90% rejections). The analysis presented above shows that seeking investment opportunities through acquiring existing facilities, with the intention of further developing them with a second generating technology through shared grid connection, is justified.

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Index and World Energy Trilemma Index as an energy transition's pace measure for policy-making using the example of Poland

Cristina Budzinska

Abstract: The current geopolitical dynamics are forcing countries and alliances to rethink their security strategies in order to adapt their domestic economies and policies to the changing political landscape. Among other aspects that ensure security, the creation of a stable energy market is a key issue on the European Union's agenda. The process of diversifying the Alliance`s energy suppliers has been underway for decades and has gained further momentum following the imposition of sanctions against the main gas supplier Russia due to its invasion of Ukraine in February 2022. Cypriot natural gas reserves, which were only discovered relatively recently in 2011, are one of the potential alternatives to Russian gas. However, they are not only beneficial to the international community, but also create regional economic opportunities that make Cyprus an important player in the energy market. Nevertheless, due to its strategic location, Cyprus faces challenges in the form of regional tensions and a lack of successful strategies for sustainable exploitation of resources.

Key words: energy security, natural gas, Cyprus, the EU.

Introduction

Establishing sufficient energy strategies remains one of the fundamental objectives of the European Union, as energy policy affects the Alliance's key values such as economic prosperity, political stability and environmental protection. In recent years, the EU has placed increasing importance on ensuring energy security and developing its energy self-sufficiency, as concerns have grown about the potential risks associated with dependence on external suppliers and global competition for energy resources leading to illegal price manipulation. Indeed, by 2022, up to forty percent of the gas consumed in the European Union was imported and countries in the Alliance were heavily dependent on a single supplier, mainly Russia (Sullivan 2024). Consequently, the European Union became vulnerable to supply disruptions, followed by economic and political tensions, particularly due to economic sanctions against Russia. In this context, the European Union has focused its energy policy on sustainability and diversification of energy sources and taking into account the natural reserves of its Member States in order to stabilize the market by preventing possible supply disruptions and price manipulation. Several countries within the Alliance have natural gas reserves and production capacities. Notable member states include the Netherlands, which has one of the largest natural gas fields in the world, also known as the Groningen field. According to the Ministry of economic affairs and

Climate, the storage capacity was estimated at about 2800 billion cubic meters in the 1970s. However, the country is currently focusing on the transition to renewable energy sources and has already become a center for innovation in the renewable energy sector. Croatia, on the other hand, has both onshore and offshore gas reserves, which offer significant potential to reduce energy imports dependence. Two of the EU's most currently important gas suppliers are Norway (via pipelines) and the United States, in the form of liquefied natural gas (LNG) which is transported by cargo ships (Eurostat 2023). However, some of the problems associated with these suppliers relate to diminishing production capacity in the North Sea and the high cost of transatlantic gas imports. Meanwhile, the Eastern Mediterranean is considered one of the potential gateways for gas production and supply, due to its geographical location. Perhaps the least known and most controversial state with significant gas reserves is Cyprus. Furthermore, the discovery of gas deposits in the Eastern Mediterranean has generated excitement due to the potential impact on the regional economy and political stability. The main purpose of this article is to examine the potential impact of Cyprus` natural gas reserves on the local and global economy and to assess the geopolitical challenges in the region.

Geographical significance

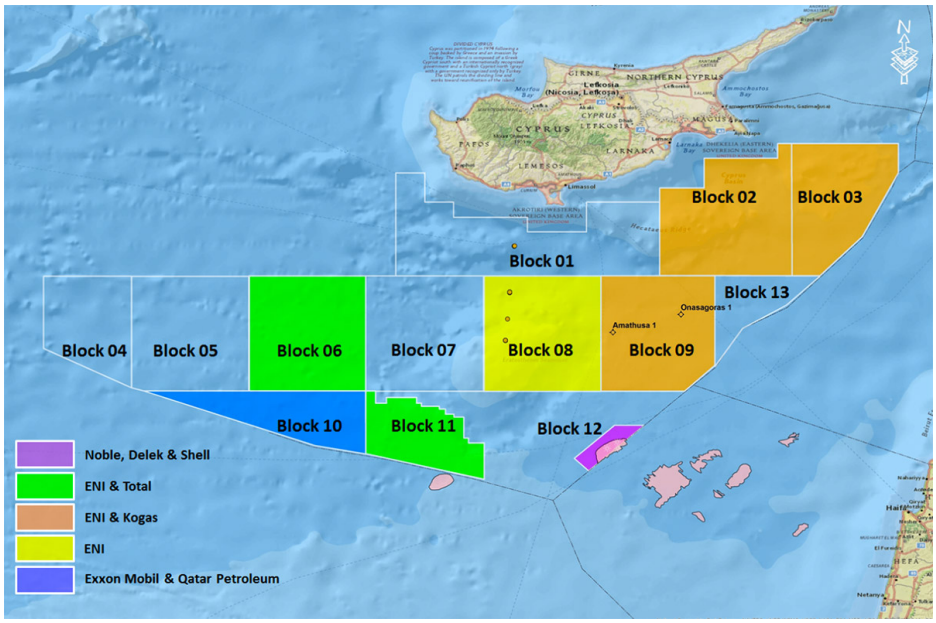
Cyprus has an advantageous location in the eastern Mediterranean as it lies at the crossroads of three continents, namely Europe, Asia and Africa, which in turn makes the island an important point on global trade and energy routes. Cyprus, officially called the Republic of Cyprus, is the third largest and one of the most densely populated islands in the eastern Mediterranean with an area of 9,251 km^2. The Greek mainland lies around 800 kilometers to the west, while the nearest Greek islands of Rhodes and Karpathos are 380 kilometers away, the same distance as Egypt to the south. The closest neighboring country is Turkey at a distance of around 75 kilometers. This geographical proximity has led to a destabilization of the region, which will be analyzed in detail in another section.

Secondly, Cyprus is known for its large deposits of raw materials due to its geographical location. There are around 220 quarries across the country, where building materials such as gravel and sand, limestone and gypsum, clay and other building stones are extracted for export (Kiprop 2019). Historically, Cyprus has large copper deposits, which have been mined on the

island since ancient times and formed a basis for the local economy. Even the official name of the island comes from copper, Cuprous in Greek. The biggest copper-producing mine in Europe is located in Nicosia, approximately 2 million tons (Ministry of agriculture, rural development and environment 2017). Today, however, copper mining is no longer one of the main sources of income as production has declined due to the development of new industries, the diversification of the economy and the decline in global demand for copper.

Furthermore, there are territorial disputes regarding the Exclusive Economic Zone, which was defined by the United Nations Convention on the Law of the Sea (UNCLOS) and grants states special rights in relation to the exploration and exploitation of marine resources, including energy production from natural gas to water and wind. Alongside other states such as Lebanon and Israel, Cyprus occupies a significant area, which has considerable natural gas reserves covering up to 100 thousand square kilometers and divided into 13 exploration blocks (Figure 1).

Fig. 1. Cyprus Offshore Blocks



Source: *NewMed Energy*,*https://www.offshore-energy.biz/is-chevron-going-back-to-the-drawing-board-for-gas-development-off-cyprus/*(access: 15.08. 2024).

This positions Cyprus as an important player in the regional energy market, enabling it to actively invest in the exploration and utilization of energy. The discovery of natural gas reserves took place only recently, in 2011, and is not yet fully explored in both geographical and economic terms. Perhaps the best known and first natural gas field discovered within the territorial

water boundaries of Cyprus is Aphrodite, located in Block 12 of the Exclusive Economic Zone and adjacent to Israel`s Yishai gas field. According to the Cyprus Hydrocarbons Company (n.d.), Aphrodite's reserves have been estimated at 129 billion cubic meters, equivalent to 51.6 million Olympic swimming pools. However, this is not the largest offshore natural gas field that Cyprus has. The Glaucus-1 field discovered and exploited by the American oil and gas company, ExxonMobil, in Block 10, is now estimated to hold between 142 and 227 billion cubic meters of gas. Approximately 1132 bcm have been discovered in the marine waters of Cyprus (Cropsey 2015: 21), and there are a total of three blocks where natural gas deposits have already been discovered and are being prepared for extraction.

Political landscape (political dynamics) in the region

Political landscape of Cyprus island is very dynamic and unstable. Starting from the overview of the key historical events leading to the current political situation, Cyprus has been always in the center of attention of foreign powers due to its economically advantageous geographical position. From historical evidence it follows that Cyprus was inhabited by Ancient Greeks around 1400 BC, and later became part of the Hellenistic world under the Kingdom of Egypt. Afterwards, it was a province of the Roman Empire, and after the collapse of the centennial Empire, Cyprus emerged as a part of Byzantine. Throughout the medieval and early modern periods, Cyprus witnessed the Crusade on its territory and fell under the Venetian control, as well as being under the Ottoman protectorate for over three centuries. In the outbreak of the First World War, Cyprus was annexed by the British Empire, and this period was marked by significant infrastructural development of the island, but also increase of tensions between Greek Cypriots who made up the majority of the population of island, strived for a union with Greece mainland, and Turkish Cypriots who desired to continued British rule, or became an independent political unit from Greek Cypriots. Eventually, in 1960 following an uprising by guerilla Greek Cypriots nationalists against British hegemony, Cyprus gained independence. By signing so-called the Zurich-London compromise agreements, representatives of both sides, namely, Greece and Turkey established Cyprus as an independent republic with a power sharing constitution (Faustmann n.d: 110). However, peaceful cooperation did not last long. The early 1960s witnessed intercommunal violence, followed by the suspension of the constitution and the withdrawal of Turkish Cypriots from the common government. Consequently, Cyprus has

been divided since 1974 following the Turkish invasion of the island in response to the military coup initiated by the Greek government. A separate Turkish Cypriot state, also known as Turkish Republic of Northern Cyprus was established by unilateral declaration in 1983, and is not recognized internationally, only by Turkey alone. Currently, the capital of Cyprus, Nicosia, has special status of a capital which is separated by a buffer zone, also known as the Green Line, controlled by the United Nations (Figure 2).

Figure 2. A map of the divided island of Cyprus

Source: Why is Nicosia the last divided capital of Europe?, https://www.thecollector.com/why-is-nicosia-the-last-divided-capital-of-cyprus/ (access: 15.08. 2024).

Division of the capital into two distinguished political entities makes it difficult to apply policies across the island, especially concerning the policies of use of natural resources. Drawing the conclusion, the territorial and political confrontation throughout the history of Cyprus led to the failure to establish *raison d`etre* as a full-fledged and integral state.

Although there are political tensions between Cyprus and Turkey, the island maintains close political relations with Greece, Israel and Egypt, which play an important role in the island's regional strategy, especially in the areas of energy production, security and diplomatic cooperation. Greece and Cyprus have developed strong bilateral relations based on historical, cultural and political ties. Firstly, both Greece and the Republic of Cyprus declare their

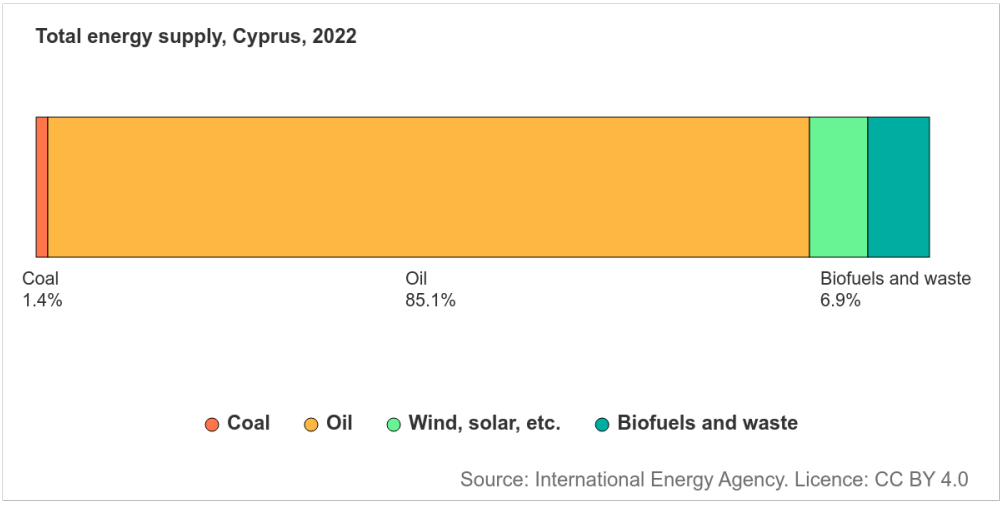
solidarity at the international level, especially with regard to the ongoing territorial disputes in the Eastern Mediterranean, as Greece supported the pro-Greek Cypriots in their military uprising to achieve reunification in 1974. In the meantime, Cyprus has developed a strategic partnership with Israel, particularly in the areas of oil and gas exploration and security cooperation. In 2010 the two countries signed a partnership within an exclusive economic zone that allows for the strengthening of the protection of territorial waters between Israel and Cyprus and grants Israel access to oil and underwater gas deposits (Nathanson, Levy 2012: 18). Furthermore, despite being a politically divided island, Cyprus is today a full member of the European Union, although it does not accept membership in the North Atlantic Treaty Organization or the Partnership for Peace alliance program, mainly due to the Greek-Turkish-British Security Guarantee Agreement as an alternative mechanism (Dz. U 1960: 5475/I). To summarize, the political landscape has always been dynamic and unstable, an island has always been oppressed by great powers and empires, and even today it is divided between two political entities. However, this has not prevented the island from developing and building political and economic relations with neighboring states.

Current economic conditions and potential trajectories

After the Republic of Cyprus gained its independence from Great Britain in 1960, the economic focus shifted from a colonial to a free market economy. With the help of various international organizations such as the United Nations and its development program, which focuses primarily on sustainable development, improving infrastructure in order to reduce poverty and help to recover economy after certain crisis, as well as significant financial support in the form of loans from the World Bank and the International Monetary Fund, the island's economy was able to expand its electricity supply, port and local infrastructure, which in turn enabled the modernization and diversification of the economy. Historically, the export of raw materials was the main driving force of the Cypriot economy. However, since the period of sustained growth and the influx of foreign investment, the domestic economy has expanded and diversified by investing in sectors such as tourism, banking, shipping and real estate, with agriculture and mining taking secondary positions. Due to continued economic growth, Cyprus was able to join the European Union in 2004 to drive economic transformation through new trade and investment opportunities. Although Cyprus is the third smallest economy in the

European Union, with an annual GDP of 32,23 billion in 2023, the economic indicator illustrated the increase of the growth domestic product by 3,2% due to main sources of income through the tourism and unique banking system which attracts foreign freelancers (European Commission 2022: 78). The banking system is a key element of the Cypriot economy, contributing significantly to gross value added in the eurozone through its reliance on subsidiaries and credit unions. However, according to the report of Central Bank of Cyprus in 2021, annual foreign investment in the island's economy has shown decline, signifying a low level of confidence in the country's economic stability and development prospects due to global economic situation, such as COVID – 19 and ongoing war in Ukraine. It indicates the potential opportunities for the development of the energy sector in the region, as the region can be considered as a potential partner for the European Union and benefiting from it. Regarding the current energy sector in Cyprus, there are some important aspects to consider. Firstly, Cyprus is still heavily dependent on imports of energy resources, mainly hydrocarbon fuels. Of the total imports, estimated at 14 billion dollars in 2023, the largest share of government spending is on imports of refined petroleum and oils, which account for 22% of total imports and are estimated at 3 billion dollars. More than 80% of Cyprus' total energy mix relies on oil, making the national economy highly vulnerable to global changes in the energy market (Eurostat 2024) (Figure 3).

