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THE ENVIRONMENTAL PROTECTION IN THE CONTEXT OF THE EUROPEAN GREEN DEAL: THE ROLE OF ARTIFICIAL INTELIGENCE

ADINA DORNEAN
Alexandru Ioan Cuza University of Iași
Iași, Romania
amartin@uaic.ro

ADA-IULIANA POPESCU
Alexandru Ioan Cuza University of Iași
Iași, Romania
ada.popescu@uaic.ro

Abstract
The climate crisis is one of the major challenges for Europe. In December 2019, European Union (EU) launched the European Green Deal (EGD). In accordance with the EU's environmental policies, one of the EGD goals is for Europe to become the world's first 'climate-neutral' continent, with net zero greenhouse gas (GHG) emissions by 2050. This goal is now also enforced by a legally binding regulation, the European Climate Law, an economy-wide framework law for the green transition, which requires to reduce Europe's net GHG emissions by at least 55% by 2030 compared to 1990 levels.
The aim of the paper is to analyze the progress in achieving EGD goals by EU countries after five years since the implementation of EGD and to highlight the role of artificial intelligence (AI) in accessing and interpreting the climate data. Presently, EU Member States are moving towards climate neutrality but if they want to meet this goal by 2050, they need to better synchronize themselves to a faster pace and more articulated measures. Measuring the results and anticipating future efforts to alleviate some of the most pressing sustainability issues of the twenty-first century requires adequate tools and technology, such as AI.
Keywords: *environmental protection; European Green Deal; AI.*
JEL Classification: F64; Q01; Q58.

1. INTRODUCTION

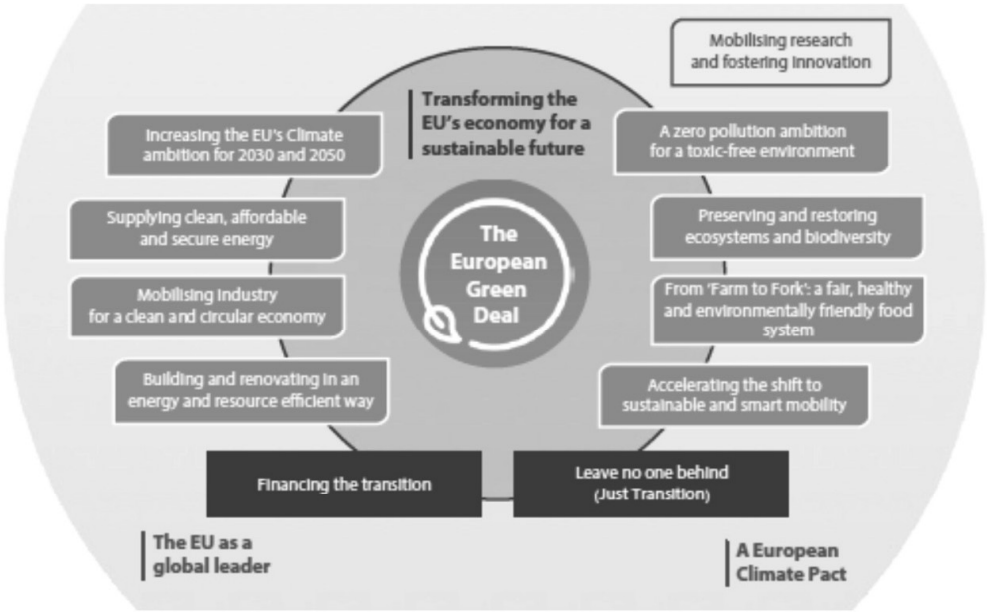
In the 21st century, environmental protection is an essential part of caring for humanity. Environmental protection (EP) includes all activities and actions which have as their main purpose the prevention, reduction and elimination of pollution and of any other degradation of the environment, according to the System of Environmental Economic Accounting (SEEA, 2016).

In December 2019, the European Environment Agency (EEA) warned about environmental challenges of unprecedented scale and urgency that Europe will have to face in the next years. According to EEA (2019, p. 9), if Europe does not take urgent action during the next 10 years to address the alarming rate of biodiversity loss, increasing impact of climate change and the overconsumption of natural resources, Europe will not achieve its 2030 goals.

In this context, the European Green Deal (EGD) was implemented in 2020 as an ambitious set of policy initiatives by the European Commission, strategies and legislative acts aimed at making the European Union (EU) climate neutral by 2050 (Negreiros and Falconer, 2021; Hayes *et al.*, 2022; Křemečková and Šreflová, 2024).

According to this objective, the EGD mentions three targets to be achieved by 2030, respectively: 1) minimum 55% cuts in greenhouse gas emissions; 2) above 32% shares of renewable energy; 3) at least 32.5% improvement in energy efficiency.

These targets are related to the eight key areas (Fetting, 2020) that make up the Green Deal, which are presented in Figure 1.



