ARTIFICIAL INTELLIGENCE AND ITS IMPLICATIONS FOR THE ECO-CLIMATE TRANSITION

Dragoș Alexandru MAIOR[*]

ABSTRACT: *The article explores the role of artificial intelligence in the eco-climate transition, highlighting the tension between its promises and its hidden costs. While machine learning algorithms can technically optimize energy distribution and support decarbonization, their development structurally requires significant resource consumption, with environmental effects that are difficult to overlook. The analysis of the European regulatory framework, particularly the AI Act, reveals both progress—through the inclusion of references to environmental protection—and significant gaps, given that concrete obligations for reporting and evaluation remain limited. The study concludes that a balance between innovation and sustainability cannot be achieved without the explicit integration of ecological criteria into regulation and without an interdisciplinary approach capable of harmonizing technological requirements with environmental imperatives.*

KEYWORDS*:* *artificial intelligence; AI Act; eco-climate transition; sustainability; climate change, environmental law*
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1. FOUNDATIONS AND PERSPECTIVES

Similar to the concept of *pharmakon*, introduced by Plato (Plato, 2011)[1] and later elaborated by Jacques Derrida (Derrida, 1981), the ambivalent nature of emerging technologies makes them capable of representing both a remedy and a problem within the eco-climate transition.

[*] PhD., Student, Ecological University Bucharest, Lawyer, Mureș Bar, ROMANIA.

[1] in the dialogue *Phaedrus*, Plato introduces the concept of *pharmakon* through a discussion on writing and knowledge. The term appears in the context of the myth of Theuth, the Egyptian god of wisdom, who presents King Thamus with various inventions, including writing. Theuth argues that writing is a *pharmakon*, a remedy for memory and knowledge, as it would allow people to retain information and transmit it further. However, King Thamus challenges this claim, stating that writing is, in fact, a poison, since it would make people rely on texts instead of exercising their memory, and would generate only the appearance of wisdom rather than genuine wisdom.

In accordance with the European perspective expressed in Article 3 of the AI Act (Manu, 2025) (European Parliament and Council, 2021), the notion of artificial intelligence designates software developed using one or more techniques and approaches such as those listed in Annex I (machine learning – ML; expert systems; hybrid techniques between the two) and which, for a set of objectives defined with human involvement, can generate outcomes such as content, predictions, recommendations, or decisions, thereby influencing the environments with which it interacts. Recital 12 (European Commission, 2021) further develops this definition, stating that the notion of an "artificial intelligence system" in the AI Act should be based on the key characteristics of AI systems that distinguish them from simpler traditional software or rule-based programming approaches, and should not include systems that rely exclusively on rules defined by natural persons to automatically execute operations.

Thus, through its capacity to analyse and synthesize information, artificial intelligence has the potential to address numerous complex challenges of humanity by creating a higher standard of efficiency and optimization: through the automation of repetitive tasks, by facilitating medical advances via the discovery of new treatments and more accurate diagnostics, and, in the context of the eco-climate transition, by generating more precise forecasts that can reduce the inherent effects of meteorological variability, thereby supporting both mitigation of and adaptation to climate change.

At the same time, however, these technical systems may also be used in ways that counteract such efforts, increasing greenhouse gas emissions, including through their own direct emissions resulting from the energy consumption required to sustain computational power.

2. THE ISSUE OF ENVIRONMENTAL PROTECTION

The awareness of environmental challenges, such as global warming, excessive pollution, the need to produce energy in a sustainable manner, or waste management, emerged relatively late on the global agenda of contemporary concerns.

Starting with the 1972 Stockholm Conference on the Human Environment, continuing with the 1987 Single European Act, which dedicated an entire chapter to environmental issues and their protection, and reaching the 2015 Paris Agreement, the ecological crisis, in the multidimensionality of its expressions, has consistently been framed under the invocation of urgency, described and inscribed as such in the "current temporal register of contemporary legal production" (Ost, 1999) apud. (Duțu-Buzura, 2023).

The risks of climate change were formally acknowledged in the 1994 United Nations Framework Convention on Climate Change (UNFCCC), whose ultimate objective was defined as "the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

The first step toward implementing this goal was the Kyoto Protocol in 1997. Its most important innovation was the creation of an international system of emission caps and trading. Each country was assigned a limit (cap) on greenhouse gas emissions under the Protocol. However, countries were allowed to buy or sell emission rights depending on their circumstances.