Fig. 3. Total Energy Supply, Cyprus



Source: International Energy Agency,https://www.iea.org/countries/cyprus (access: 15.08. 2024).

The main importers of oil and petroleum resources to Cyprus is mainly Israel (94% of total import), the country which also provides the infrastructure (Fylaktos, Zachariadis 2023: 15).

Furthermore, the Republic of Cyprus is the only country within the European Union that does not have natural gas in its energy mix. This can potentially mean a lack of a sufficient portfolio to diversify domestic energy supply, as well as the lack of proper infrastructure and the recent economic stagnation during COVID-19 and the sanctions against Russian gas following the full invasion of Ukraine in 2022, which Cyprus has been exposed to in recent years. To understand the potential benefits of using local natural gas as an alternative to heavy fuels, it is important to understand and analyze the economic benefits and explore domestic energy companies and partnerships with neighboring countries.

To start with the economic perspective: the 4 offshore natural gas fields with estimated reserves of 368 billion cubic meters can be exploited by Cyprus for several decades, as the hypothetical annual consumption does not exceed 2 billion cubic meters. Such significant natural gas reserves can reduce the island`s dependence on fuel exports, diversify electricity sources and attract foreign investment, which would further boost economic growth in Cyprus. According to the reports of the Cyprus state-owned oil and gas company, also known as Cyprus Hydrocarbons Company (CHC), currently only a few of the explored blocks have been granted the licenses belonging to the national oil and gas companies, such as ENI Cyprus Limited, KOGAS Cyprus Limited and TOTAL E&P Cyprus BV (The Cyprus Hydrocarbons Company n.d.). The current partnership between the Cypriot administration and the American oil and gas company ExxonMobil and Qatar Petroleum International Upstream LCC, granted in 2017, enabled the discovery of natural gas reserves of approximately 141 to 226 billion cubic meters.

Another aspect that should be considered to ensure domestic energy supply is the construction of offshore pipelines and key infrastructure that require investment, further financial support for sufficient maintenance. In order to understand the pros and cons for the Cypriot government, it is essential to analyze the spending of such infrastructure, as it could be a cushion for Cyprus` future energy development. Firstly, 13 years after the first discovery of natural gas deposits, Cyprus is not yet ready to start extracting it due to several problems, including the high cost of equipment. In 2020, Cyprus unveiled a project to build an LNG terminal in the port of Vassilikos. Carole Nakhle, an energy economist and managing director of the energy company Crystol Energy, explained in an article for the non-governmental organization GIS that the imported gas will be transported through pipelines to the onshore plants that are connected to the island`s energy system and in turn generate electricity (Nakhle 2023). This initiative has been estimated at around 543 million euros and is being built under Chinese leadership. Part of

the funding is being provided by the European Union as part of the Reconstruction and Development Initiative (Aristeidou 2020).

Secondly, from an economic perspective, Cyprus' GDP ($32 billion) is almost twenty times smaller than that of Norway ($547 billion), another major gas supplier to the EU, making it difficult to invest in such projects from state`s budget, which is why it is more cost-effective to cooperate with foreign companies in the exploration and extraction of certain natural resources.

However, if we look at the potential export of Cypriot gas to European countries, Cyprus is less compatible than Norway, the OPEC member states and the United States of America. For example, Norwegian gas reserves capacity is 1430 billion cubic meters, which makes Norway the third largest supplier after Russia and Qatar (European Parliament 2023:3). The transportation of American LNG, in turn, covers 50% of total LNG imports of the EU (European Council 2024). However, one fact should not be ignored: transportation of natural gas from the US is potentially expensive and very volatile, from $100/MMBtu (~293 kWh) in 2022 to $11/MMBtu in 2024 (Zaretskaya 2024), while Norwegian natural gas resources tend to run out. Therefore, the export of Cypriot natural gas can be considered in the context of further cooperation between European states, especially in cooperation with other Mediterranean states, such as Israel and Egypt. To summarize, compared to the Norwegian natural gas and oil resources and the American natural gas resources that they supply to Europe in the form of liquefied natural gas, Cypriot resources are incompatible and do not have a major impact on the external market, but can significantly diversify energy sources at the national level.

Geopolitical challenges

Concerning the geopolitical challenges in assessing the potential of Cyprus` natural gas reserves, there are several factors to consider. First, the ongoing territorial disputes over maritime borders between Greece and Turkey. The conduct of political and economic affairs under two separate jurisdictions complicates the political decision-making processes on the island of Cyprus. According to international law, the natural gas reserves in the exclusive economic zone belong to Cyprus, but Turkey does not recognize Cyprus as a sovereign state. After Turkey proclaimed the Turkish Republic of Northern Cyprus by occupying 37 percent of the island, it declared itself the rightful owner of the natural gas reserves in the region.

One of the prominent points of contention between the Greek and Turkish governments over gas supplies intensified in 2018 as Europe stepped up its efforts to diversify its energy suppliers due to its highly unstable dependence on Russian gas. The initiative was to expand the EastMed pipeline, through which gas from Israel and Cyprus will be routed through Greece and eventually distributed in Italy. The capacity of the pipeline is about 10 billion cubic meters per year, which would cover about 2% of Europe's natural gas needs. Although the contribution is relatively small, it will help to diversify the sources of supply for the European gas network and improve the economic opportunities of the Mediterranean region, including Cyprus. The Turkish reaction to the initiative was particularly critical and hostile. It was claimed that this project violated Turkey's maritime rights and economic interests and that the Turkish Cypriots would not benefit from the natural resources of the region (Merz 2020).

Secondly, as we have already discussed above, Cyprus has managed to establish bilateral diplomatic relations with neighboring countries, and Israel is no exception. The countries have signed agreements related to a common area for natural gas exploration, namely the Yishai gas field, which belongs to Israel's maritime zone but is geologically connected to Cyprus' Aphrodite gas field. On this basis, the question of the proper distribution of resources and the regulation of legal financial management arises between the two countries. In the previous decade, both Cyprus and Israel faced uncertainties in cooperation. The issue of the joint share of energy resources is due to the fact that Cyprus owns the majority of the field, about 91%, while Israel only holds between 7% and 9%, but the two countries had not yet agreed on payment for exploitation and partnership. As noted by Danny Zaken, the Middle East's leading independent news source, Cyprus wanted to acquire rights to Israeli oil and gas companies, while Israel wanted to remain as a partner (Zaken 2022). According to gas market expert Gina Cohen, if the deal is successful, Cyprus and Israel will be able to supply 15 billion cubic meters of gas to Europe as well as meet local gas demand for 25 years (Cohen 2022).

Furthermore, Cyprus is still very vulnerable in terms of security, as it is not a member of a formal alliance such as NATO or the EU security and defense framework. As it lies at the crossroads of different cultures, it will eventually become a focal point of geopolitical tensions. Together with the ongoing Turkish occupation of the island, Cyprus is exposed to external threats in the form of radical Islamic terrorism, illegal migration and maritime piracy. Cooperation with Israel in 2012 aimed to sign defense agreements under the new Israeli Prime Minister Benjamin Netanyahu, allowing the Israeli Air Force to operate over the airspace and territorial

waters of the Greek administration of Southern Cyprus to protect energy resources (Agdemir 2016: 106). However, this initiative was sharply criticized by the Turkish government and the Lebanese terrorist organization Hezbollah, as they saw it as a direct threat to their interests in the region. As journalist Hellena Smith noted in an article in the British Guardian newspaper, the Greek administration of southern Cyprus received threats in the form of 'become a target if it allows Israel to use its territory' (Smith 2024).

Finally, the issue of further extraction of natural gas often becomes a political instrument in election campaigns. As Michaele Kamba's article points out, there were cases during the election campaign that 'sensed the potential to score points and made gas an election issue' (Reuters 2012). The manipulation of natural gas reserves began several years before the official discoveries of hydrocarbons and the Cypriot government made several offers to international investors to attract foreign investment (Nakhle 2023). Moreover, the issue of inappropriate usage of European Union`s funds while building before mentioned the terminal in Vassilikos has been reported to the European Public Prosecutor's Office, an independent office which is investigating crimes against the financial interests of the EU (EPPO 2024). The concerns about corruption were reported by Cypriot auditors after not meeting the deadline and suspicious 'management of public and European funds' stated by Cypriot audit officer Marios Petrides (OCCRP 2024). To conclude, energy sufficiency of the Republic of Cyprus is heavily dependent not only on economic prosperity, but also on geopolitical challenges and tensions in the region.

Conclusion

Establishing sufficient energy policy, the diversification of the energy mix through the use of domestic natural gas reserves remains one of the main issues on the European Union's agenda. The tendency to diversify suppliers of key energy sources has intensified after Western countries imposed economic sanctions on Russia in response to the unprovoked military aggression and occupation of Ukraine in 2022. Cyprus itself is a gateway between three continents and plays a crucial role in global trade and energy routes and as a member of the alliance, is considered a potential domestic supplier of natural gas as it has reserves of 1132 billion cubic meters. As part of the Exclusive Economic Zone, which allows countries to cooperate under the joint exploration and exploitation of marine resources Law, Cyprus increases its chances of efficient and thorough exploration of its natural reserves and attracts foreign investment.

However, the dynamic and unstable political landscape and the current division of the island between two political powers through the demarcation line illustrates the negative impact on the economic prosperity of the island as well as the increase in political tensions in the decision-making processes. Finally, the ongoing discussions about the appropriate sharing of geologically linked resources show that bilateral relations are necessary to ensure the sustainable development of the region.

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Pan-European Energy Initiatives and their implementation. Incoming Black Death as threat for Nuclear Energy Renaissance

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Abstract: This work focuses on the prospects of pan-European initiatives to enhance the energy rigidity situation in Europe from the Russian Federation. Additionally, it examines the current documented changes in the retrospective on the Green Deal and its reform from within, in the narratives of strengthening the position of Nuclear Energy in Green Taxonomy. All of this is encapsulated within a palette of metaphors for the illustrious cultural Renaissance, which, as a significant event in European history, resulted from an external catastrophic catastrophe known as the Black Death. This event had a considerable influence on the subsequent release from the burdens of the past for the sake of a promising future. The work addresses several fundamental questions regarding the "European" nature of the Energy Renaissance, the pan-European initiatives themselves, and the labeling of the creation of small nuclear modular reactors of the 4th generation as a strategic stance aimed at strengthening the competitiveness of Europe in the current economic and strategic environment. The primary objective of this work is to investigate the phenomenon of Nuclear Energy Renaissance, establish a distinct terminological foundation for it, and formulate the prospects of nuclear energy in Europe. The research questions revolve around the issue of the expansion of Europe's energy crisis and the potential for nuclear energy to emerge as a viable option for the future of the EU through the deconstruction of EU Energy Policy under a New Green Taxonomy. It also questions the potential for nuclear energy to become a mainstream form of energy in Europe and how deep we can expect the involvement of European states in supporting raising initiatives regarding nuclear energy while facing at the same time the direct threat from the Russian Federation. The hypothesis of this work is that, after the energy crisis, nuclear power in Europe received a second chance despite the expansion of nuclear power plants around the world, advances in technology, and increased safety standards. The conflict in Ukraine and the subsequent crisis demonstrated that the green agreement can be maintained only if nuclear energy is included in the Green Taxonomy of the European Union. For the sake of a good methodological analysis, it was preferred to rely on various official documents published from various institutions of the European Union, academic articles on energy in Europe and statistical information for a broad outlook and case study analysis. Article works under the framework of Mixed-Methods Research for better awareness regarding truly diverse areas of study such as Energy Policies as well as usage of official published statistics, tables, and other quantitative methods variations.

Key words: Nuclear Energy Renaissance, SMRs, Energy Sovereignty, Industrial Alliance, Green Deal, Green Taxonomy

Introduction

The great cultural-intellectual, technological, and scientific achievements of Ancient Greece and Rome still have an imprint on the hearts of every European. The very attraction to such nostalgia in the 14th century was due to the mysterious aesthetics of lost grandeur, persecuted by the church for its pagan nature. The Renaissance era emerged as a socio-economic phenomenon, characterized by the expansion of large manufacturing cities and the establishment of urban-type republics that accumulated enormous wealth through the importance of trade routes. According to Norman Cantor, a prominent American medievalist, Europe would not have been as transformed without the impact of the Black Death, which raged on the European continent in 1346 and ended the lives of millions of people (Cantor 2015: 138). It was one of the first times that mankind encountered a mass catastrophe that forever changed the demographic and

social hierarchy. In the distant future, it could only be comparable with the consequences of the Lisbon earthquake in 1755. Another renowned historian, David Herlihy, made a candid assertion in his book *The Black Death and the Transformation of the West*: "The Black Death was a trauma that liberated a new", new incarnation, adorned in an outdated attire that we commonly refer to as the Renaissance (Herlihy 1997: 59-60). The Black Death, on the one hand, was a calamity that had the potential to eradicate the enduring legacy of European civilization. However, on the other hand, it served as a catalyst for the emergence of a new era and the rebirth of the new spirit of enlightenment through the revival of old that worked in synergy with an institution that once aimed to eradicate the great name of ancient Rome.

Today, within the souls of individuals who have dedicated their lives to the study of a potent phenomenon as atomic energy, there exist the seeds of their Renaissance, founded on the practical implementation of the inventions of genuine progress as the perfection of the collective power of the spirit of mankind. The study of atomic physics during the 20th century acquired a significant breakthrough character in all spheres of human development. The concept of controlling atomic matter by man sparked secular enlightenment, overcoming the chains that man imposed upon himself to constrain his desire for knowledge. Regrettably, the era of great discoveries has passed, but for those who witnessed massive catastrophes, nuclear energy remains the subject of internal moral debate, or it will always remain a remnant of the past.