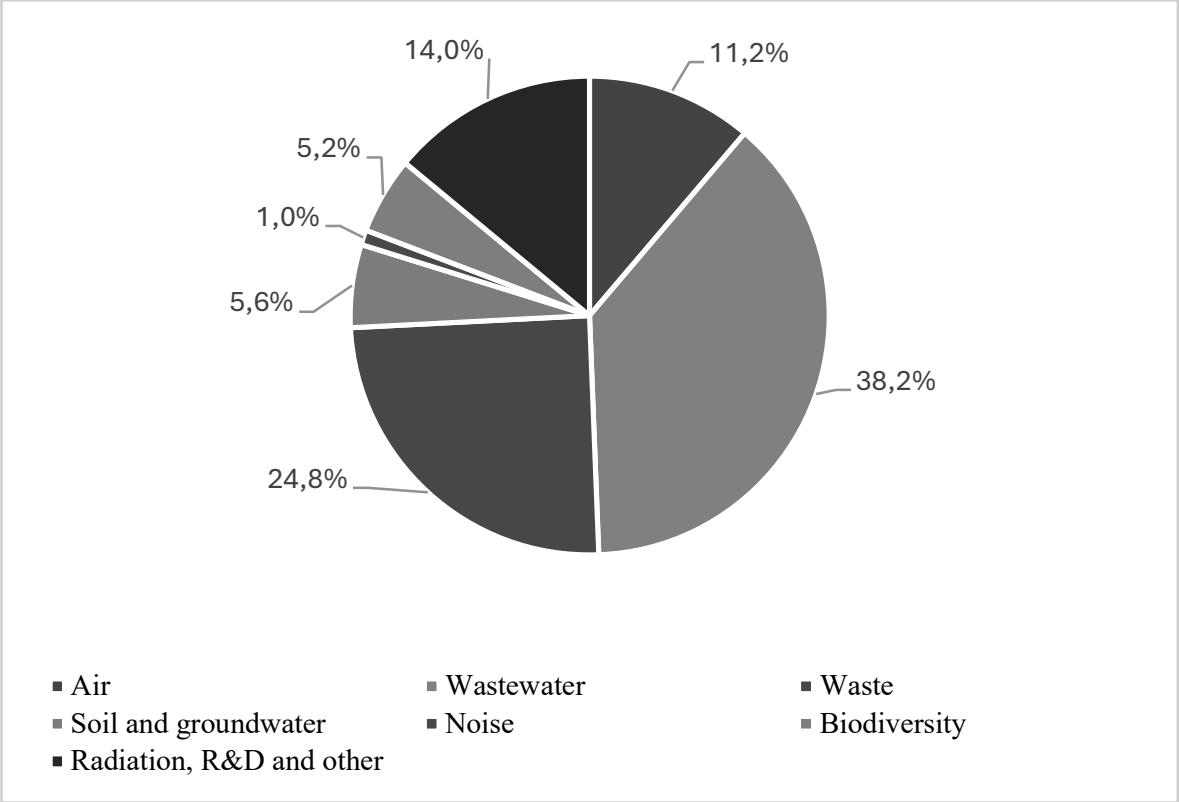
Source: Eurostat (2024, p. 24)

Figure 1. The European Green Deal

The European Green Deal highlighted investment as one of the key levers for the implementation of the EU's climate and environment-related policies. In 2024, the EU invested EUR 76 billion into assets essential to provide environmental protection services (Eurostat, 2025).

In Figure 2 we can observe the distribution of investments for environmental protection by environmental domain, made by all EU countries in 2024. We can

see that the largest number of investments was dedicated to wastewater (38.2%) and waste management services (24.8%). In 2024, only 14% was related to protection against radiation, to environmental RandD and other environmental protection activities, including general environmental administration and education, 11.2% went to air protection, 5.2% to biodiversity and landscape protection, 5.6% to soil and groundwater protection, and the remaining 1% to noise reduction.

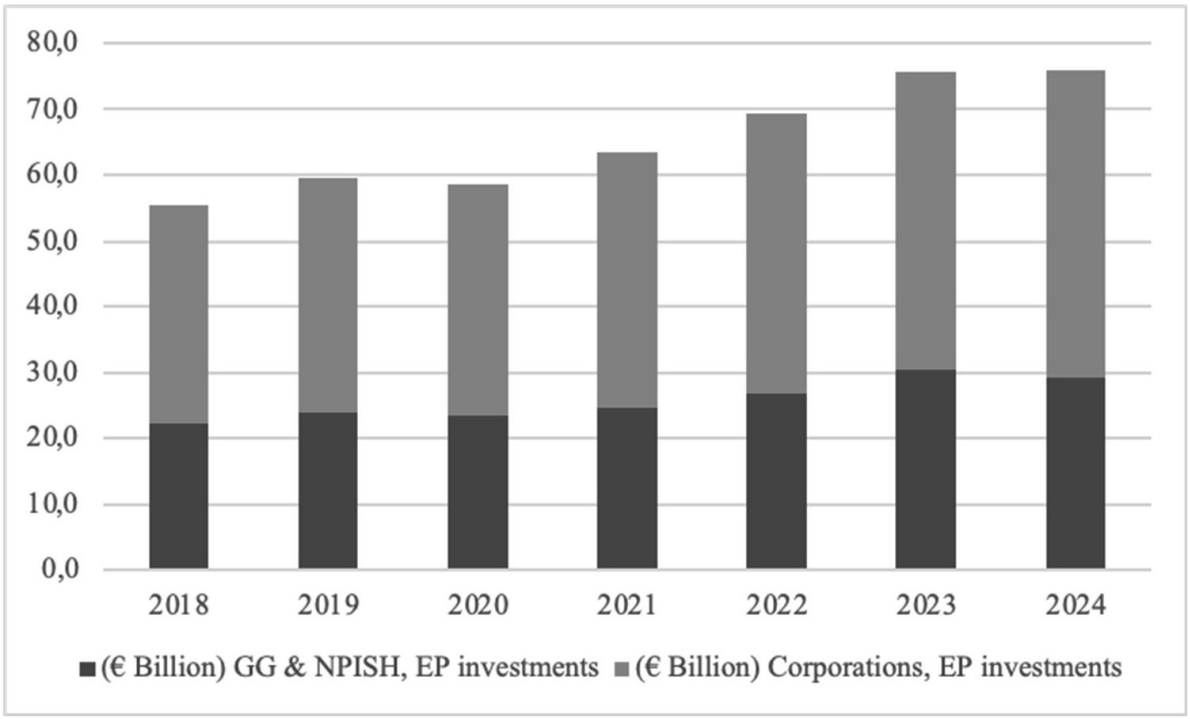


Source: Eurostat (2025)