The Paris Agreement, which was adopted at the 2015 United Nations Conference on Climate Change, has reconfirmed and concretized these processes in terms of advancing the development of concrete implementation strategies harnessing a collective global effort. The main aspects include the need to limit the increase in global average temperature from pre-industrial levels to well below 2°C; increase adaptive capacity to cope with the inevitable impact of climate change (sea level rise, droughts, storms, and extreme weather events); reduce greenhouse gas emissions and increase their absorption by ecosystems – or achieving carbon neutrality.

The European Green Deal, launched in 2019 as a comprehensive strategy to transform the economy of the European Union into a sustainable one that can achieve climate neutrality by 2050, seeks to reduce greenhouse gas emissions while growing with green technology to protect the natural environment. More precisely, the instrument seeks to produce sustainable energy through increasing renewable energy use, reducing fossil fuel dependence, and improving energy efficiency. A key component of this is the transition of a circular economy by promoting reuse of resources and reducing waste, emphasizing durability and repairability of products.

From the outset, the European Union has played a pioneering role in the fight against climate change as an early proponent of global awareness and even introduced the measures of the Kyoto Protocol long before it commenced ratification. Consequently, the EU's readiness to exercise its position as a global leader was almost a foregone conclusion in negotiating and adopting the 2015 Paris Agreement and, subsequently, in the EU's international promotion of its objectives.

The "policy of exemplarity" not only intended to spur internal emulation but it also sought to produce a spill-over effect that would incite third countries into climate action. It has produced a significant normative and institutional output, reaffirming the EU's self-acclaimed position as a global leader in this field (Thieffry, 2021)apud. (Duțu-Buzura, 2023).

By pursuing this position, the EU does not merely implement a local approach but also offers a vision for the social transformation to a sustainable society that sets the groundwork of a global frame for other states and regions to aspire too and reflectively adapt a similar approach to address the social and climate challenges. Thus, the consolidation of common objectives represents an overt intention to change paradigms- "on the part of societies and economies" towards an increasing stability to the environment and sustainability.

The key elements of the eco-climate transition include *inter alia*, the decarbonisation of the economy through a reduction of greenhouse gas emissions, the abandonment of fossil fuels and the adoption of renewable energy sources; improvement of energy efficiency; transitioning to a circular economy.

It is often stated that technology is the key to the world's *"grand challenges"* of the 21st century, with artificial intelligence as the new frontier—a *"technological revolution of infinite significance,"* likened to the disruptive power of electricity or the automobile. As a prototypical disruptive innovation, AI shakes up the traditional ways in which knowledge can be acquired and knowledge can be managed and used, and has a reach that stretches into almost every space of human endeavour (Duțu, 2024).

Accordingly, the phenomenon of the adoption of AI-mediated systems has proliferated rapidly in recent years, doing the unprecedented work of exponentially accelerating technological development. However, given the scale and complexity of climate-related issues, a concerted effort is now required to figure out how best to utilize these new forms of technology to address climate change.

In other words, while the legal framework of ecological duties currently exists, the problem is how we may best apply these new technological tools in these contexts, and what normative frameworks exist or should be developed to control the ways in which these tools are utilized.

3. THE AI ACT AND ARTIFICIAL INTELLIGENCE IN THE CLIMATE CHALLENGE

3.1. The Use of Machine Learning Algorithms in the Reduction of Greenhouse Gas Emissions

Greenhouse gases are chemical species in the atmosphere that contribute to retaining the heat of the earth's surface by capturing the thermal radiation being emitted—most commonly called the 'greenhouse effect'. Since the industrial revolution, human activity has hugely increased the concentration of these gases, which increases the greenhouse effect resulting, directly, in climate change.

In 2018, the Intergovernmental Panel on Climate Change (IPCC) (Field, et al., 2012) reported that the world would have reached a catastrophic level unless global greenhouse gas emissions could be reduced to net zero over the next thirty years. Nevertheless, the quantity of greenhouse gas emissions has only increased in the years since the report.