Pan-European Initiatives

The central theme of the work is precisely timed to coincide with the pan-European nature of leading initiatives in the European Union regarding nuclear energy regulations, and its increasing significance considering issues with the regulation of prices in numerous countries of the European Union, as well as the threat of EU energy sovereignty. The first thing to point out is *the Proposal for a Regulation of The European Parliament and of the Council amending Regulations (EU) 2019/943 and (EU) 2019/942 as well as Directives (EU) 2018/2001 and (EU) 2019/944 to improve the Union's electricity market design* that was published in 2023. The proposal referred to in the title is comprehensible as it addresses a crucial concern in the energy sector pertaining to electricity prices and the financial well-being of individuals as a result of the sanctions imposed on all forms of coal supplied to the EU from Russia, as well as reductions in gas supply. In addition to the declarations regarding the

significance of deregulation of the electricity market, a greater involvement of states in price control, and the expansion of investments in renewable energy sources. It is also noteworthy to mention the additional measure to facilitate new investments in nuclear energy, as stated in Article 19b (European Commission 2023: 37). The proposal is currently under consideration in the European Parliament and The Council. Nonetheless, its primary significance lies in its origins as a supranational representative of the member nations of the European Union, rather than as a singular proposal from any nation-state or coalition. Additionally, there appears to be a significant precedent for the absence of any mention of gas-fired sources of electricity production, indicating a firm belief in nuclear power as a more promising alternative to them. This will undoubtedly impact the long-term viability of nuclear energy rhetoric among EU states. The second document that is called *Commission delegated regulation (EU) 2022/1214*, which was put up for adoption in 2022 and entered into force in 2023, is perhaps even more fundamental to the discussion on the implementation of initiatives related to nuclear energy in general, and from which all other political measures aimed at strengthening the position of nuclear energy in the Green Deal are derived. The essence of regulation hinges on the inclusion of nuclear energy in the Taxonomy for appropriate investment, accompanied by precise criteria to ensure compliance with the primary guidelines on carbon neutrality. Furthermore, due to numerous internal contradictions, it is permissible to utilize nuclear power solely as a transitory method to achieve the objectives set by the Green Deal itself (European Commission 2022: 2-3). The third initiative aims to implement the strategy of an inter-European Industrial alliance within the EU and outside, which advocates for enhanced development and investment in small modular reactors of the fourth generation, incorporating enhanced technologies for reprocessing and recycling nuclear fuel, and all aspects of waste management, in accordance with the criteria adapted in Energy Taxonomy. The initiatives constitute fundamental elements in the rise of the Nuclear Energy Renaissance in the European Union.

Nuclear Energy Renaissance - European Phenomenon?

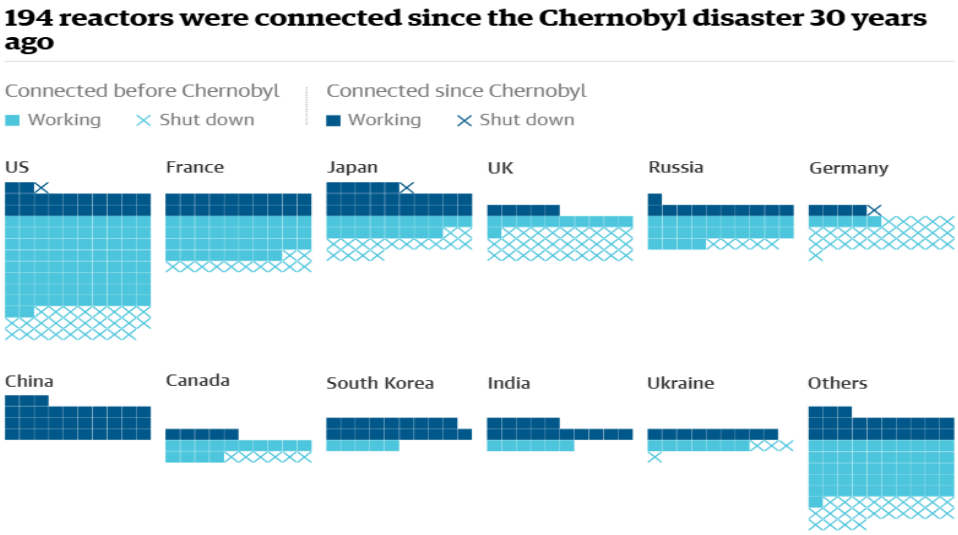
The phenomenon commonly referred to as an Energy Renaissance lacks a formal terminological basis and is more strongly associated with the general trend towards obtaining cleaner energy and stepping away from fossil fuels usage. The question remains unanswered whether the Renaissance is solely concerned with obtaining energy through sustainable and safe generating technologies, without releasing any other harmful substances besides CO_2. Also, the

question remains on the nature of the Nuclear Energy Renaissance: whether it is exclusively European, whether the same trends arise between other continents, whether it derived from a quantitative factor of numerous new power plants construction, whether it is about technological innovations as SMRs etc. The notion of the Energy Renaissance holds a metaphorical significance, and the analogy with the European Cultural Renaissance has a direct resonance with it. Not long ago, the overall sentiment toward nuclear energy was mostly pessimistic and negative within the public outlook towards nuclear energy and its widespread proliferation in relation to its destructive potential. Following the Second World War, various social and activist organizations expressed their disapproval of nuclear energy and deemed it an ineffective means of ensuring future energy security. Nonetheless, we are witnessing a re-emergence of nuclear energy in the general discourse owing to the escalation of the energy sovereignty crisis. To obtain a fresh perspective on a fundamentally different reality, it is imperative that we must liberate ourselves from preconceived notions and unite in the fusion of environmentally friendly renewable sources and nuclear energy. Regrettably, at the onset of significant transformations, during which the European Union assumed its exclusive role as a staunch advocate of renewable energy, all changed with the onset of the conflict in Ukraine, determined as the Black Death of the 21st century and great challenge, which will ultimately determine the fate of Europe's energy sovereignty and its position as global power.

When asked if the Energy Renaissance is an exclusively European phenomenon, there are several answers to this fundamental concern. It is a known fact that only Europe and Japan have reached a consensus on a common position to limit the impact of nuclear energy on the grid. Furthermore, the nuclear race and the general tension of the Cold War era particularly traumatized the populace due to the potential global conflict between the West and the USSR. It is imperative to recall the Chernobyl Disaster of 1986, which profoundly altered the political and social landscape regarding the narratives on energy consumption from Nuclear Power Plants. It led to countries such as Italy abandoning the production of nuclear energy and closing its final station in 1990. Germany consistently insisted on the closure of the final three nuclear power plants by 2023, and as indicated by the statistics, the total world electricity production experienced a decline of up to 10% from the 1986 values by 2022 (Buchholz 2022). According to Figure 1, the Chernobyl nuclear catastrophe has not affected other countries, and the total number of nuclear power plants has continued to increase across the world. Since Chernobyl,

China alone has opened more than 50 nuclear power stations and by 2016 their number doubled from 194 to 406 (The Guardian 2016).

Fig.1. Number of nuclear reactors connected since 1986 Chernobyl disaster with their operational status



Source: The Guardian 2016 https://www.theguardian.com/environment/2016/apr/30/has-chernobyl-disaster-affected-number-of-nuclear-plants-built (access: 17.09.2024).

Many decommissioned nuclear power plants were of sufficient age to permit their continued operation. It demonstrates that there was a certain anti-nuclear agenda visible in politics of that period that was intertwined with the rise of the first wave of Green Activism in Europe. Furthermore, it demonstrates the exclusivity of the Nuclear Energy Renaissance in Europe, observing a statistical fact that was already revealed. The Fukushima incident did not have an impact on any closure of nuclear facilities or conservation of plans to build them outside Japan in Asia. Japan has merely delayed the construction of large nuclear power plants with at least 1300 MWe Capacity Gross: Shimano-3 and Ohma-1 (World Nuclear Association 2024). It is also important to provide public support for the further implementation of initiatives such as these, particularly in such a country as Japan with a disengaged society in general, as was observed through past parliamentary elections. In Japan, there were reports of a moderate increase in positive opinions among the public toward the unavoidability of nuclear power use, but this was only up until the Fukushima Daiichi accident, as they decreased significantly post-accident; meanwhile, after more than 10 years of the accident, there was a slight decrease in opinions toward nuclear power non-use and a slight increase in positive opinions toward nuclear power use (Yamagata 2024: 2). Returning to China, the state that has undergone numerous transitions over the past century, directs a new narrative regarding the country's foreign and domestic policies towards cooperation in reducing CO2 emissions into the atmosphere and renewable energy infrastructure

development. The strategy and further domestic results of work in this direction were voiced in the organization of the United Nations for the topic of prospects for cooperation of the global South as a geopolitical goal. This suggests that China, in turn, would like to be the main technology supplier in developing countries by pushing the European Union into the behind-the-scenes. After 2018, China's newly installed capacity of solar PV accounted for more than 40% of globally installed capacity and reached 392GW. Wind power generated 370GW, or 37% of global capacity. In 2023, there has been an additional spike in solar installation; by August 2023, new capacity exceeded 100GW (United Nations 2023: 26). However, it is too early to say that China is the same as Russia's geopolitical maneuvers against European Energy sovereignty, and there is an affirmative argument. Despite the figures, one can observe a certain fundamental pattern when looking at the location of the same wind turbine constructions in China. Their main location is in the provinces of Inner Mongolia and Gansu. At this point, the northern wind power potential accounts for about 78% of the total wind power potential in the country, which is inconsistent with Huang's (2020) findings that 90% of China's wind power potential is in the north (Yu, Gui & Yang 2022: 13103). Their location is justified by the fact that the sparsely populated areas of these provinces do not require large nuclear or thermal reactors due to the length of the regions and the associated costs. The considerable number of windmills is a convenient alternative, given that the focus is still on building new nuclear power stations in the extremely populated eastern provinces of China (Jiang and Xiao 2018: 139). The media attention around the world has also caught the common statement of the MFAs of China, South Korea, and several other countries about the vehement criticism of the radioactive waste discharge from Fukushima. It was a more political than a environmental concern on the Chinese side and therefore no actual sanctions were imposed on Japan, as can be seen from a passage of China's foreign policy ministry. The Japanese government failed to prove the legitimacy and legality of the ocean discharge decision, the long-term reliability of the purification facility, and the authenticity and accuracy of the nuclear-contaminated water data (MFA of People's Republic of China 2024). Despite a strong emphasis on the logistics system for the distribution of energy and electricity, this framework serves as solid evidence of the effectiveness of such management of nuclear and renewable energy mix, which can be used to establish a new wave of innovation in Chinese industry and contribute to the preservation of planet Earth.

Path to Innovations – SMR`s

Innovation and the implementation of revolutionary technologies play a key role in transforming the existing framework, thereunto evolving our perceptions of social relations with interdependent values within human society. The European Cultural Renaissance was no exception and presented a varied modernization of urban planning in the areas of living, architecture, technology, and science. The blueprints that were created in the 15th century by Leonardo da Vinci are not indifferent to any respected self-scientist who cannot imagine the quality and ingenuity of genius. Within the scope of today's energy science, great attention is paid to one unique scheme within the framework of nuclear energy discourse. Small modular reactors, commonly called SMRs, represent a new category of nuclear innovation that aims to provide sufficient energy while reducing construction costs and saving time. Peter Beck and Malcolm Grimston from the Royal Institute of International Affairs have formulated the position of large nuclear reactors relative to other known means of electricity generation on the market:

> *Regarding economics, it was already mentioned earlier, that the competitive position of new nuclear power plants has deteriorated over the last decade owing to the development of gas-fired combined cycle generating plants and the effect of deregulation of the electricity market. The generating industry is looking for reactor designs of lower cost per unit of capacity, higher efficiency and flexibility regarding scale, but most developments on offer for the LWR are for large scale plant which are unlikely to achieve this.* (Beck and Malcolm 2002: 42)

As novel approaches to nuclear fuel and waste management emerge, the potential for reducing emissions and environmental damage is highly respected in environmental engineering. Large reactors require substantial resources, such as water, to be continuously cooled, which presents significant challenges due to their size and mobility. This is not the case with SMRs, which do not require large land and river networks. Under the present war-induced circumstances, there are already initial stages of an Industrial Alliance to lobby for small modular reactors in the European Union, led by France (WNN 2024). From 29 to 30 May 2024, the alliance held its first assembly, which included not only representatives of energy corporations, institutes, and their countries, but also representatives from countries that are not part of the European Union, such as Ukraine and the Institute of Research and Design (European Commission 2024). This is, in fact, in its early design — the Pan-European Initiative aimed at strengthening Europe's energy sovereignty. At the time of NEA Research in 2021, only France is conceptually

developing a 170 MWe capacity multi-module nuclear reactor in the European Union based on the light water reactor type (LWR-PWR) from the NUWARD design (NEA 2021: 18).

Obstacles on the path for future

Despite significant advancements in the planning of the Pan-European innovation towards small modular reactors, numerous obstacles remain in the way of achieving these solutions. The initial aspect is less significant and relies on funding and intellectual capital to generate and disseminate technology, as witnessed in the United States, China, Russia, and South Korea. In many ways, France's interest is not just an individual decision to continue as one of the advanced powers and not lag its competitors in the field of nuclear energy. Rather, it involves the rest of Europe and its intellectual and financial capital in a fundamental shift in Europe's energy sovereignty in such a challenging period. Euratom's report specifically mentions the geopolitical significance of this competition and the direct involvement of the EU itself. The European Union must be at the forefront of new developments, ensuring a European industrial value chain while being at the top of safety and radiation protection standards for SMRs (Euratom 2023: 40). Therefore, we can take as an example the case of U-Battery, a conceptual design developed jointly by Manchester and Delft universities, which, due to its inability to find sustainable financial support, was unable to come out within its concept. In 2023, its development was completely closed (Urenco 2023). The second aspect pertains directly to the conflict in Ukraine and the significant shifts it entails, as opposed to the strategy promoted by the alliance, which emphasizes the modular reactors construction approach. Missile attacks by the Russian Federation on energy facilities in Ukraine have gradually destroyed energy planning and left cities in a daily state of collapse and blackouts, disrupting the work of public logistics and infrastructure. This has been particularly the case for thermal and hydroelectric power plants. Around 20 substations and electric stations were being hit by Russia, as what have been documented through research (Polityuk 2024). At the same time, there is an incredible tension at the Russian-occupied Zaporizhzhia Nuclear Power Plant, where the presence of military contingent and equipment has been repeatedly observed, as well as the construction of fortifications around the station. The IAEA mission is constantly monitoring the station, but no political decision on isolating the station from combat hasn't been taken. However, it is not anticipated that there will be a gradual escalation, as a nuclear catastrophe always entails additional dimensions.