Figure 2. Investments for environmental protection in EU-27 in 2024, by environmental domain (% of total EP investments)

If we analyze the evolution of investments in EU countries over the period 2018-2024 (Figure 3), we notice the upward trend after 2020, the year when EGD was implemented. Also, during the analyzed period about 59.9 – 61.4% of total environmental protection investments was spent by corporations and the difference 40.1 (2018) – 38.6% (2024) was spent by general government (GG) and non-profit institutions serving households (NPISH).

In this context, the realization of the EGD's multifaceted objectives will require major investments in cost-efficient solutions, beyond diverting former fossil fuel investments to energy efficiency and renewable.



Source: Eurostat (2025)

Figure 3. Investments for environmental protection in EU-27, 2018–2024

The paper is structured as follows. Section 2 reviews the literature regarding EGD and AI, section 3 analyses the progress in achieving the EGD goals and sections 4 presents the conclusions regarding the role of AI in accessing the climate data and interpreting correspondingly to the EGD targets.

2. LITERATURE REVIEW

The EGD is the growth plan for a climate-neutral Europe by 2050 (Koundouri *et al.,* 2024) and comprises distinct areas, including climate action, energy, agriculture, industry, infrastructure, environment and biodiversity, transportation, finance and development, and research and innovation. The EGD functions as an integrated environmental, social, and economic framework, encompassing a wide range of policy areas and initiatives designed to drive the transformation of the EU into a more sustainable and climate resilient society, while promoting economic growth and social equity.

Within this new growth strategy, the environmental dimension is no more undersized compared to the economic one (Paleari, 2022, p. 197), as it emerges from the eight key EGD policy goals, namely, achieving climate neutrality; supplying clean, secure and affordable energy; promoting sustainable mobility; encouraging the transition to a circular economy; supporting to build and renovate in an energy and resource efficient way; creating a toxic-free environment; preserving Europe's natural capital and designing a fair, healthy and

environmentally friendly food system. These goals are indivisible from the scientific point of view, so that we cannot achieve carbon neutrality without substantial progress in all the other thematic pillars (Charveriat and Holme, 2021, p. 8).

The EGD consists of eight major policy areas (as we saw in Figure 1), and each policy area consists of dedicated regulations, strategies and funding sources for related projects that have different stages of maturity but all aim towards the same objective required by "Fit for 55" (Hayes *et al.,* 2022):

1) *Increasing the EU's climate ambition for 2030 and 2050* requires at least 55% less net greenhouse gas emissions by 2030, compared to 1990 levels and becoming the first climate neutral continent by 2050.
2) *Supplying clean, affordable and secure energy* requires strengthening interconnections between energy systems through the development of modern infrastructure, enhancing energy efficiency, initiating the decarbonization of the gas sector, promoting cross-border cooperation, and fully exploiting the potential of offshore wind energy.
3) *Mobilizing industry for a clean and circular economy* necessitates a new industrial policy rooted in circular economy focusing on modernizing industrial sectors through the promotion of climate-neutral and circular products, with particular emphasis on energy-intensive industries.
4) *Building and renovating in an energy- and resource-efficient* way asks to construct and renovate energy-efficient buildings (the design should be in line with the circular economy, digitalization, climate-proof), and to develop innovative financing for renovations including social housing, schools and hospitals (leave no one behind strategy).
5) *A zero-pollution ambition for a toxic-free environment* means to preserve biodiversity, reduce pollution from excess nutrients, reduce microplastic pollution, review air quality standards, reduce pollution and improve prevention of industrial installations and sustainable alternatives for chemicals.
6) *Preserving and restoring ecosystems and biodiversity* requires targeted actions to rehabilitate degraded ecosystems, especially those with high potential for carbon capture and storage, while also aiming to prevent and mitigate the impact of natural disasters.
7) *From farm to fork: a fair, healthy and environmentally friendly food system* means to ensure sustainable food production and security, to reduce food loss and waste, to combat food fraud along the food supply chain and to support research, innovation, technology and investments in accelerating the transition to sustainable, healthy and inclusive food systems from primary production to consumption.
8) *Accelerating the shift to sustainable and smart mobility (90 percent reduction of GHG by 2050 in comparison with 1990)* supposes to "go

digital" – automated mobility, smart traffic management systems, smart applications; requires using different modes of transports, for example rail or water; means to end subsidies for fossil fuels; to introduce EU Emissions Trading System (ETS) for maritime, road transport and buildings.

Apart from these eight areas, Hayes *et al.* (2022) mentioned separately a ninth area, which refers to provide dedicated funds (Just Transition Fund) for regions with high carbon intensity, which will be disproportionately affected by the transition (*Leave no one behind – Just Transition Mechanism).*

Related to these eight key areas, Olczyk and Kuc-Czarnecka (2025) developed in their paper a composite indicator, the European Green Deal Index (which is a new indicator), to analyze the implementation of the EGD in the EU Member States. This index is based on 26 indicators (Olczyk and Kuc-Czarnecka, 2025, pp. 9-10) proposed by the European Commission, categorized under the three pillars of reducing climate impact, protecting our planet and our health, and enabling green and just transition. Developing a composite indicator is more useful and efficient compared to an individual analysis for all these 26 indicators, one by one, to identify the leading and lagging countries as well as the convergence/divergence between EU countries on their path towards a zero-emission and climate-neutral economy.