However, just as artificial intelligence cannot exist without electricity, in the framework of decarbonization, it is evident that at some point industrial sectors will have to reverse their sources of energy from fossil fuels to electricity. Therefore, it is apparent that demand for electricity will be increasing, and thus we will have the task of making electricity systems as efficient as possible.

Without getting into technical details, but for providing a specific example that might be useful for how artificial intelligence might be able to help, low-carbon electricity sources can be categorised in two potentially broad ways: (1)variable, and (2)controllable.

Variable sources, by nature, are subject to external influences (e.g., solar panels produce electricity when there is sun and wind turbines only when wind occurs). In contrast, controllable sources, such as nuclear and geothermal plants, do not experience the aforementioned limitations and typically provide a continuous stream of energy.

As it presently stands, most electricity is delivered to consumers via a grid that requires supply and demand to balance perfectly at all times. In other words, it is apparent that energy produced from variable sources has to be supported through a fossil fuel-based production with only limited support from storage technology. The combination of variable and controllable sources can potentially be further improved through the introduction of machine learning regimes that help reduce the emissions generated by the fossil fuel based source (as a complement) and help support the transition to a carbon-free system through better use of variable energy.

It is apparent that both production and consumption are variable, and that accurate forecasting can help with scheduling in real time and with long-term planning. In this regard, short-term or real-time forecast may help reduce reliance on fossil fuel (nonrenewable) sources, while long-term forecasting could help operators identify with greater precision wind or solar sites and the best locations for building variable energy plants.

Thus, artificial intelligence can contribute to improving the current processes of energy production and distribution by accelerating the resolution of system optimization challenges, such as those associated with *optimal power flow* (Hasan, 2020).

With respect to controllable energy sources, one may envisage the use of artificial intelligence to identify potential geothermal sites by processing satellite imagery and seismic data (U.S. Office of Energy Efficiency & Renewable Energy, 2019). In the case of nuclear reactors (Chen, 2018), AI systems can assist in detecting cracks and anomalies through the interpretation of video data. Moreover, within the field of nuclear fusion reactors, it must be noted that although research has advanced toward hydrogen-based energy generation—holding the potential of producing carbon-free electricity—current experiments still consume more energy than they produce. Nonetheless, with sustained research efforts, amplified by machine learning techniques, one may realistically expect significant progress within an optimal timeframe (Humphreys, 2020).

Without extending the list of technical examples, it should be emphasized that similar optimization projections are equally applicable to the fields of transportation (Ermagun, 2018), construction, and industry.

In conclusion, under the guiding principle of optimization—facilitated by the processing capacity of artificial intelligence systems—it may be affirmed that their deployment can substantially contribute to achieving the goal of reducing greenhouse gas emissions, as committed under the international agreements referenced in the introductory section of this work.

3.2. Artificial Intelligence, Resource Consumption, and the Need for Reporting

In relation to the ambivalent nature of artificial intelligence highlighted earlier, it is, as anticipated, self-evident that emerging technologies rely on an energy source in order to operate, thereby raising the question of the carbon footprint resulting from the computational power required by such algorithms.

Accordingly, it is first necessary to consider the hardware component of these systems, since the functioning of software applications presupposes a technical infrastructure capable of delivering sufficient computational capacity—namely, data centres.

The International Energy Agency's (IEA) annual electricity report (International Energy Agency (IEA), 2023) indicates that data centres consumed 460 TWh in 2022, a figure projected to surpass 1,000 TWh by 2026. In practice, the electricity consumption of data centres is expected to double by 2026, according to the IEA, which attributes this increase to energy-intensive tasks such as artificial intelligence.

According to the report, the 460 TWh consumed by data centres in 2022 represented two percent of global electricity demand. Computing power and cooling constitute the largest energy expenditures within data centres, and the rapid expansion of AI-related services has driven providers to make substantial investments in this sector.

In 2018, data centres within the European Union consumed 76.8 TWh of energy. This figure is projected to rise to 98.5 TWh by 2030, representing an overall increase of 28%. Such growth can be observed not only in absolute terms but also in relative terms: in 2018, data centres accounted for 2.7% of the Union's electricity demand, and this share is expected to reach 3.21% by 2030 should development continue along the current trajectory (European Parliament and Council of the European Union, 2023).