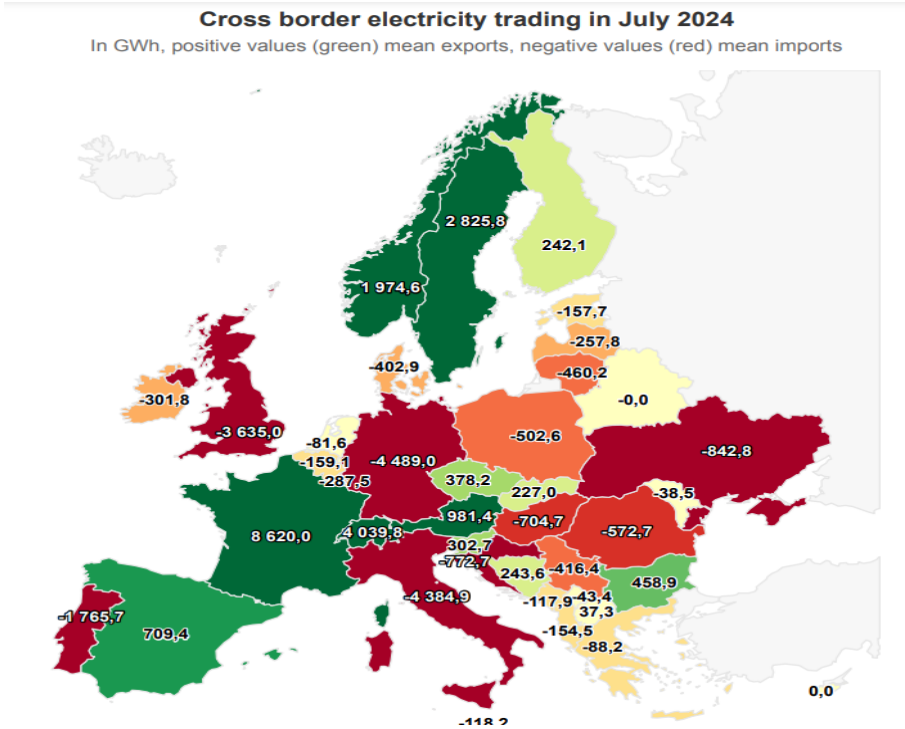
Throughout history, no nuclear power plant has been targeted or attacked by any other nation. This suggests that it may be directly a lever of pressure, but not the objective of destruction, that will trigger the chain reaction. Regrettably, this does not negate the fact that crucial infrastructure facilities, such as Nuclear Power Plants, necessitate meticulous oversight and substantial investments in air defense systems to deflect potential missile attacks or drones. The recent media report regarding a Russian drone spying on a nuclear power plant in Brunsbüttel, Germany, which is currently under investigation, serves as a noteworthy illustration (Tiwari 2024). Due to the development of small modular reactors, NATO will require more air defense systems to safeguard these facilities and enhance strategic coordination.

As previously mentioned, it was precisely the catastrophic actions associated with the utilization of nuclear energy that engendered such a strong public aversion towards discussing the subject of atomic energetics. These include the destructive power of atomic arsenals, military vehicles such as aircraft carriers and submarines, and numerous accidents with nuclear power stations that extend beyond accidents on Chernobyl and Fukushima. At that time, the world was witness to a singular dichotomy, namely that of environmentalists who oppose the utilization of nuclear energy, and those who advocate for atomic energy as a necessity in a world where progress plays a leading role in preserving its own influence. Among them were various groups of people, representatives of mass culture, war veterans and even church activists whose contribution was especially widespread in Central Europe (Ault 2021: 100-101). This picture is still prevalent today, especially in Germany. Despite the war, the damage done to the Nord Stream, and the return of gas directly from Russia, Germany persists in adhering to the gas core of its energy policy and intends to construct additional gas-fired units with a new trading partner — Norway. It is also planned to open coal mines that have been shut down due to their detrimental effects on nature (Kędzierski 2023). The rejection of Germany's atomic program may be attributed to its neutral status as a non-nuclear state and fear coming from other political actors. Furthermore, for logistical reasons, to develop the atomic program, it will be necessary to retrain engineering personnel, burocracy, and allocate substantial funds into the economy, which is unthinkable with the current state of German economic stagnation. The German Republic is not ready for such a significant transformation and already prioritized its energy mix that were allowed to do as transition stage by The Council of EU. The European Council has acknowledged the need to ensure energy security while respecting Member States' right to choose their energy mix and to choose the most appropriate technologies. Some Member States use or will use nuclear energy as part of their national energy mix (Euratom 2023:

40). As stated in *the Proposal for a Regulation of the European Parliament and of the Council amending Regulations (EU) 2019/943 and (EU) 2019/942 as well as Directives (EU)2018/2001 and (EU) 2019/944 to improve the Union's electricity market design* of March 14, 2023, the goal is to solve the energy crisis, which has significantly affected the electricity market for consumers and businesses (European Commission 2023: 1-2). As previously stated, many of the proposals are being halted due to the reaffirmation of nuclear power as a crucial component of the revised Green Deal and its stated objectives by 2050. Consequently, certain states whose energy is directly dependent on nuclear power plants are being given an advantage, while others are being forced to undergo significant changes by abandoning gas and coal.

The chaotic picture of the distribution of electricity exports and imports in Europe is another basis for a fundamental restructuring of the entire core and strategy of EU energy policies. Nuclear power plants can be one of the ways out of this crisis. The European Union has an uneven distribution of energy responsibilities due to its weak influence over national governments. Observing (Figure 2) map chart in July 2024, states such as Germany and Italy each import a total of 4,400 GWh of electricity, whereas France, as the leading nation in the construction of nuclear power plants, exports a total of 8,862 GWh (Fraunhofer 2024).

Fig. 2. Cross border electricity trading in July 2024 across the Europe



Source: Fraunhofer 2024, https://www.energy-charts.info/charts/import_export_map/chart.htm?l=en&c=UA&interval=month&month=07 (access: 17.09.2024).

Since February 2024, Italy, the UK, and Germany have been confronted with a critical issue that only serves to exacerbate the prospect of stabilizing prices in the electricity market that only led to the confession that was written as the primary objective in the European Commission official proposal. According to Eurostat, the implementation of the initiatives regarding the obtention of electricity from renewable sources has not become popular among household owners of Europe in the most populated countries, and progress in this direction unfortunately departs from the predictive goal of the Paris Agreement (Eurostat 2022). Despite several objective advantages of implementing renewable energy sources, which can reduce the burden on the electricity market and improve the state of the budget deficit and set a new level of personal freedom for people and their financial well-being, the availability, simplicity, and practicality of technology plays a vital role. Despite their enormous contribution to the dissemination of green energy and the preservation of environmental concerns, solar panels remain a niche and entertaining phenomenon, rather than a mandatory requirement in every building. The war in Ukraine only reinforced the importance of the existence of autonomous environments for obtaining electricity through the involved missile attacks on critical infrastructure as thermal power stations. It is unimaginable for us to exist without access to a continuous supply of electricity and the operation of cable networks. Moreover, the recent conflict in Ukraine demonstrates how the Russian Federation is attempting to undermine the morale of the populace that has been impacted by this conflict. Opportunities to circumvent this death loop can be found in the paradoxical view of the combined desire to overcome and liberate oneself from the burden of hatred and fear of nuclear power and provide a greater emphasis on deregulation of the electricity market and encouraging the installation of renewable sources of electricity. Moreover, the decision of the European Commission and nuclear alliance of the states to incorporate nuclear energy into the Green Taxonomy and modify the Green Deal as a global initiative leading to the allocation of funds for the implementation of an energy strategy to alleviate the crisis holds significant importance (The Economist 2022).

Geopolitical Confrontation

Not only did France play a decisive role in the decision, but also the active involvement of the Czech Republic, one of the largest beneficiaries of military assistance to Ukraine. The Czech Republic expresses grave concern regarding the substantial presence of Russia in cases of aid for the construction of nuclear reactors in Hungary and Slovakia, as well as the escalating

presence of the aggressor state on EU territory. The decision was deemed exceptional, namely, to involve a partner from South Korea in the construction of nuclear power plants and, as per the news release, to confirm the agreement by 2025 (Shaw 2024). It is not South Korea's first appearance in the European political arena, as Poland had previously made a deal to supply weapons to Seoul, especially tanks, due to the growing threat from Russia. South Korea is providing bilateral assistance to Europe in order to swiftly respond to the current turmoil (Reuters 2024). When considering other geopolitical actors, it is impossible not to mention Turkey as one of the main trading partners for many EU countries and a provider of labor. With Erdoğan's rise to power, relations between the EU and Turkey have seriously deteriorated, allowing Russia to become involved in the construction of the Nuclear Power Plant and increasingly pull back on key partnership of the EU countries in promoting their values in the Turkish political landscape and further talks in conflict resolution in Cyprus. A very illustrative point was given by Mehmet Çağatay Güler in his book *Building Nuclear Empire* about Russian nuclear geopolitical doctrine:

> *Thirdly, among the other countries where the Russian Federation has been pursuing nuclear power plant projects, Turkey, along with Hungary, is a member country to North Atlantic Treaty Organization (NATO). Considering the decades-long tensions between NATO and Russia, having an ally that is not only a neighbor and a pro-Western country but also a NATO member would provide an opportunity for more influence and balance for Russian foreign policy in Turkey and even beyond* (Güler 2020: 17).

The Russian military doctrine is actively encouraging hybrid wars and the disintegration of open diplomatic and commercial ties. The military coups in Burkina Faso, Niger, and Mali, during which the PMC Wagner took responsibility as the guardians of order, have emerged as a distinct red line for France. The political orientation of these rebels is based entirely on the political support and legitimacy of the war that the Russian Federation is waging. Russia behaves like a plague, not only attempting to eradicate all that it and the European Union share, but also rapidly disseminating by obstructing any supplementary pathways to energy recovery. These countries in West Africa hold significant importance in terms of their resource potential and the export of ore for nuclear power plants. At the same time, Putin, for full consolidation with the ruling military regime, is going to invest in the construction of the Nuclear Power Plant in Burkina Faso (Aradi 2023).

Conclusion

To summarize, the conceptual initiatives of several nations that are experiencing energy vulnerabilities and anticipating Europe's continued prominence on the global stage leave a promising impression in the resistance against the global threat posed by Russia. Simultaneously, there remains considerable uncertainty and apprehension regarding the implementation of novel innovations in small modular reactors, particularly if such a solution fails to garner additional support from the remaining nations of the Union and focuses on the proliferation of air defense systems. The fundamental narrative aims to incorporate nuclear sources into the overall formulation of the Green Deal to adapt to the contemporary European energy sovereignty and its constructive interaction with zero-waste renewable energy sources as a component of the European Energy Renaissance.

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Infrastructure of Protective Structures – Inventory of Existing Facilities, Safety Assessment, Threat Scenarios, and Response Capabilities and Needs for the City and Municipality of Dębica, Based on Experiences from the Conflict in Ukraine

Adrian Maziarz

Abstract: War threats associated with escalating geopolitical tensions pose a serious danger to the civilian population, compelling the authorities of the Republic of Poland to undertake protective measures. This paper analyzes the state of security and the level of public awareness regarding crisis management, using the city and municipality of Dębica in the Podkarpackie Voivodeship as a case study. The research encompasses protective structures and local territorial units, identifying key issues within the region. The findings indicate deficiencies in the infrastructure of protective buildings and crisis management systems, which undermine the community's capacity to respond effectively to threats. Residents demonstrate insufficient knowledge regarding the locations of protective structures and the necessary skills for crisis management. This paper emphasizes the importance of education and public awareness in the context of civil protection, presenting recommendations aimed at enhancing the safety of local communities. These recommendations serve as a foundation for future actions at both the regional and national levels.

Key words: Crisis management, Protective structures, Radar systems, Military security, War in Ukraine

Introduction

The social security of Polish citizens, in the face of increasing international tensions and military threats, has become a key topic in political and social debates. Following the outbreak of the war in Ukraine in 2024, questions regarding the state's ability to protect its citizens from external threats have gained particular significance. Heightened perceptions of military risk have prompted both government officials and the public to reflect on the effectiveness of existing defense mechanisms and protective facilities. An analysis of the security situation at the local level, using Dębica in the Subcarpathian Voivodeship as an example, highlights the challenges related to crisis management and building social resilience.

Effective public safety relies on the cooperation of local institutions, emergency services, and the community. Crisis management in the context of civil defense requires an integrated approach that combines technical, organizational, and social aspects. Local governments play a crucial role in raising public awareness and preparing society for potential threats.It is essential for residents to be aware of existing risks and know the procedures for responding to crisis situations. Furthermore, assessing the condition and readiness of local protective structures and analyzing the actions taken by authorities for their modernization become necessary. Issues related to the availability of protective resources and the perception

of safety within society require in-depth analysis. This paper aims to examine the state of security and public awareness in crisis management in Dębica, with particular emphasis on local protective structures. Such analysis is of significant importance for shaping future security policies in Poland, contributing to a better understanding of the needs of local communities and the challenges faced by authorities in protecting citizens.

Types, Condition, and Resilience of Protective Infrastructure Units

Classification of Protective Structures

According to recent terminology and inventory, protective structures are categorized into three main types:

Shelters: A structurally enclosed (hermetic) protective building designed to safeguard people, equipment, material reserves, or other assets from complex threats impacting from various directions. The following classes of shelters are distinguished:

-P Shelters - Basic resilience.

-A Shelters - Basic resilience with additional protection against blast waves with overpressure values of $\Delta pm \geq 0.1$ MPa.

Hiding Places: A non-hermetic protective structure equipped with basic installations that ensure the safety of people, equipment, material reserves, or other assets from specified threats impacting from various directions. The following classes of hiding places are distinguished:

-Category I - Basic resilience.

-Category II - Basic resilience, primarily offering protection against penetrating radiation from radioactive fallout.

-Category III - Protection only against conventional threat agents.

Temporary Shelters: A protective structure providing resistance against specific threats and the effects of extreme weather phenomena, ensuring a level of protection based on technical and constructional capabilities. (Guidelines of the Chief of Civil Protection of the Country 2018:14-17).

Protective infrastructure is also divided by intended use as follows:

-(M): Structures intended for residents.

-(Z): Structures intended for workplace personnel.

This classification is critical in crisis management, allowing for the appropriate utiliztion of structures according to the type of threat and the needs of the population. (County Command of the State Fire Service in Sanok, n.d.).

Protective structures in the city and municipality of Dębica

Dębica, a medium-sized city in the western part of the Podkarpackie Voivodeship, has a population of under 43,000 and covers approximately 34 km² (Statistics Poland 2024). The city possesses 271 protective structures that can accommodate over 67,000 individuals, comprising 254 provisional shelters and 17 reinforced bunkers. These reinforced bunkers, located mainly in industrial areas, can shelter about 1,500 people, including 500 residents and 1,000 workers. The provisional shelters provide capacity for nearly 66,000 people, including aproximately 55,500 residents and over 10,000 workers, meeting safety standards in terms of overall capacity.