Countries that would not be able to achieve the "Fit for 55" targets could face significant consequences, such as financial penalties for noncompliance, which could be substantial (Brożyna, Strielkowski and Zpěvák, 2023, p. 13). Moreover, inadequate action on climate change may have serious environmental and social consequences, such as the rise in the frequency and intensity of natural disasters, shortages of food and water, and public health crisis. These could trigger social unrest and political instability, as people may hold governments responsible for failing to respond effectively to the climate crisis.

There are pros and cons for the EGD. For example, Montini (2021) stated that EGD lacks a coherent approach and fails to integrate its several goals and objectives within a single and comprehensive policy and legal framework. In his study, Montini (2021) highlighted the role that the environmental integration principle, as enshrined in Article 11 Treaty on the Functioning of the European Union (TFEU) may play in this context and, despite observing the negative present state of the environmental integration principle, it concludes with a proposal to give a renewed meaningful role to the principle in the implementation of the EGD.

As it was argued many times, even though it is ambitious, the Green Deal faces numerous major challenges because of its political, economic, social, and technical dimensions.

During the last few years, some of the specialists in the field started to analyze the potential use of artificial intelligence (AI) in order to accelerate towards the

goals of the Green Deal, especially because time is of the essence today more than ever.

Thus, it is believed that AI can enable the implementation of the EU Green Deal by making climate action smarter, faster, and more efficient across multiple sectors. Clean energy, sustainable and smart mobility, building renovation and efficiency, agriculture and the protection of biodiversity, circular economy, monitoring and enforcement, citizen engagement in environmental protection and behavior change are a few of the areas where AI could bring progress (Gailhofer *et al.*, 2021).

To understand how AI can help environmental pursuits, it is important to know what it is and what it can do. There are many and diverse definitions of the AI, depending on the field it can be used or its lifecycle's stages such as research, design, development, deployment, and utilization (UNESCO, 2020). AI systems are considered "technological systems which have the capacity to process information in a way that resembles intelligent behavior" (UNESCO, 2020, p. 4).

A broad language definition that is commonly used in the EU states that AI is based on "systems that display intelligent behavior by analyzing their environment and taking actions – with some degree of autonomy – to achieve specific goals" (European Commission, 2018, p. 2; High-Level Expert Group on Artificial Intelligence, 2019, p. 1). In fact, AI systems are comprised of algorithms and models that can provide the AI system with the ability to act with some level of autonomy (Zuiderwijk *et al.,* 2021). They generate abilities to learn, plan, predict, and control (UNESCO, 2020).

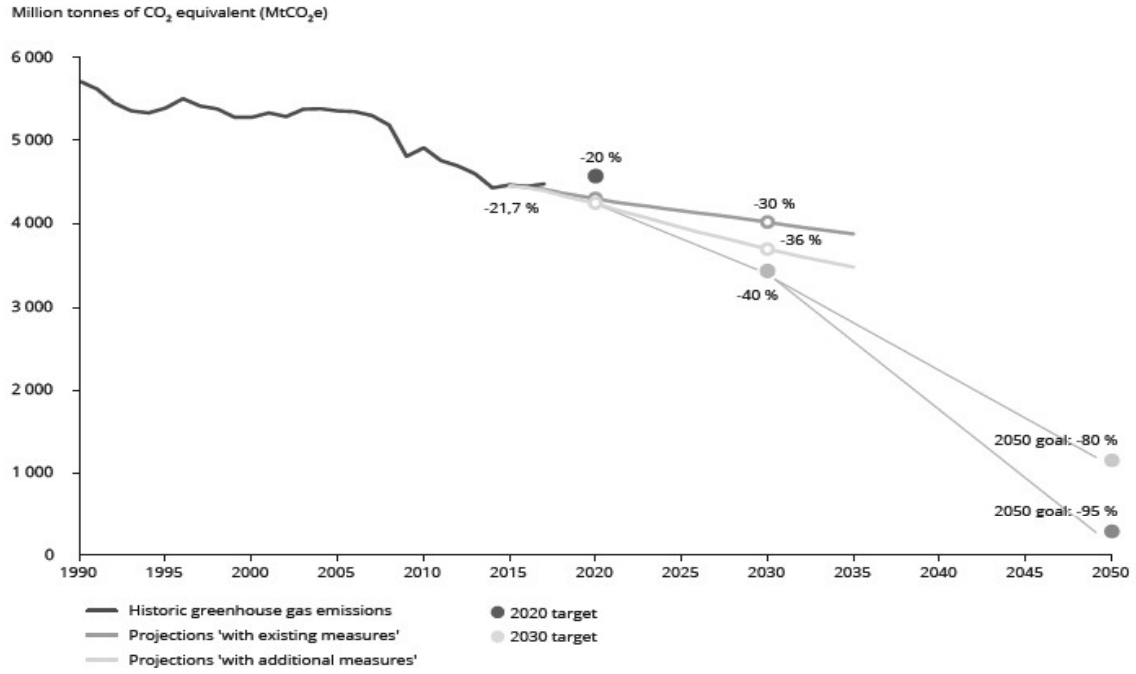
In order to have a successful outcome, the use of advance computing technology for meeting the Green Deal goals requires that AI systems themselves to be energy-efficient (O'Donnell and Crownhart, 2025). Also, public and private actors must share environmental data responsibly and the same EU ethical standards while using AI.