Specifically with regard to data centres, the *European Union's Energy Efficiency Directive*[2] imposes new obligations on operators across the continent. Among these is the requirement to monitor and report emissions for any data centre with a capacity exceeding 500 kW.

Beyond electricity, however, these hardware systems also require water to maintain optimal operating temperatures. Once used, cooling water is either recirculated—where cooling towers or heat inverters are in place—and subsequently reused, or it is discharged as industrial wastewater. In both cases, there is also a measurable water loss through evaporation.

Water consumption in data centres varies considerably. For example, Google's large-scale data centres, which support major services, consumed on average approximately 2.1 million litres of water per day over the past year. In contrast, smaller data centres typically report much lower usage, averaging about 68,100 litres per day. When compared with household use in the United States, one large data centre consumes roughly the same volume of water as 4,200 individuals (Zhang, 2023).

During the life cycle of artificial intelligence production, freshwater is both withdrawn and consumed for server cooling and manufacturing processes. Water withdrawal (also referred to as "water use") designates the extraction of water from surface or groundwater sources for various purposes. Consumption is defined as the difference between withdrawal and discharge, and thus refers to any water permanently removed from the immediate hydrological environment due to processes such as evaporation or incorporation into products and vegetation (Reig, 2013). For instance, in 2022 Google's proprietary data centres withdrew 25 billion litres of water and consumed nearly 20 billion litres for on-site cooling, with the majority (77%) consisting of potable water (Google, 2023) (Google, 2024).

Looking more closely, according to one study (Strubell, 2019), training a single state-of-the-art AI model can emit as much carbon dioxide as the total emissions of five automobiles over their entire lifetime. Another study has shown that generating a single image with artificial intelligence may consume as much energy as charging a standard smartphone (Luccioni, 2023).

Therefore, the exponential growth of AI technologies raises concerns about their long-term environmental impact, since the ecological costs associated with the AI revolution remain largely unaccounted for.

Given the *ecological and climate-related imperatives*, updated regulations and technological improvements, including those related to efficiency, are essential to moderating the increase in energy consumption. The European Union's legal regime for environmental protection incorporates a complex network of regulations, directives, and decisions. In this context, particularly relevant are the *ETS Directive* (Emissions Trading

[2] European Parliament and Council of the European Union (2023) *Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955*. *Official Journal of the European Union*, L 231, 20 September 2023, pp. 1–158.

System)[3] and the *WFD* (Water Framework Directive)[4]. Although these instruments do not explicitly address artificial intelligence, their technology-neutral formulations may be understood as implicitly encompassing the emergence of new technologies. Restricting, however, the scope of this study to the perspective of the AI Act, it is appropriate to address the following aspects.

In its early draft version, in 2021, the AI Act did not address climate-related issues. Following the stage of public consultation, however, various NGOs expressed concern in this regard, and as a result, the Act underwent certain amendments on the matter. In its current adopted form, from the very first article it is established that the regulation aims to improve the functioning of the internal market and to promote the uptake of human-centred and trustworthy artificial intelligence (AI), while at the same time ensuring a high level of protection for health, safety, and the fundamental rights enshrined in the Charter—including democracy, the rule of law, and environmental protection—against the harmful effects of AI systems within the Union, while also supporting innovation.

The AI Act introduces a regulatory framework based on the classification of systems according to the level of risk they pose to users and to society. In practice, it divides AI applications into four risk categories, each with its own specific rules and obligations:

Unacceptable-risk systems (Article 5: systems of subliminal manipulation, social scoring, and real-time facial recognition); High-risk systems (Article 6; Annex III); Limited-risk systems (Article 50); and Minimal-risk systems (not strictly regulated under the AI Act, since they are considered not to require compliance with special requirements as they do not pose risks to fundamental rights).

The AI Act acknowledges—albeit in an indirect manner—environmental protection as one of the fundamental rights relevant to assessing the risks posed by an AI system in Recital 28[5]: “In addition to the many beneficial uses of artificial intelligence, it may also be misused, providing new and powerful tools for manipulative, exploitative and social control practices. Such practices are particularly harmful and abusive and should be prohibited, as they are contrary to the Union’s values of respect for human dignity, freedom, equality, democracy, the rule of law and the fundamental rights (Truța, 2025) enshrined in the Charter, including the right to non-discrimination, to data protection and to privacy, as well as the rights of the child.”