The Dębica municipality, which spans 138 km² with a population of 25,688 (Statistics Poland 2024), has 43 protective structures available for roughly 9,000 people. These include 42 provisional shelters accommodating around 8,000 individuals—nearly 5,000 residents and 3,500 workers—and one shelter for 25 residents (County Fire Department in Sanok, n.d.). Although this infrastructure can only serve about 33% of the municipality's population, it aligns with the 2018 guidelines of the Chief of Civil Defense, which stipulate that shelters should be available for at least 25% of the registered population in each administrative unit (Supreme Audit Office 2024). The uneven distribution of shelters across the municipality results in reliance on Dębica's more developed protective infrastructure, presenting chalenges for crisis management and regional planning. It is important to acknowledge potential discrepancies in the data due to limitations in the Fire Department's inventory and the "Sheters" application database (Supreme Audit Office 2024). Such discrepancies should be considered in the analysis, particularly given potential updates or changes in infrastructure.

The condition and equipment of protective structures vary by type and location whether in residential, workplace, or public buildings—and reflect the resources managed by the responsible authorities. Since inventories of protective infrastructure were halted in 2004, many facilities across Poland remain under-equipped. In Dębica, most bunkers are outdated, featuring ventilation and power systems from the latter half of the 20th century and lacking basic supplies such as water and medicine. Many bunkers are empty, secured only with

reinforced doors, and in poor condition due to previous uses that compromised their structural integrity (City Office of Dębica 2024).

A Supreme Audit Office review of 39 protective structures across 20 municipalities found that, among 25 bunkers and 19 shelters, only three bunkers and two shelters were in very good technical condition. The majority failed to meet required standards, with 17 bunkers and 10 shelters deemed non-compliant. None of the five partially operational bunkers met hermeticity standards. Common issues included damage, missing installations, blocked emergency exits, and unmaintained ventilation systems. For example, inspections in Wałbrzych revealed structures qualifying only for Category III protection against conventional threats, with non-functional ventilation and emergency exits flooded with groundwater. In Giżycko, a sealed emergency exit and lack of essential equipment highlighted similar deficiencies (Supreme Audit Office 2024). These findings underline the importance of modernizing protective infrastructure and ensuring readiness for potential crises.

Experiences from the war in Ukraine regarding protective structures and threat scenarios

Protective structures are crucial for social security in the face of military threats, providing rescue during wartime. The example of Ukraine, which, despite being aware of the threats from the Russian Federation between 2014 and 2022, did not sufficiently develop protective infrastructure before the full-scale conflict, illustrates this issue. According to data from 2023, out of 50,195 inspected structures in Ukraine (78% of all facilities), 9% are inaccessible, and 23% are unfit for use. In Kyiv, of the 2,156 inspected facilities (48% of protective structures), 37% are unprepared to fulfill their function, including 9% of facilities that are closed. The mayor of Kharkiv, Ihor Terechov, indicated that Ukraine was not prepared for a full-scale war, which serves as an important lesson for Poland in this regard (Mikołajczyk 2023).

This thesis is supported by numerous attacks on Ukraine. Between December 29 and January 2, 2023, the largest use of weaponry since 2022 occurred in Ukraine, according to the General Staff of Ukraine. The attack involved 158 aerial assets, including 122 ballistic and cruise missiles and 36 Shahed drones. Ukrainian defenders successfully shot down a significant number of missiles and drones. The main targets of the attacks were critical and military infrastructure, with Kyiv becoming a particular victim, suffering the heaviest casualties since the onset of the conflict. The port infrastructure in Odesa, factories in Lviv, Kharkiv, Dnipro, and Zaporizhia also experienced attacks, resulting in the deaths of many

civilians. Additional attacks took place in Selydove and Drohobych. On December 29, Russians attacked Sumy and Cherkasy oblasts, resulting in one death. On December 30, kamikaze drones struck the Kherson and Khmelnytskyi oblasts, with some being shot down. That evening, missiles hit Kharkiv, injuring 22 people, and Selydove was attacked again. On December 31, Russians conducted the largest kamikaze drone attack, using 96 drones, most of which were shot down. The attacks affected Zaporizhia, Kharkiv, and the Mykolaiv, Odesa, Kyiv, and Khmelnytskyi oblasts. Missiles hit Kropyvnytskyi and Chuhuyiv. On January 1, another major drone attack occurred, with Ukrainian forces shooting down most of them. The General Staff of Ukraine also reported that on January 2, Russians employed 99 ballistic and cruise missiles and 35 kamikaze drones; most of them were destroyed by Ukrainian defenders. The attack resulted in the deaths of five civilians and injuries to 127 others (Wilk, Żochowski 2024).

These attacks underscore the intensity and scale of the use of weapons by the Russian Federation, as well as their focus on attacks on critical infrastructure, which have a profound impact on civilians and destabilize the internal situation in Ukraine. In Russian strategic culture, a key role is played by the so-called strategy of destruction, which involves exhausting the economic, material, and human resources of the opponent. Its goal is to lead to a loss of will to continue defensive operations by the governing body of the state. As indicated by Alexander Svechin, a Soviet theorist of this strategy, it is essential to weaken the opponent through actions aimed at depleting their resources, ultimately enabling a decisive strike. These actions also include brutality against the civilian population, aimed at intimidating society and weakening its resistance (Turowski 2024).

In the context of the above events, the scenarios developed for the purpose of this work and to visualize the problem regarding potential threats in Poland, such as “Bakhmut”, “Hostomel”, and “Harassment,” reveal the importance of proper preparation for crisis situations. The “Bakhmut” scenario illustrates extreme threats that may arise in the event of a full-scale conflict, particularly concerning Russian aggression against Poland. In the event of a breakthrough in Ukraine's defenses or the total defeat of that country, the capture of the strategically important city of Rzeszów by Russian forces would represent a turning point, potentially forcing Poland to urgently organize a new line of defense to the west of the current front. In this context, the studied region, due to its strategic location, may become a crucial point of resistance, analogous to Bakhmut, which has become a symbol of devastating fighting. The geographical similarities of Dębica to Bakhmut, such as distances from

borders and larger cities, suggest that similar military actions could occur. In the case of Bakhmut, the fighting was not only brutal but also prolonged, leading to the destruction of not only infrastructure but also the social fabric of the city (Dyner 2023: 1).

This example serves as a warning that, in light of contemporary threats to the studied region, it could take on real shapes. The scenario assumes that intense clashes and material warfare could lead to mutual destruction of forces, with each side striving to capture and maintain key strategic points. In this context, Dębica could become the target of intense artillery shelling and positional warfare, which could necessitate an organized evacuation of the civilian population. The scenario assumes that such military actions could lead to chaos, panic, and numerous cases of self-evacuation among residents. Local authorities should be prepared for potential humanitarian crises and establish procedures for population protection, which may include creating evacuation points, providing information, and offering support to those who may need assistance. The example of Bakhmut clearly shows that in the case of Dębica, the war could transform into a devastating and protracted struggle, where each side would strive to maintain control over the city at all costs. The destruction of civilian infrastructure, including energy, communication, and water supply systems, could lead to a humanitarian crisis that would exacerbate the suffering of residents. Therefore, it becomes essential to implement procedures aimed at protecting the population, including organizing shelters, securing resources, and establishing evacuation plans.

On the other hand, the “Hostomel” scenario focuses on the attempt to capture Rzeszów by Russian forces, which could represent a significant operational objective in the region. This scenario assumes that the aggressor will seek to gain operational advantage in the eastern part of the Podkarpackie Voivodeship through coordinated land attacks, air support, and airborne operations. Similar to the situation in Hostomel, where the key element of the opponent's strategy was the landing at the “Antonov” airport. Which constituted one of the most pivotal events of the war’s first day, shaping the trajectory of the initial phase of the entire Kyiv campaign (Gawęda 2022).

The capture of the airport in Jasionka in the Dębica region could open the way for further operations. This threat includes not only direct attacks on the city but also attacks on logistical infrastructure, especially railways. Gaining control over this infrastructure could block supply deliveries to Rzeszów, which would, in turn, weaken the region's defensive capabilities. In such a scenario, the studied region, located near the city of Rzeszów, might be forced to react quickly to threats, which would be associated with difficulties in organizing the evacuation of residents. Faced with the growing threat, residents might make decisions about

self-evacuation, leading to chaos and confusion. In the case of the "Harassment" scenario, threats could take the form of regular attacks on critical infrastructure and civilian facilities. Such actions aim not only to destroy physical resources but also to instill fear and destabilize the region. These attacks could target energy networks, bridges, communication hubs, and administrative buildings, ultimately leading to paralysis of social and economic life in the studied region. Regular attacks, even of limited intensity, could force the population to take evacuation measures, resulting in many instances of self-evacuation. In a situation where such actions are sporadic, the city may continue its basic administrative and logistical functions, but with limited effectiveness. However, as the threats escalate, the evacuation of the civilian population will become a necessity, potentially leading to a significant humanitarian crisis.

Military threats to the civilian population, early warning system, and response time in relation to protective infrastructure

Air Defense (AD) is designed to ensure the safety of a country's airspace by reducing threats to an acceptable level, which is crucial for national independence. It is divided into specialized and general defense. Specialized air defense includes military actions such as ground-based air defense forces, fighter aviation, radiotechnical units, and electronic warfare, all supported by modern command systems that aim to detect, identify, and neutralize aerial threats. In cases of incursions by enemy air forces and threats, General Air Defense (GAD) intervenes, utilizing available human and material resources to minimize the effects of aerial attacks. This includes alerting, evacuating, masking, and organizing shelters. According to the National Security Strategy of 2014, GAD supports specialized defense by protecting civilians from the consequences of attacks, forming an integral part of the national security system (Michalski 2016:3).

Tab. 1. Detection Range of Radar Units in Service of the Republic of Poland

Radar system	Range (km)
PAT-31DL	470
NUR-12M	470
NUR-12ME	350
NUR-15M	240
NUR-31	200
PATRIOT	100
AVIA-W	100
ZDPSR „BYSTRA"	80
ZDPSR „SOŁA"	50

Source: Own elaboration based on (MDAA 2023), (Dura 2023), (Kwika 2015:86-88).

Radar reconnaissance refers to a set of organizational, technical, and tactical actions carried out by specialized units to acquire information about aerial objects. This process relies on the analysis of signals reflected or emitted by these objects, conducted by units of the Radiotechnical Forces and radiotechnical units of the Air Defense Forces, which serve as a key method for airspace control (Kwika 2015:80).

Considering the radar detection capabilities of individual radar systems in the Armed Forces of the Republic of Poland, the average detection range of the mentioned systems is approximately 213 km. For the purposes of this study, the reference points selected for the analyzed region are the areas of the cities of Rzeszów and Jasionka, due to their significance in the context of the conflict in Ukraine, which presents a high probability of encountering any of the mentioned systems in the region. Dębica, located 50 km west of Rzeszów, serves as a critical point in the event of a potential attack. If a threat is detected at a distance of 500 km east of Rzeszów, the object would need to cover approximately 550 km to reach the studied region. Distances may vary depending on the directions of attacks, necessitating a more precise analysis. Given the modern weapon systems and tactics employed, it is essential to consider variations in distances in a broader strategic analysis. A key aspect of ensuring the safety of residents in the city and municipality of Dębica is defining the time frames within which they can reach protective structures. Average results from the Cooper test indicate that individuals aged 8 to 50+ can cover between 1900 to 2000 meters in 12 minutes ("Cooper Test for Everyone" n.d.).

In the context of a threat, such as the detection of an Iskander-M missile at a distance of 470 km, residents would have approximately 4 minutes to react. Due to the high risk of panic among the civilian population and limited road capacity, the use of motor vehicles as a means of transport to protective structures is dismissed. In a crisis situation, roads would quickly become impassable. Therefore, the protective structures system must account for these factors to ensure an efficient response from residents and avoid the exclusion of certain social groups.

The protective infrastructure in the region is characterized by diversity regarding the types of protective units, the number of facilities, their distribution, and capacity. Based on the analysis of average effort results and the conducted assessment, it can be concluded that reaction times and times to reach protective buildings can drastically change depending on the types of weapons used.

Protective structures should be positioned as close as possible to permanent residences, and the recommended distance between them should not exceed 150 m (Guidelines of the Chief of Civil Protection of the Country 2024:2).

The infrastructure of protective buildings in the region largely fails to meet these requirements. In the municipality of Dębica, aside from the Pustków-Osiedle agglomeration, which has 32 protective structures, there are only 11 similar facilities, which are significantly dispersed. This creates a real risk of rapid overcrowding of structures during threats and a lack of alternative routes to shelters for other residents.

The attack on Kyiv on March 25 demonstrated that the time to hide from hypersonic missiles is merely 3 minutes, rendering shelters located further from the threat completely ineffective and wasteful of funds. Furthermore, in many cities, including Kharkiv, recent tragic events have shown that alarm signals often sound only after a missile attack (Pragmatika 2024).

This underscores the significant threats posed by the use of modern weaponry, which have a profound impact on the response time of citizens to threats and the time it takes to reach protective structures. In the context of contemporary armed conflicts, such as the war in Ukraine, where military technology is evolving at an incredibly rapid pace, response time becomes a critical factor in ensuring the safety of the civilian population. Modern weapons, such as ballistic missiles and drones, can reach their targets in just a few minutes, leaving little time for rescue actions to be taken. In this context, the ability of citizens to react swiftly to alarms and warning signals is essential for minimizing casualties among the civilian population. Moreover, the effectiveness of early warning systems and communication networks is crucial, as they can significantly enhance the public's preparedness and ability to respond. Ensuring that protective measures, such as protective structures, are accessible and known to the community can also make a vital difference in saving lives during times of crisis.

Tab.2. Response Time to Exemplary Air Assault Means

Type: (ALW)	Maximum Speed / Terminal Velocity (km\h)	Maximum/Mean Detection Range (km)	Flight Time (min)
9K720 Iskander	7 560	470	≈3,44 min
9K720 Iskander	7 560	213	≈1,69 min
Ch-101	972	470	≈29 min
Ch-101	972	213	≈13,14 min
Ch-47M2 Kindżał	12 240	470	≈2,18 min
Ch-47M2 Kindżał	12 240	213	≈1,04 min
Shahed 131/136 (Geran-2)	185	470	≈2 godz. 32 min
Shahed 131/136 (Geran-2)	185	213	≈1,15 godz.

Source: Own elaboration based on Cranny-Evans, Kaushal 2022, Dura 2024, Łysoń 2022, Michalik 2022.

Public opinion research

The research conducted for the purposes of this scientific work was carried out in two phases, allowing for a diverse and comprehensive dataset. The first phase of the study took place from April 9 to May 19, 2024, while the second, expanded phase occurred from October 21 to November 3, 2024. In the second phase, the sample size was increased from 124 to 250 respondents to obtain more comprehensive results and enhance the representativeness of the group. The respondents were aged between 18 and 78 years, ensuring demographic diversity within the sample.

Data collection was conducted using an online survey form, facilitating efficient outreach to a broad range of participants. The selection criteria included demographic aspects, such as residence in the studied region and being at least 18 years old, which ensured that the opinions gathered came from adult residents. The recruitment process was random, increasing the likelihood of obtaining a sample that was diverse in terms of socio-demographic characteristics. The distribution of the survey link was managed by enumerators residing in the city and municipality of Dębica, which allowed for effective engagement with local communities. The organization of the study aimed not only to gather residents' opinions from both local government units but also to ensure that the research reflected a wide range of perspectives from both urban and rural inhabitants. The use of an online survey form preserved the anonymity of the respondents, which may have increased the honesty of their answers.