In this respect, the EU AI Act, adopted in 2024, is the first comprehensive legal framework for regulating artificial intelligence in the European Union. Its primary focus is on ensuring that AI systems are safe, transparent, non-discriminatory, and respect fundamental rights. However, critics say that the AI Act, in spite of introducing some environmental transparency (e.g. energy disclosure for general-purpose AI models), is primarily focusing on protecting people from AI risks and lacks binding environmental safeguards for AI developers (Pagallo, 2025).

3. ANALYSIS OF THE PROGRESS IN ACHIEVING EGD GOALS

The report of the European Environment Agency (EEA) highlighted that environmental pressures remain substantial despite the progress in reducing them (EEA, 2019, p. 13) and identified serious gaps between the state of the environment and existing EU near- and long-term policy targets (EEA, 2019, p. 7).

Figure 4 shows that between 1990 and 2017 the total greenhouse gas (GHG) emissions declined by 1.2 billion tons of carbon dioxide equivalent (CO2e), which represents a reduction of almost 22 % in this period of 27 years. According to the EEA (2019, p. 159) the reduction in total GHG emissions since 1990 means that only the 2020 target was within reach. In this context, significant efforts will therefore be needed to reach the 2030 target and even more substantial efforts, to reach the 2050 objective (EEA, 2019, p. 159).



Source: EEA (2019a, p. 158)

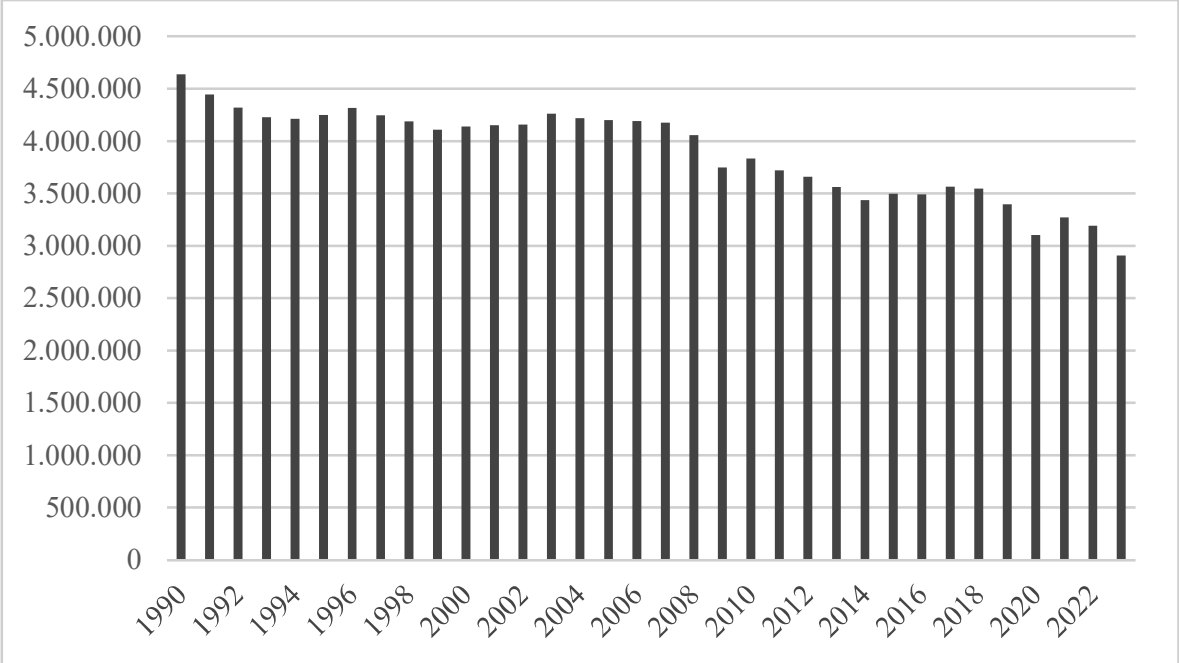
Figure 4. Greenhouse gas emission trends and projections in the EU-28, 1990-2050

The EU is the sum of its Member States, and most Member States have reduced emissions since 1990 (EEA, 2019a, p. 163). Approximately 50% of the EU's net reduction in greenhouse gas (GHG) emissions can be attributed to Germany and the United Kingdom. However, the overall progress made by the majority of Member States was partially counterbalanced by increased emissions in a few Member States. Thus, in the following years, EU and its Member States have to make important efforts in achieving the EGD goals.

According to Montini (2021), the transformation envisioned by the EU under the Green Deal is structured around several priority objectives, three of which are particularly significant for environmental protection. These include the decarbonization goal, aimed at achieving a climate-neutral Europe by 2050; the transition to a circular economy, which promotes a shift from a linear to a circular economic model; and the zero-pollution goal, which underscores the importance

of reviewing and updating environmental legislation, particularly concerning air, water, and soil, with the ultimate aim of creating a toxic-free environment.