The research questionnaire consisted of nine questions, three of which pertained to demographic aspects (age, gender, place of residence), while the remaining six focused on the issues being studied. For the analysis presented in this paper, five substantive questions were included, formulated as closed questions with single-choice answers. This approach facilitated the coding and analysis of results, also encompassing specific age groups (1-24, 25-34, 45-54, 55-64, 65 and older). One of the questions (question 5) offered three alternative single-choice responses. The absence of a Likert scale may have affected the precision of the results, limiting the ability to assess the intensity of respondents' attitudes. Employing a Likert scale in future studies could enhance the accuracy of responses. Nevertheless, the closed format of the questions increased the objectivity and clarity of the results. Given the limited sample size, which may not be fully representative, the findings of the study are indicative in nature. Nonetheless, the study aimed to gather data that could serve as a starting point for future, more advanced research on a larger scale.

Tab.3. Research questions asked

1). Are you concerned about military threats to the Polish nation related to the ongoing war in Ukraine?
2). Do you possess knowledge or skills in responding to crisis situations?
3). Are you aware of the locations of protective structures in your area?
4). After the outbreak of the conflict in Ukraine, were you informed by the city or municipality of Dębica about the locations of protective structures and procedures for responding to crisis situations?
5). Do you believe that the actions and preparedness of the city and municipality of Dębica are sufficient to protect the population in the event of military threats?

Source: Own elaboration.

Question 1: In relation to concerns about Poland's security in the context of the war in Ukraine, 70% of respondents are not indifferent to the threat. The sense of danger is present across all age groups, particularly among those aged 35–44 (79% expressing concern) and 45–54 (81%). These two groups make up 39% of all respondents expressing concern about the situation. The high level of concern among middle-aged individuals may be linked to their social and professional roles and their responsibility for family.

Question 2: Regarding the level of knowledge and skills necessary for handling crisis situations, 59% of respondents report a lack of practical skills. Women residing in the city of Dębica are more likely to indicate this deficiency compared to other groups. Among the 35–44 and 45–54 age groups, 79% and 75% respectively acknowledge a lack of competence. Both groups represent a significant portion of those who admit to lacking skills, suggesting that middle-aged individuals may struggle with preparation for crisis situations. In the 65+ age group, this percentage drops to 37%, which may indicate a higher level of preparedness, possibly due to greater life experience.

Question 3: In studies concerning the knowledge of the locations of protective structures, 80% of respondents admit to lacking this information. Men residing in the city of Dębica are more familiar with these locations. The lack of knowledge is widespread across all age groups but is particularly pronounced among the 35–44 age group (86%) and 45–54 age group (87%). Respondents from these age groups make up 36.8% of all survey participants who admitted to not knowing the locations. In contrast, only 62% of respondents aged 65+ lack this knowledge, which may suggest that older individuals, due to more extensive experience and possibly greater interest in safety, possess such information to a higher degree.

Question 4: In relation to the question concerning the informational activities undertaken by local authorities to inform residents about the locations of protective structures since the

outbreak of the war in Ukraine, the research results indicate that a significant majority of respondents (85.6%) have not encountered clear information on this topic. This lack of communication is noticeable across all age groups, regardless of gender or place of residence; however, an especially high percentage of inadequate information was recorded in the 45–54 age group, where as many as 93% of respondents stated a lack of noticeable informational activities. This may reflect the inadequacy of local government efforts to reach this age group, which often plays key social and professional roles. The lowest percentage of individuals declaring a lack of information (78%) was noted in the 18–24 age group. Although this is a lower percentage compared to other groups, it still indicates significant gaps in communication efforts. Younger age groups may be more open to diverse sources of information, which may explain their somewhat better perception of access to information about protective structures. It is worth noting that respondents who reported a lack of awareness of information following the outbreak of the war in Ukraine constitute 35.6% of all study participants who expressed similar opinions.

Question 5: In a survey concerning the region's preparedness for civil protection and crisis management, 79.2% of respondents indicated a lack of trust in the region's level of readiness for potential threats, while 24% assessed it positively, and 23% did not have sufficient knowledge to make a definitive judgment. There were no significant differences in opinions based on gender or place of residence. A low level of trust prevailed across all age groups, especially among the 55–64 age group (91% lack of trust) and 65+ group (almost 100%). These groups represent 15% of all responses indicating a lack of trust. The younger age group (18–24) more frequently stated that the region is well-prepared for such threats, but even so, the majority (69%) still believed that the region is not adequately prepared, with 20% of this group admitting to lacking sufficient knowledge to make a definitive assessment.

The study on the attitudes of residents of the surveyed region towards safety in the context of the war in Ukraine and preparedness for crisis situations revealed significant trends and gaps that could impact the effectiveness of crisis management. The highest sense of threat was recorded in the 35–44 and 45–54 age groups, suggesting that middle-aged individuals, often burdened with professional and family obligations, are most aware of potential dangers. At the same time, these groups show deficiencies in practical crisis skills (59%) and knowledge of protective infrastructure. Over 80% of respondents admitted to lacking information about the location of protective structures, emphasizing insufficient informational efforts, particularly visible in the 45–54 age group, where 93% of respondents did not

observe adequate actions from local authorities. These findings highlight the need for intensified educational campaigns and improved communication from local governments.

The high level of distrust in the region's crisis preparedness (79.2% of respondents) reflects a general sense of insecurity, with the highest rate of distrust recorded among older individuals (55–64 and 65+), possibly due to their greater experience and expectations regarding the effectiveness of public institutions. Younger age groups, despite being more open to various sources of information, also recognize significant shortcomings in preparatory measures. In summary, the study's results clearly demonstrate the necessity for more comprehensive educational initiatives and more effective crisis communication to increase public knowledge and a sense of security.

Conclusion

In light of the current geopolitical situation related to the war in Ukraine and destabilization in Eastern Europe, Poland must face new challenges in the realm of national security. This requires a comprehensive approach to modernizing protective infrastructure, particularly in the Dębica region. Analyses indicate a shortage of shelters and inadequate equipment, highlighting the need not only for the modernization of existing facilities but also for the construction of new ones. At the same time, it is crucial to educate citizens about behaviors in crisis situations, which can significantly enhance the effectiveness of crisis management. Research shows that the society has significant gaps in knowledge regarding the locations of protective structures and procedures to follow in crisis situations. The lack of effective informational actions from local authorities and the negative assessment of the region's preparedness for crisis management confirm the need to intensify educational efforts.

Emphasizing the role of education and effective information flow in crisis situations is key to ensuring the safety of citizens. “A very important issue is also the education of society in terms of countering threats. Responding in a crisis situation requires gathering information and ensuring its flow, avoiding hasty actions, anticipating the course of events and their potential consequences, as well as ensuring the effective functioning of public administration” (Nosalski 2016:100). These tasks seem to be neglected by local authorities, as confirmed by the analysis of the responses from the surveyed group. From a strategic perspective, it is essential to define and understand the role and tasks of the studied region in terms of the country’s defense, particularly concerning potential military threats such as missile attacks

or sabotage. There is also a visible need to develop radar detection systems to minimize the occurrence of blind spots in radar detection, especially along Poland's eastern borders. The conclusions from the conflict in Ukraine show that modern threats require not only the expansion of protective infrastructure but also the adaptation of crisis management strategies to new realities.

Investments in the modernization of protective facilities, as well as their expansion and technological development, are crucial for ensuring national security and effective protection of citizens. In summary, there is an urgent need for a comprehensive modernization of protective infrastructure and effective public education regarding safety. To provide citizens with an appropriate level of protection in the face of contemporary threats, well-coordinated actions from local authorities and active collaboration with citizens are essential.

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Role of ESG reporting in small and medium-sized enterprises: benefits, challenges and the EU's regulatory push

Emir Gurlevuk

Abstract: This article examines the growing importance of Environmental, Social, and Governance (ESG) reporting, focusing on small and medium-sized enterprises (SMEs) and the European Union's (EU) regulatory framework. The research is structured around three key questions: the motivations behind the EU's implementation of ESG regulations, the benefits SMEs can derive from adopting ESG reports, and the challenges businesses face during this process. Moreover, the article explores how the EU's regulatory push is driven by goals related to environmental sustainability, social responsibility, and corporate governance, aiming to align with global climate initiatives. It also investigates how SMEs can benefit from ESG reporting by improving operational efficiency, securing access to capital, and building stronger stakeholder relationships. However, it acknowledges the significant challenges faced by businesses, including compliance costs, difficulties in data collection, and the complex nature of regulatory requirements. Through a comprehensive analysis, this paper provides insights into the evolving role of ESG in shaping business practices and policy, with particular emphasis on its impact on SMEs and the broader EU economy. The findings aim to contribute to a better understanding of ESG as a strategic tool and its implications for businesses within the EU regulatory context. At the end of the article, the case study thoroughly details how DHL, a company that has proven itself in the logistics sector and ESG reporting, managed the process and the key aspects they focused on.

Key words: SMe, Corporate Social Responsibility (CSR), Sustainability, European Union, Enviromental, Social and Governance (ESG) Report

Introduction

The term 'ESG' was introduced in 2004 in 'Who Cares Wins' and was introduced to find ways to incorporate the aspects of ESG into the capital market (Helfaya, Morris, Aboud, 2023, as cited in Swiss Federal Department United Nations of Foreign Affairs and United Nations, 2004). From this point on, ESG is seen as an extension of traditional CSR (Corporate Sustainability Report) and socially responsible investment. The era in which organizations solely prioritized an increase in company profits has long since ended. This is because the global population is facing issues such as the climate crisis, global warming, and the depletion of natural resources. Therefore, the ESG (Environmental, Social, and Governance) report, established to protect these concerns, is one of the essential reports for companies to survive and use global resources efficiently. Investors and consumers expect organizations not only to succeed in production or service delivery but also to be responsible for topics such as environmental management, waste management, and energy use, which will be written about later in this article. This expectation places a responsibility on companies, which must also heed the importance of these issues as societal and environmental conditions change globally, as well as the emergence of regulations enacted by governments on these matters. The Corporate Sustainability Reporting Directive (CSRD) aims to make it mandatory for companies to report on sustainability,

environmental, social, and governance (ESG) issues. According to the following timetable, companies will fall under the scope of the CSRD: In 2024, large public companies with more than 500 employees and large non-EU listed companies will be required to report. In 2025, all large companies meeting two of the following three criteria will be included: (1) an annual average of 250 employees or more, (2) total assets of €25 million (an increase from €20 million under the Commission's recent amendment), or (3) €50 million in sales (up from €40 million under the amendment). The SMEs (Small and Medium-sized Enterprises), which are the subject of this article, will be required to start reporting from 2027. However, uncertainties remain as standards have not yet been established. Listed SMEs may report using less intensive standards and can request an exemption from reporting requirements for two additional years, allowing them to delay reporting until 2029. Non-listed SMEs are not subject to the CSRD but may choose to report voluntarily under simplified standards if sustainability information is requested. Finally, in 2028, companies located outside the EU with sales exceeding €150 million in the EU must be either a large or listed subsidiary or a significant EU branch. These companies are required to submit reports the year after they fall under the scope of the CSRD.

What motivates the European Union to implement ESG regulations

The European Union and its member states are facing a significant challenge. They aim to promote sustainable development to comply with international agreements such as the 2030 Sustainable Development Goals and the 2050 climate neutrality targets. Achieving this requires numerous fundamental changes that will contribute to global sustainability. The EU is implementing regulations that impose new obligations on businesses, initially targeting large and listed companies; however, these regulations will also extend to small and medium-sized enterprises (SMEs) operating within supply chains. When examined in terms of environmental, social, and governance (ESG) factors, these regulations encompass various aspects, including: the usage of energy resources by an organization, its waste management policies, efforts towards net-zero emissions, impacts on biodiversity and the climate crisis, water pollution, and deforestation. Additionally, they address the organization’s connections and effects on local communities where it operates and provides services, stakeholder relationships, accurate consumer information, data protection and privacy policies, health and safety practices, as well as efforts toward human rights and ethical principles. They also cover decision-making factors necessary for good governance, corporate transparency, accountability, inclusiveness, and compliance culture.

As can be seen, the European Union does not mandate ESG reports solely for sustainability and environmental development. Rather, it also aims to enhance investor awareness, promote social responsibility and transparency, gain a competitive advantage, ensure regulatory compliance and legal obligations, manage risks, and address the impact on society and stakeholders. By making ESG reporting compulsory, the EU seeks to promote sustainability and integrate economic growth with environmental, social, and governance responsibilities.

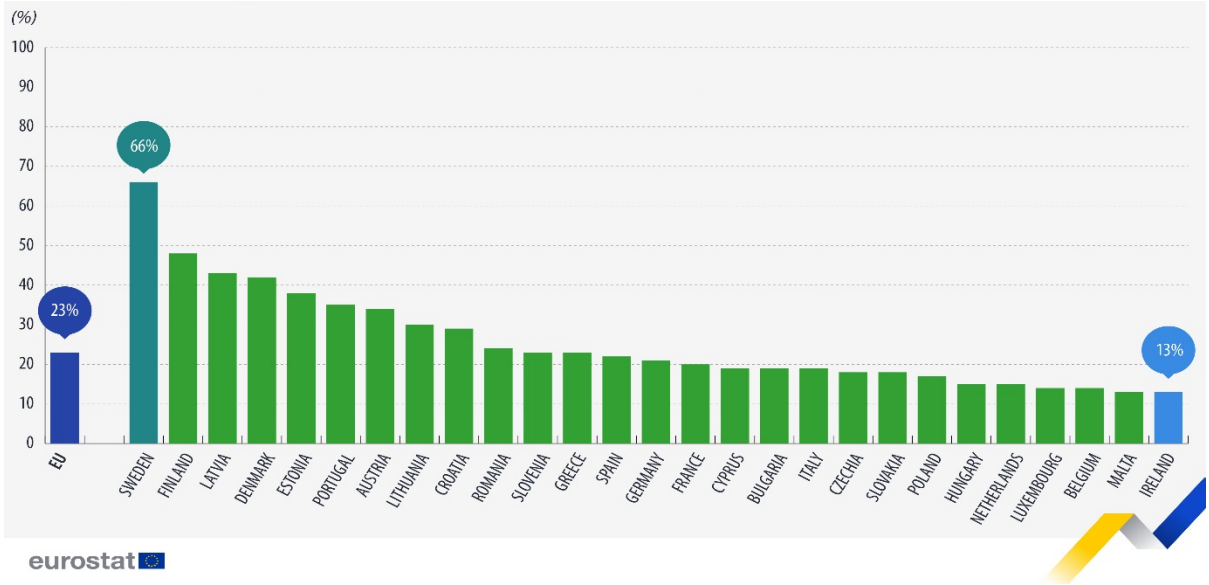
The European Union's environmental interest in ESG (Environmental, Social, and Governance) reporting is driven by key objectives such as achieving sustainable development goals, combating climate change, and ensuring environmental sustainability. ESG reporting provides companies with a framework to assess their environmental, social, and governance performance, and the EU is working on regulations to make this reporting mandatory. In alignment with the 2030 sustainable development goals, the EU focuses on environmental objectives like reducing carbon footprints, preserving biodiversity, encouraging a circular economy, and ensuring the sustainable use of natural resources. Comprehensive policies and regulations, including the European Green Deal and the EU Environmental Action Programs, are in place to meet these targets.