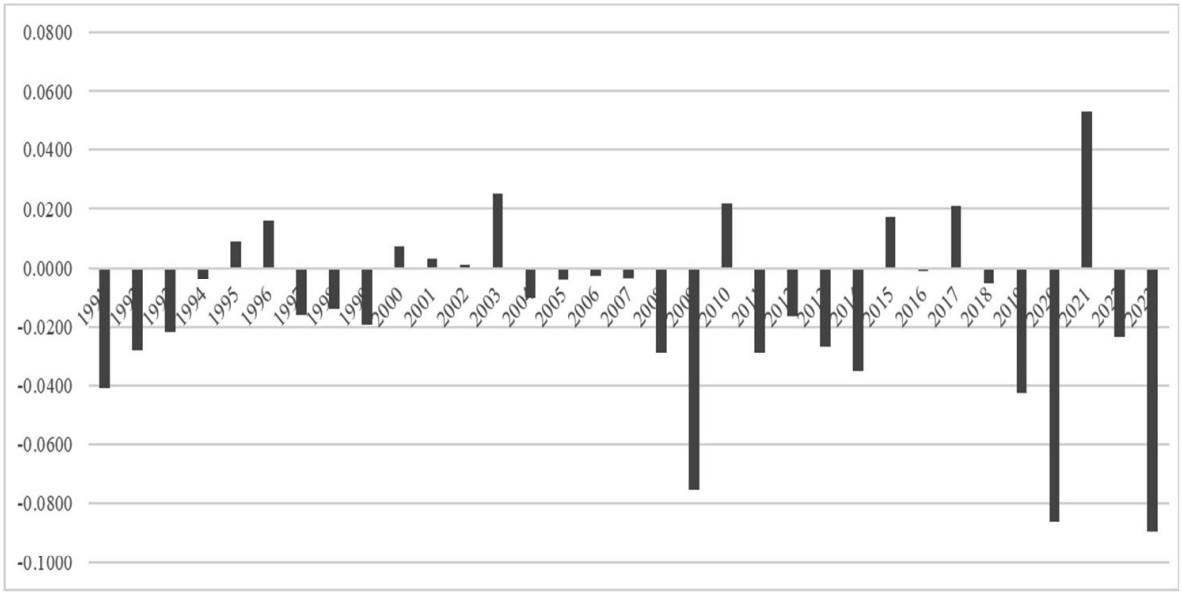
Correspondingly, we analyze and discuss three indicators, which we consider most important (but not sufficient) to highlight the trajectory of EU in the path of accomplishing the EGD targets.



Source: EEA (2025b)

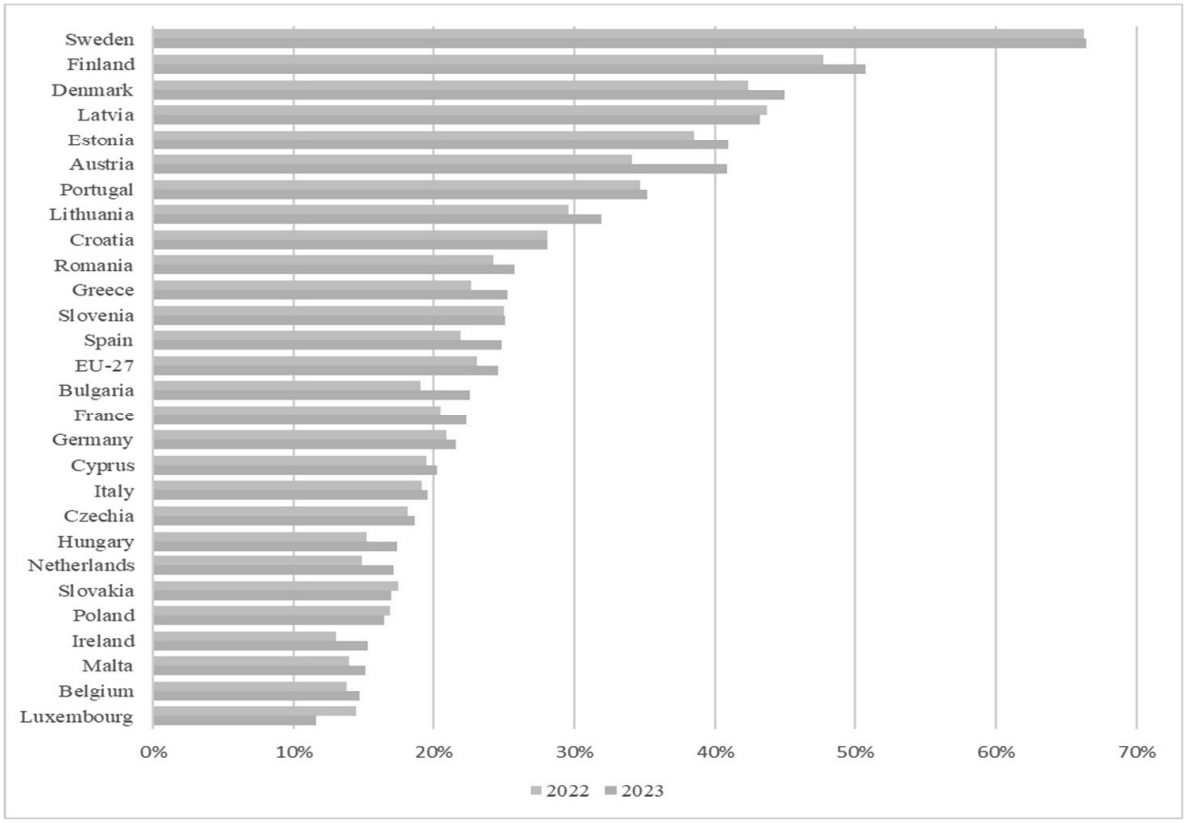
Figure 5. EU-27 emissions, 1990-2023, kt CO_2 eq

It is well established that the increase in CO2 emissions has been directly linked to climate change. Thus, first, we analyze the evolution of emissions at EU level for the period 1990-2023 (Figure 5). We can observe the downward trajectory of emissions, with a minimum level recorded in 2023 (according to the latest official EU data submitted by the EEA), which represents a reduction by 9% in 2023 compared to 2022 (Figure 6), the largest relative reduction in greenhouse gas emissions in the EU since 1990. This is a good signal that confirms the EU's progress to reduce its share of global emissions.



Source: EEA (2025b)

Figure 6. Annual percentage change emissions in EU-27, %



Source: EEA (2025c)

Figure 7. Share of energy from renewable sources in EU countries in 2022 and 2023

In our opinion, another important indicator is represented by the share of energy from renewable sources (Figure 7) because increasing the renewable energy sources (RES) contributes to reducing CO_2 emissions, improving energy security and to achieving sustainable development goals.

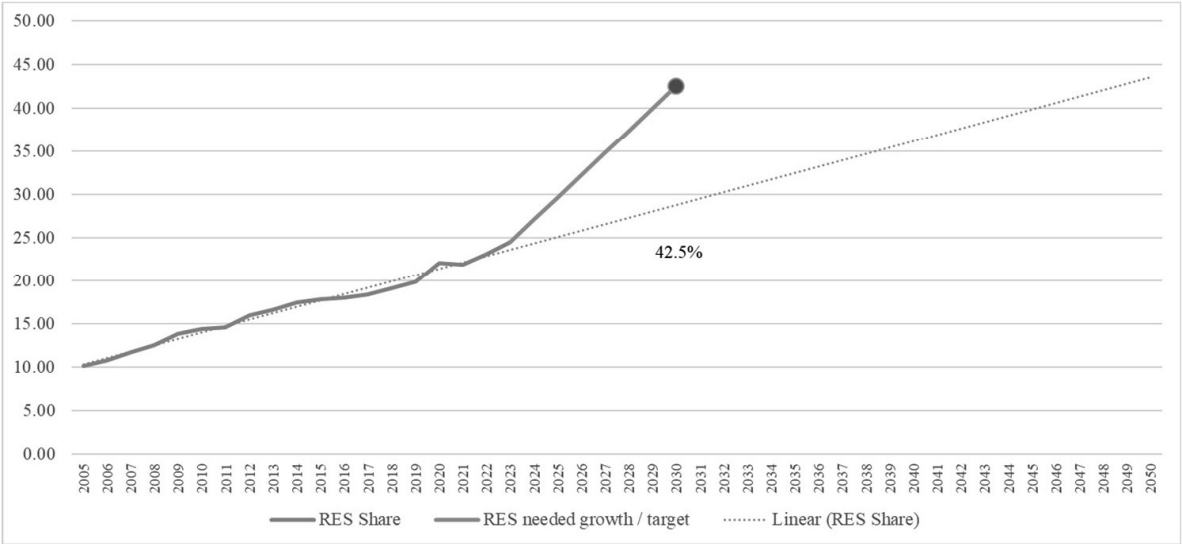
Figure 7 illustrates that in 2023, Sweden, Finland, and Denmark recorded the highest shares of renewable energy sources (RES) among EU Member States. This was attributable to robust hydropower industries in Sweden and Finland, alongside wind energy and extensive use of solid biofuels for district heating. In contrast, Luxembourg and Belgium reported the lowest levels of renewables, with respective shares of 12% and 15%.

Since 2005, Denmark, Sweden, and Estonia have recorded the most significant growth in RES shares, each achieving an increase of over 20%. In contrast, Croatia, Slovenia, and Romania have registered a modest progress, with RES shares rising by less than 9% between 2005 and 2023 (EEA, 2025a).

If we analyze the data on a short term, between 2022 and 2023, as illustrated in Figure 7, 22 EU Member States registered an increased their RES shares. Austria, Bulgaria and Finland dominate the ranking, having increased their RES shares by 3% or more in 2023. In contrast, Latvia, Slovakia, Luxembourg and Poland decreased their RES shares, compared to 2022.

If we analyze the progress towards RES targets at EU level (targets were not introduced for individual countries, but each Member State will contribute to this common target) we noticed that in 2023, the share of RES increased by 1% compared to 2022, reaching the level of 24.5%. This increase represents a historical high following the adoption of the revised Renewable Energy Directive.

As we have mentioned in the Introduction section, high levels of investment are needed to meet the 2050 goals of the EU Zero Pollution Action Plan. This plan aims that by 2050, the EU to reduce pollution to the extent that it no longer harms human health and natural ecosystems.



Source: EEA (2025c)

Figure 8. Progress towards renewable energy source targets for EU-27

The most recent report of EEA (2025c) presents the evolution of the zero pollution targets for 2030. There are six core targets and three of them have also sub targets and as we can see from Table 1, only target 1 and target 4b are on track to meet the target by 2030; target 4c, 4d and 5a indicate that the EU is likely on track, so they indicate that are chances to meet these targets by 2030; target 3, target 4a and target 6a indicate that the EU is unlikely on track and two targets, 5b and 6b are definitively showing that EU is off track to meet the target by 2030. Thus, progress is uneven and the best results have been achieved in reducing the health impacts (premature deaths) of air pollution and reducing the use and risk of chemical pesticides.

The answer to the question "will the EGD objectives be achieved in 2030 and 2050?" should not be based only on the synthetic analysis of three indicators (the evolution of emissions, share of energy from renewable sources and zero-pollution), but on a series of indicators whose processing is and will be much more efficient with the help of AI.