For instance, the EU Green Deal sets new CO_2 (carbon dioxide) standards requiring all new cars and vans registered in Europe to be zero-emission by 2035. As a step toward this goal, average emissions of new cars must be reduced by 55% by 2030, and emissions from new vans by 50%. This will place road transport on a path toward zero-emission mobility by 2050 (European Commission 2021). Furthermore, these regulations extend beyond road transport to include measures in aviation and maritime transport. For example, there are targets to gradually reduce the average annual greenhouse gas intensity of energy used on ships, with a focus on promoting renewable and low-carbon fuels. In aviation, to encourage sustainable aviation fuels (SAF), the required share of SAF to be blended with kerosene by aviation fuel suppliers has been increased, and this blend must be provided at EU airports (European Commission 2021). SAF fuels, made from renewable materials such as mustard seeds, sugarcane, and used cooking oil, serve as low-carbon alternatives to traditional jet fuels, contributing to both recycling and reducing carbon emissions.

At the EU level, the share of renewable sources in gross final energy consumption reached 23.0% in 2022. Compared to 2021, this represents an increase of 1.1 percentage points (pp).

This figure was 19.1% in 2018 and is estimated to reach 24.1% in 2023. According to the available data, in 2022, Sweden led among EU countries, deriving 66.0% of its gross final energy consumption from renewable sources. Finland (47.9%) and Latvia (43.3%) also utilized significant amounts of renewable energy. Denmark (41.6%) and Estonia (38.5%) increased their energy consumption through wind and solid biofuels. Portugal (34.7%) and Austria (33.8%) turned to renewable energy sources supported by hydropower and biofuels. However, countries like Ireland, Malta, Belgium, and Luxembourg had renewable energy shares ranging from 14.4% to 13.1%. In total, 17 of the 27 EU members reported shares below the EU average of 23.0% (Tab. 1). This data can be considered a result of the EU's positive insistence on the use of renewable sources in energy.

Tab 1. Overall Share of Energy from renewable sources in 2022 in Europe



Source: Eurostat 2023.

The environmental section of ESG reporting allows companies to present their environmental impacts to the public more transparently. This transparency enhances credibility among stakeholders, investors, and society, thereby strengthening the reputation of businesses. The EU is considering making ESG reporting mandatory not only for large companies but also for SMEs. In this context, reporting on the environmental performance and sustainable business practices of SMEs is emerging both as a legal requirement and as a tool for enhancing their competitive advantage (European Union 2022).

Additionally, ESG reporting is closely related to the EU's efforts to transition to a circular economy. The circular economy is an economic approach where the value of products, materials, and resources is maintained in the economy for as long as possible, and waste generation is

minimized (Önder, 2018, as cited in European Commission, 2015). Through ESG reporting, companies are expected to assess and optimize environmental aspects such as resource use and waste management. This approach is important in alignment with the EU's goals for transitioning to a low-carbon economy, emphasizing the preservation of natural resources and the minimization of environmental risks.

In summary, the carbon emission reduction targets established under the European Green Deal are part of the environmental perspective of ESG reports. Companies disclose the measures they take to reduce their carbon footprint, the sustainable energy sources they utilize, and their circular economy practices in their ESG reports, thereby fulfilling legal requirements and contributing to the EU's overall goals for a sustainable future. This makes companies' environmental performance more transparent to investors and the public, thereby supporting the necessary transformation for a more sustainable economy. The EU's approach to ESG reporting from an environmental perspective not only helps businesses assess their environmental impacts but also supports them in achieving social, economic, and environmental sustainability goals. This process enables companies to fulfill their environmental responsibilities, manage environmental risks, and contribute to the EU's green transition objectives.

The European Union views ESG (Environmental, Social, and Governance) reporting as a tool for social responsibility. Within the framework of social sustainability, it emphasizes how companies should contribute to their employees, communities, and other stakeholders. Key aspects include protecting workers' rights, ensuring safe working conditions, and supporting community-benefiting projects. On the other hand, Davis (1973) argues that a company is not socially responsible simply by meeting the minimum legal requirements. He believes that companies should go beyond legal obligations and accept additional social responsibilities. This means that just protecting workers' rights does not automatically establish a corporate social responsibility (CSR) culture. As previously mentioned, alongside the "E" (Environmental) in ESG reports, consumers and stakeholders now expect companies to provide information regarding ethical practices, how employees are treated, and their safety. This social responsibility is not necessarily tied directly to a company's business operations. Companies that demonstrate their CSR awareness by sponsoring civil society organizations, charity campaigns, or volunteer projects show a broader commitment to social responsibility. For instance, a 2019 Edelman survey revealed that 53% of consumers believe that brands should contribute to at least one social issue unrelated to their direct business operations. This indicates that consumers are increasingly preferring companies that focus not only on business goals but also on contributing

to social causes. In essence, consumers expect brands to be sensitive to societal issues and to play an active role in solving them.

Corporations with an awareness of social responsibility can become more respected and recognized in society. This is because people are empathetic beings, and negative aspects such as mistreatment of employees, exploitation, or harm to the environment and animals can discourage consumers and investors from supporting such companies. For instance, if an SME is part of a larger company's supply chain and engages in worker rights violations, these actions could lead to significant loss of reputation and financial setbacks when noticed by other companies or the public. A good example of how investor and public perception can shift regarding companies that violate worker rights is the case between Foxconn and Apple. Foxconn, a major Chinese supplier that manufactures Apple products, came under public scrutiny in the 2010s due to reports of poor working conditions. Allegations surfaced that workers were forced to work excessive hours, were underpaid, and faced inadequate safety standards. These issues became even more visible after tragic incidents, including worker suicides. In response, Apple introduced new standards, demanding that Foxconn and other suppliers improve workers' rights, and increased inspections. Additionally, Apple collaborated with third-party auditors to ensure better working conditions.

The European Union's regulatory push in ESG (Environmental, Social, and Governance) reporting aims to ensure that companies meet their responsibilities regarding labor rights, societal contributions, and consumer obligations. Companies are required to provide transparency on issues such as accurate consumer information, data protection and privacy policies, support for impoverished communities, workforce diversity, equality, inclusion, employee engagement and satisfaction, health and safety, human rights, ethical principles, fair wages, labor standards, and sustainable supply chains (European Union 2022).

According to Khan (2011), corporate governance is a system that regulates the processes, policies, and relationships between stakeholders to control, manage, and achieve the goals of companies. This broad term encompasses processes, traditions, policies, laws, and institutions. Corporate governance aims to ensure that an organization achieves its objectives and regulates relationships among stakeholders, including the board of directors and shareholders. While the definition of corporate governance generally follows certain lines, a more formal and widely accepted definition is provided by the Organization for Economic Cooperation and Development (OECD) in the "Principles of Corporate Governance" report published in 2004. According to the OECD, corporate governance involves a series of relationships between a company's

management, board, shareholders, and other stakeholders. This structure defines the company's objectives and outlines ways to achieve these goals and monitor performance. Furthermore, the existence of an effective corporate governance system helps build the trust necessary for the smooth functioning of a market economy. Corporate governance lowers capital costs and supports companies in using resources more efficiently to foster their growth (OECD 2004: 11).

The governance standards set by the European Union (EU) in ESG reporting include various regulations aimed at ensuring transparency, accountability, and ethical behavior in company operations. These regulations can be defined as follows: The Board Composition and Independence: The EU emphasizes the importance of diverse, independent, and competent boards for effective corporate governance. Board members must have the necessary qualifications and experience to ensure the long-term success of the company. Transparency and Accountability: The EU promotes open and honest communication between companies, shareholders, and other stakeholders. This involves providing accurate information about business operations, performance, and strategies in ESG reports, enabling stakeholders to hold companies accountable for their actions. Shareholder Rights: EU regulations stress the protection of shareholder rights, particularly in decision-making processes. For shareholders to have a significant influence on corporate governance, companies must serve the interests of all stakeholders, not just the board or managers. Ethical Behavior and Compliance: EU laws require companies to adhere to ethical principles, legal requirements, and social responsibility in their operations. This includes compliance with anti-corruption laws, respect for human rights standards, and fair treatment of employees. Long-Term Strategy and Risk Management: The EU mandates that companies implement long-term sustainability-focused strategies and establish adequate risk management practices to address environmental and social risks (European Commission 2021).

The European Union places significant importance on "Governance" or more specifically, "Corporate Governance" in ESG reporting, emphasizing companies' adherence to ethical standards and sustainability requirements. This governance allows stakeholders and investors to access more detailed and transparent information, ensuring that company operations are visible and in line with legal and ethical norms. As a result, it addresses potential concerns and attracts new investors, leading to safer, ethical stock markets, improved company sustainability, and enhanced financial performance. The positive impacts of corporate governance are discussed in the article's section on ESG reporting benefits for SMEs.

The Benefits of ESG Reporting for Small-Medium Enterprises

Small and Medium-sized Enterprises (SMEs) often form the backbone of a country's economy. In fact, these businesses represent 99% of all businesses in the EU. The definition of SMEs is particularly important in terms of access to financing and EU support programs targeting these businesses (European Commission). Therefore, the European Union aims to enhance market vitality and help SMEs adapt to the modern world by subjecting them to necessary regulations and reports.

However, SME classifications differ between countries. Typically, the key factor in classification is the number of employees, which divides companies into micro, small, or medium-sized enterprises. Due to fluctuations in currency or exchange rates, revenue amounts cannot be perfectly aligned, so countries have set their own criteria. For example, while the required number of employees for a company to be classified as an SME is the same in Turkey as in Europe, the annual net sales revenue or any part of its financial balance sheet has been adjusted in Turkey. In Turkey, the revenue must not exceed 500 million Turkish liras for medium-sized enterprises, 100 million for small enterprises, and 10 million for micro enterprises (KOSGEB 2023).

The key point to understand here is the definitions or criteria set by countries before classifying companies as SMEs. This is clearly demonstrated by UNIDO’s establishment of 50 different definitions for small-scale industries across 75 countries (Onyiriuba, 2016, as cited in Evborokhai 1989). Therefore, as mentioned earlier, even if employee count is considered, other classifications may vary between countries. Each country defines SMEs according to its own economic needs, and these definitions are generally based on fundamental criteria such as sales turnover, balance sheet size, capital, and number of employees. However, the quantitative values of these criteria differ from country to country. For this reason, there is no universally accepted single definition of an SME (Onyiriuba, 2016).

However, since much of our focus is on the European Union, the companies referred to as SMEs from now on will be those that align with the EU's own definition and scales. According to the EU definition, the key factors determining whether a business qualifies as an SME are outlined in Table 2.

Tab. 2. Categorization of companies according to SME classifications in EU

Company category	Staff headcount	Turnover	or	Balance sheet total
Medium-sized	< 250	≤ € 50 m		≤ € 43 m
Small	< 50	≤ € 10 m		≤ € 10 m
Micro	< 10	≤ € 2 m		≤ € 2 m

Source: SME definition, https://single-market-economy.ec.europa.eu/smes/sme-fundamentals/sme-definition_en (access 27.10.2024).

However, when presenting this table, the European Union has also noted: 'These ceilings apply to the figures for individual firms only. A firm that is part of a larger group may need to include staff headcount/turnover/balance sheet data from that group too.'

ESG (Environmental, Social, and Governance) reporting, when prepared in accordance with European Union standards, provides significant benefits to SMEs. The importance of profitability for a company's sustainability is undeniable; profitability is achieved through factors such as increasing sales, exploring new business areas, or expanding with additional branches. However, while ESG reporting may not directly generate profits, it indirectly supports a company's sustainability, enhances investor confidence, and increases market value.

This concept can be compared to the use of concrete and steel in constructing a building. Reinforced concrete serves as the foundation of the structure, akin to a company's profitability. However, properly curing the concrete or employing vibration techniques to strengthen it enhances the building's durability, much like ESG reporting contributes to long-term corporate health. Similarly, in the field of electrical and electronic engineering, the pathways and batteries on a circuit board represent a company's profitability. The soldering of these pathways, symbolizing ESG reporting, ensures long-term operational reliability. Without soldering, the circuit may function temporarily but will eventually fail due to oxidation.

In conclusion, ESG reporting may not be a mandatory requirement for a company's operations—at least until the European Union mandates it universally—but it serves as a strategic tool to enhance and maintain profitability. It strengthens investor relations, ensures corporate viability, and offers a competitive advantage, highlighting its importance as more than just a compliance measure.

When evaluated in the fields of business and finance, ESG (Environmental, Social, and Governance) reporting offers significant benefits to SMEs. These reports hold considerable value for all stakeholders. The potential users of ESG reports include investors, customers, employees, competitors, lenders, media, non-governmental organizations, academics, analysts, and researchers (Şeker & Şengür 2022). Therefore, the preparation of ESG reports in a clear and comprehensible manner positively influences these stakeholders and provides substantial advantages to businesses.

The benefits of ESG reporting for SMEs can be summarized as follows:

Investment attraction potential: ESG reporting highlights a company's commitment to environmental and social responsibility, which can attract environmentally-conscious investors and facilitate financing opportunities. Additionally, by fulfilling these responsibilities, a company can increase its brand awareness and prestige through its social and environmental contributions.

For example, participating in global aid efforts or social projects can enhance a company's reputation. If a company operating in Country A provides support to Country X, which has experienced a natural disaster, or contributes to a public awareness project in Country X, this could create a positive perception in that region. However, it is essential that such actions are not carried out solely for marketing purposes. Social and environmental responsibilities should stem from the genuine goodwill or social sensitivity of the company's leaders, reflecting a sincere approach. In this way, both ethical values are upheld, and sustainable success is achieved.

Competitive advantage: ESG practices provide businesses with a significant edge over competitors. Sustainability-focused strategies enhance a brand's reputation, attracting more customers. These initiatives not only demonstrate that a company is profit-driven but also show its commitment to environmental and social responsibility. ESG reporting transparently reflects a company's adherence to these values, distinguishing it from competitors. This, in turn, allows the company to appeal to a broader customer base and secure long-term success.