In this study we considered only a few indicators, but according to United Nations Environment Programme Data Catalogue (2025) there are 21637 total datasets available, which is difficult to analyze and interpret manually.

Although an unprecedented amount of climate data is now available, effective crisis management depends on how this data is accessed, interpreted, and utilized. AI plays a central role in enabling this process.

Table 1. Zero pollution target analysis for 2025

Target	Content	Value	Progress
Target 1	Reduce by more than 55% the health impacts (premature deaths) of air pollution	- 45% Baseline year 2005	On track
Target 2	Reduce by 30% the share of people chronically disturbed by transport noise	-2% Baseline year 2017	Off track
Target 3	Reduce by 25% the EU ecosystems where air pollution threatens biodiversity	-13% Baseline year 2005	Unlikely on track
Target 4	a) Reduce nutrient losses by 50%	Stable Baseline year 2012-2015	Unlikely on track
	b) Reduce the use and risk of chemical pesticides by 5 %	-46% Baseline year 2015-2017	On track
	c) Reduce the use of the more hazardous chemical pesticides by 50%	-25% Baseline year 2015-2017	Likely on track
	d) Reduce the sale of antimicrobials for farmed animals and in aquaculture by 50%	-28% Baseline year 2018	Likely on track
Target 5	a) Reduce plastic litter at sea by 50%	-29% Baseline year 2015	Likely on track
	b) Reduce by 30% microplastics released into the environment	+7 to +9% Baseline year 2016	Off track
Target 6	a) Reduce significantly total waste generation	-0.5% Baseline year: not defined	Unlikely on track
	b) Reduce residual municipal waste by 50%	-1.5% Baseline year: not defined	Off track

Source: EEA (2025b, p. 11)

According to Jensen, coordinator of the Digital Transformation subprogramme at the United Nations Environment Programme (UNEP, 2022), AI refers to systems or machines capable of performing tasks that traditionally require human intelligence, and which can progressively enhance their

performance over time by learning from the data they collect. Also, Jensen identifies several domains in which AI can contribute to addressing environmental challenges, ranging from the design of energy-efficient buildings to deforestation monitoring and the optimization of renewable energy deployment. He notes that AI applications can operate at various scales, such as using satellite data to monitor global emissions or, at a more detailed level, enabling smart homes to automatically switch off lighting or heating after a set period. One example in this respect is the UNEP's World Environment Situation Room (WESR), launched in 2022, which uses AI to analyze complex and multidimensional environmental datasets.

Overall, it is undeniable that AI has a strong potential to accelerate the achievement of EGD goals. However, EU needs to enhance its regulatory framework for AI use that will enable a deep coordination between technological innovation and EU environmental policy.

4. CONCLUSIONS

The present research showed that the road to achieving the EGD's ambitious objectives is not without its hurdles. We agree with Pisani-Ferry, Tagliapietra and Zachmann (2023) affirmation that stated that meeting the EU's climate-change mitigation goals will require EU countries to take increasingly challenging decisions in the next few years. To align the EU governance framework with increasing climate ambitions and challenges, greater centralization for ETS and stronger incentives are needed to ensure that Member States will follow the same unified plan. In addition to delivering direct benefits in terms of energy and climate outcomes, such an approach could also generate substantial benefits for other EU goals, including innovation, industry, competitiveness, nature conservation, digitalization, and public health (Pisani-Ferry, Tagliapietra and Zachmann, 2023, p. 18).

The overall success of the EGD will be based on the development and implementation of a wide range of strategies and regulations across its eight priority areas. The reduction of greenhouse gas emission illustrates the complexity of balancing diverse interests and the challenge of achieving the broader objective of contributing to the 2030 Agenda and the Paris Climate Agreement. While the 55% emission reduction target has been criticized by scientists and climate activists as being insufficient, stakeholders whose livelihoods depend on the fossil fuels view it as too ambitious (Fetting, 2020).

The EGD is a product of the EU's green and development policies, and the theory is currently a bit ahead of practice in this field, strategically aiming to promote sustainable development and green transition. The EGD main objectives consist of a wide set of parallel and concurrent goals (Montini, 2021, p. 97) and given the variety of those goals, it is not easy to predict whether it will be possible to achieve all of them within the fixed time frame. In this context, we consider

that AI could help accelerate the achievement of Green Deal goals through data-driven decision-making, precision solutions especially in agriculture, industry, and energy. It could also quantify the progress made and help making accurate climate predictions and scenario planning for policymakers.

At the same time, AI systems could track companies' emissions and resource use and thus could help to better monitor the implementation of EGD standards by companies, detecting "greenwashing" practices. Specialists are unsure if companies' current adoption and promotion of eco-standards reflect genuine commitment or merely serves as "greenwashing" (Gajović, 2024), a tactic to enhance profits through symbolic environmental actions. Alternatively, their attitude may indicate limited financial capacity or a lack of awareness regarding the long-term economic benefits of green investments.

However, the use of AI is directly linked to accurate environmental data and, since environmental protection is a global effort, the access to AI should be granted to all, ensuring that all regions, especially rural and underserved ones, can benefit from AI tools.

This paper contributes to the extensive discussion on EGD role in promoting Europe to become the world's first 'climate-neutral' continent, with net zero GHG emissions by 2050, by analyzing some of the key policies area, which have been set by the European Commission at European level. Future research can investigate comparatively the progress of achieving EGD goals by the EU-27 countries, using a composite indicator, similar to European Green Deal Index developed by Olczyk and Kuc-Czarnecka (2025), but which will comprise the three pillars of sustainability: environment, economy, and social needs.

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