Risk management: ESG reporting allows companies to more effectively assess environmental and social risks. This helps businesses anticipate future operational disruptions, thereby reducing potential costs and ensuring a more efficient operation. By adopting a proactive approach to environmental changes, social issues, or governance challenges, companies can achieve sustainable performance in the long run.

Legal compliance: In regions such as the European Union, regulations regarding ESG reporting are increasingly becoming stricter. Early adopters among SMEs can more easily comply with these regulations, avoiding potential penalties and gaining a competitive advantage. This enables companies to meet their legal obligations more efficiently, reduces future operational risks, and supports sustainable growth.

Partnership and supply chain relationships: Large companies may require compliance with ESG standards within their supply chains. SMEs that engage in ESG reporting have a higher chance of partnering with these large companies. As mentioned earlier, ESG reporting will be mandatory for large companies in the European Union starting in 2024. As a result, companies that operate in accordance with ESG standards are more likely to be included in the supply chains of these organizations. By doing so, SMEs can not only establish themselves within these supply chains but also continue their sustainable growth with the support of these larger companies.

Cost Savings: Environmental sustainability practices, such as energy efficiency, can significantly reduce operational costs. These practices optimize the company's energy consumption, leading to long-term reductions in energy bills. This, in turn, positively impacts the company's balance sheet and can increase profit margins. Additionally, reducing resource consumption lowers the company's environmental footprint, enhancing its reputation within society and among environmental stakeholders. Thus, sustainability strategies not only generate cost savings but also support the company's long-term economic and environmental sustainability.

Employee Engagement: Compliance with social and governance criteria can increase employees' loyalty to the company and also strengthen the desire of talented and qualified individuals to work at your company. For example, in 2021, when Honda Turkey decided to close its factory in Çayırova, it offered meaningful closure compensation and special rewards to all its employees. This included a performance bonus equivalent to one month's salary for employees with no absenteeism or reports, 48 months of salary for employees with more than 10 years of service, and 40 months of salary for those with less than 10 years. Honda’s commitment to its employees not only occupied a significant place in the Social section of its ESG report but also became a gesture that was widely talked about across Turkey for a long time.

Globalization: From 2028 (possibly extending to 2031), companies wishing to operate in the European Union will face difficulties in conducting trade within EU countries unless they comply with ESG reporting. This is not limited to the EU; other major countries, such as the

United States, China, and Russia, may also make it harder for companies without ESG reporting to operate in their territories. In this context, SMEs can gain a competitive advantage in global markets by learning and adopting ESG reporting early. SMEs that start preparing these reports before the requirements are enforced will have the opportunity to globalize more cost-effectively and swiftly.

Other benefits I would like to briefly mention, aside from the topics above, include: ESG reporting reduces information asymmetry, ensures the accessibility of management decisions, protects shareholders' rights, helps create anti-corruption and anti-takeover policies, promotes consumer health, safety, and data privacy in products and services, encourages gender equality and women's employment by promoting the presence of women in management positions and boards, and fosters collaboration with stakeholders within an accountability framework. Due to these potential benefits, the demand for the information included in ESG reports and the use of ESG performance data is steadily increasing, and this usage is expected to become more widespread globally in the coming years (Şeker & Şengür 2022).

In Summary, ESG reporting offers significant benefits to SMEs. Although it may not directly increase profitability, it supports long-term sustainability by enhancing investor confidence, boosting market value, and improving a company's reputation through environmental and social responsibility. ESG reporting helps companies better manage environmental and social risks, comply with regulations, and proactively address potential operational disruptions.

SMEs benefit from ESG reporting by becoming eligible to be part of large companies' supply chains, which is particularly crucial as ESG reporting becomes mandatory for large companies in the European Union in 2024. These practices also promote environmental sustainability, leading to cost savings and reduced operational costs, while increasing brand recognition. Moreover, ESG-focused companies can foster a loyal workforce and attract skilled employees.

The growing global trend of mandating ESG reporting means that SMEs that adopt these practices early will be able to better compete in international markets. Additionally, ESG practices promote consumer health, safety, and privacy, protect shareholders' rights, encourage gender equality, and foster collaboration with stakeholders, all of which contribute to the company’s competitive edge and long-term success.

Challenges for SMEs in the implementation of ESG reporting

Approximately 400 million SMEs worldwide continue to form the backbone of economies. These businesses account for over 95% of all companies and contribute 60-70% to global employment, playing a critical role in job creation. However, despite being classified in the same category, SMEs differ significantly due to factors such as geographic location, culture, knowledge base, managerial competencies, and employee skills.

These differences make it unrealistic to expect the same quality and efficiency in ESG (Environmental, Social, and Governance) reporting transitions from all SMEs. For instance, some businesses may not have even heard of ESG reports, while others, despite being aware, have yet to take action. Meanwhile, some actively provide ESG reports. This global diversity can pose significant challenges, especially when attempting to establish a standardized global framework or practice.

For example, one country's workforce might be industrious, productive, and respectful of rights but lack effective enforcement of rules. Conversely, another country's workforce might show low motivation and efficiency, yet strictly adhere to regulations. Such variations make implementing global policies or standards challenging, presenting either burdensome rules or aspirational targets for many companies.

This section focuses on the challenges SMEs may encounter while implementing ESG reporting. It is crucial to note that these challenges are not uniform across all businesses. Even within the same country or region, companies may face different obstacles. Therefore, a broad perspective is essential to understanding the fundamental challenges SMEs face in ESG reporting processes.

As Ang (2024) states, limited budgets, human resource challenges, and lack of understanding are some of the key factors preventing small and medium-sized enterprises (SMEs) from starting ESG (Environmental, Social, and Governance) reporting." However, let's explore these challenges in more detail:

1) Resource Shortage: Lack of data quality and standardization cause the problem of appropriate assessing of companies' ESG performance SMEs often lack the financial and technical resources necessary for ESG reporting (Clark et al., 2015). SMEs often lack the financial and technical resources necessary for ESG reporting. The process of ESG reporting involves collecting data, analyzing it, creating reports, hiring or contracting experts, and setting up

cooperation agreements, among other activities. All these steps are costly and time-consuming, which is a significant barrier for businesses with small budgets.

2) Lack of Awareness: Many SMEs do not have sufficient information about the benefits ESG can bring to their businesses or the potential consequences of failing to implement ESG reporting. In fact, particularly in countries outside the EU, many SMEs may not even be aware of the existence of ESG. Although this lack of awareness might not seem like a significant issue today, it could pose serious challenges in the future when it becomes difficult to adapt to ESG standards. Delaying implementation could lead to more costly and complex processes.

3) Compliance Costs and Complexity: ESG standards are typically designed for large businesses, making it more difficult for SMEs to comply. For example, SMEs that have not previously implemented worker rights or occupational health and safety standards may struggle to meet the "Social" component of ESG. Another example is that integrating ESG factors into investment decision-making processes also creates practical challenges for investors, such as determining materiality, establishing appropriate benchmarks, and measuring the financial impact of ESG considerations (Grewal & Serafeim, 2020).

4) Lack of Management Support: The lack of commitment from top-level management can negatively impact the ESG reporting process. If some managers are indifferent to ESG issues, other board members may need to spend time and effort persuading them, which can delay the process. The absence of management support is one of the main reasons ESG initiatives fail to gain acceptance and be effectively implemented within organizations. Moreover, according to Gernego et al. (2024), the lack of standardization and transparency in ESG rating methodologies can be seen as one of the barriers to ESG integration. This indicates that the board of directors needs to take this matter more seriously.

5) Cultural and Regional Differences: Geographical and cultural factors create significant diversity in ESG practices. While some regions have a high level of ESG awareness, others may have very low awareness. This diversity can make it difficult to prepare a standardized report on a global scale. Each region’s unique interpretations and applications of ESG could prevent SMEs from achieving the desired efficiency, making the process more complex and costly over time.

In Summary, The challenges SMEs face in implementing ESG reporting include information gaps, lack of expertise, financial constraints, limited awareness of ESG reports, difficulty complying with standards, insufficient workforce, cultural differences, technological

limitations, and a lack of understanding of the importance of ESG. To overcome these challenges, SMEs can seek local consultancy services, organize training and awareness programs on ESG topics, and share knowledge and experiences with other similar companies.

Case Study: ESG Practices in Limser

Port operations and the logistics sector are under increasing pressure to align with Environmental, Social, and Governance (ESG) criteria. As part of Kınay Holding, Limser has taken various steps to integrate ESG criteria into its activities. This study aims to analyze Limser's ESG strategies, the challenges it has faced, and its performance in this area, drawing lessons from its experience

Limser was established in 2009 under Kınay Holding to carry out port operations and related logistics activities. Its name is derived from the first three letters of the Turkish words "Liman" (Port) and "Servis" (Service). Currently, the company operates actively in the Aliağa and Samurlu districts of İzmir, Turkey, providing services such as empty and full container storage, handling, container repairs, and container delivery to vehicles. In port services, they offer machine-assisted or manual container stuffing/unloading, full inspection/examination services, lashing/unlashing, and collaborate with TCEGE Port Operations to conduct ship operations.

If we are to examine Limser's compliance with and approach to ESG reports in detail:

- Enviromental

Limser prioritizes two fundamental criteria in its environmental approach: reducing carbon emissions and managing waste. The company has identified energy efficiency as a primary goal in port operations, minimizing unnecessary use of machinery and vehicles, and preventing electricity from being wasted by workers. These practices have been implemented to reduce both costs and the use of fossil fuels. Additionally, the use of electric and low-emission equipment has been increased, and projects aimed at reducing dependency on fossil fuels have been launched.

In terms of waste management, Limser has invested in infrastructure to separate industrial and organic waste generated at the port and to improve recycling rates. Recycling bins are available within the port and storage facilities, and the company adopts a disciplined and

systematic work approach to reduce waste and environmental pollution, rather than acting arbitrarily. These environmentally conscious practices have led the local community to view Limser positively, recognizing its efforts to minimize harm to nature.

Moreover, to protect the marine ecosystem, waste generated within the port area is regularly cleaned and disposed of through collaboration with TCEGE.

- Social

It can be said that Limser has made significant progress in the social aspect of ESG reporting. The rights provided to employees are at a level far above the standards of other companies. For instance, employees are offered balanced and nutritious lunches prepared by a professional dietitian, free of charge. These meals are carefully prepared to include desserts, beverages, and essential nutrients required daily. Additionally, transportation services are provided to facilitate employees' commute to and from work. For those who miss the service, managers offer free rides to public transportation hubs. Limser has minimized the hierarchy between workers and management, creating a more equitable work environment where managers actively work alongside employees. Workers can comfortably request leave, negotiate changes in their schedules, or ask for permission to leave early if their work is completed ahead of time. These practices demonstrate Limser's commitment to valuing its employees' rights, personalities, and efforts.

Moreover, the company maintains a dedicated occupational health and safety specialist at its facility, ensuring regular checks of employees' equipment. Mandatory occupational health and safety training and exams are provided for new hires. Limser prioritizes the health and safety of its employees, requiring medical check-ups for new hires, including tetanus vaccinations and comprehensive health screenings, all covered at private hospitals by the company.

In terms of diversity and inclusion, Limser employs a high number of women. For example, female forklift operators, who are rarely seen in the logistics sector, are part of the workforce. The company supports the professional development of such employees by covering expenses such as license renewals and exam fees. Women are employed in various roles, including forklift operations, warehouse duties, office work, and other service areas. Additionally, Limser places significant emphasis on employing individuals with disabilities, providing job opportunities for those with physical impairments or serious health conditions.

Lastly, Limser places great importance on employee and intern training. Each year, the company invites new interns from all over Turkey, organizes conferences at universities, and

ensures that interns collaborate with managers to gain practical experience. The company provides detailed training for new employees and interns, offering not only theoretical knowledge but also hands-on and active work experience.

- Governance

Limser adheres to principles of ethics and transparency by conducting all its operational processes openly with its investors. The company offers internal and external investors the opportunity to visit the facility to observe operational processes directly and address any concerns or inquiries they may have. Investors are even welcome to actively participate in these processes and contribute to management if they wish. Continuously enhancing its environmental sensitivity, Limser is committed to meeting its stakeholders' expectations regarding environmental goals and operates accordingly. The company places great importance on its investors and customers, regularly inviting them to its offices to strengthen relationships in a warm and hospitable environment. These efforts help renew mutual collaborations and restructure existing agreements.

Limser prioritizes environmental, social, and regulatory risks in its risk management approach. The company focuses on areas such as carbon emissions, energy use, workforce diversity, employee satisfaction, and legal compliance, clearly communicating its commitments in these areas to its stakeholders. To ensure an effective quality management system, Limser has embraced Process-Based Management and Risk-Based Thinking philosophies, integrating them as key components of its corporate culture. The company accepts legal requirements and other obligations as minimum standards, monitoring, measuring, and improving its compliance and responsibilities to ensure their sustainability.

Limser aims to maintain the highest level of information security in all areas of its operations and continuously improve its information security management system. The company identifies, evaluates, and implements necessary controls for risks related to the confidentiality, integrity, and accessibility of information. It also measures the performance of information security processes and uses this data to set objectives. By addressing its vulnerabilities and threats through investments in infrastructure, work environments, hardware, software, and training, Limser minimizes potential risks. Additionally, Limser is committed to meeting the security standards required by its customers, stakeholders, and legal obligations. This approach clearly demonstrates the company's governance advancements and its ability to provide a secure environment for its customers and investors.

As a result, Limser's commitment to sustainability and ethical practices not only strengthens its reputation among investors and stakeholders but also ensures long-term success in achieving its environmental and social goals. By focusing on reducing carbon emissions, efficient waste management, and employee well-being, the company sets an example in integrating sustainability into its core operations. With its ongoing investments in environmental initiatives and social responsibility, Limser demonstrates its commitment to creating a positive impact on the community, employees, and the environment. Moreover, through transparent governance and solid risk management, Limser is well-positioned to tackle the challenges it faces and continue contributing to a more sustainable future.

Conclusion

ESG reporting has become an increasingly important tool for businesses to align with sustainability, ethical governance, and social responsibility. Within the European Union's regulatory framework, ESG reporting offers both significant opportunities and notable challenges for SMEs. While it provides benefits such as attracting investments, gaining competitive advantage, and strengthening long-term operations, SMEs also face issues like limited resources, lack of knowledge, and the complexity of compliance processes. The European Union's regulatory push highlights the critical role SMEs play in achieving sustainability goals, encouraging these enterprises to integrate ESG principles into their operations. Although the transition may be challenging, SMEs that adopt ESG practices early can position themselves as leaders in sustainability, gain access to broader markets, innovate, and build strong relationships with stakeholders In the coming years, the success of SMEs in ESG reporting will depend on the implementation of simple and clear rules, better access to information and guidance, and the organization of educational programs to raise awareness on the subject. By overcoming these challenges and adopting ESG principles, SMEs can not only meet regulatory requirements but also transform the process into an opportunity to grow their businesses and achieve a stronger competitive edge.

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