Moreover, in Annex III, elaborating on Article 6(2), the Regulation classifies artificial intelligence systems used in critical infrastructure (such as utilities and electricity) as high-risk systems.

Thus, although the AI Act does not explicitly address environmental protection as a major risk factor in artificial intelligence systems, it nevertheless includes within the risk categories those AI systems deployed in industries with ecological impact and in critical

[3] European Parliament and Council of the European Union (2003) Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC. Official Journal of the European Union. Available at: http://data.europa.eu/eli/dir/2003/87/oj (Accessed: 30 August 2025).

[4] European Parliament and Council of the European Union (2000) Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Union. Available at: http://data.europa.eu/eli/dir/2000/60/oj (Accessed: 30 August 2025).

[5] European Union (2024) Recital 28 – Artificial Intelligence Act. Available at: https://artificialintelligenceact.eu/recital/28/ (Accessed: 30 August 2025).

sectors. In this way, the assessment of environmental impact remains an indirect responsibility of those implementing such technologies.

Indeed, one could also frame environmental protection within the classification criteria set out in Article 7(2)(g): namely, *the extent to which the outcome produced by an AI system is easily reversible, bearing in mind that certain effects*—such as the reduction of greenhouse gas emissions—are difficult to reverse, or in the field of environmental law, may even be irreversible.

Accordingly, by applying the filter proposed by the Regulation and reaching the conclusion that we are dealing with a high-risk system, developers are placed under an obligation to report to the competent authorities any incidents or malfunctions that could affect users' rights. Furthermore, developers are required to provide detailed documentation regarding the functioning, purpose, and testing of the system, including information on the data used to train it (Coman, 2025). Within this technical documentation, it may reasonably be assumed that indicators concerning the energy consumption of the AI system should also be included, thereby establishing a mechanism for verification and control, subsequently through audit, of resource consumption.

An analysis of Annex IV[6], which sets out the technical characteristics that should form part of the documentation, reveals that the issue of energy consumption is not expressly included. From an ecological perspective, it would have been appropriate to include in the technical file specifications concerning the computational resources employed, with details on the processing power required for the development, training, and operation of the system, as well as an assessment of its impact on climate change, including the greenhouse gas emissions generated.

In this context, we would venture to argue that an explicit recognition of the right to environmental protection within the AI Act would have been appropriate.

Another concern lies in the fact that, with regard to artificial intelligence systems other than those classified as high-risk, the AI Act merely encourages, but does not mandate, compliance with the aforementioned requirements.

In other words, with respect to these systems, service providers will not be obliged, for example, to report information on energy consumption. Article 95 of the AI Act stipulates that the Artificial Intelligence Office and the Member States shall facilitate the development of codes of conduct for the voluntary application of specific requirements for all AI systems, based on clear objectives and key performance indicators to measure the achievement of those objectives, including elements such as, but not limited to: (b) the assessment and minimisation of the environmental sustainability impact of AI systems, including with regard to energy-efficient programming and techniques for the efficient design, training and use of AI.

The European legislator merely encourages the drafting of voluntary codes of conduct concerning environmental sustainability. However, such voluntary commitments fall far

[6] *"A detailed description of the elements of the AI system and of the development process, including: (c) a description of the system architecture, explaining how the software components rely on each other or feed into each other and integrate into the overall processing, as well as the computing resources used for the development, training, testing and validation of the AI system."* (AI Act, Annex IV, point 2(c)) - European Parliament and Council of the European Union (2024) Annex IV – Technical documentation referred to in Article 11(1), in Regulation (EU) 2024/… (Artificial Intelligence Act). Official Journal of the European Union. Available at: https://artificialintelligenceact.eu/ (Accessed: 30 August 2025).

short of what is needed to mitigate contributions to climate change in a key and rapidly expanding sector of technological and economic development, as the history of failed voluntary commitments to limit climate change has clearly demonstrated (Nordhaus, 2020).

As we have perhaps already suggested, in the climate context a potential regulatory problem arises from the possibility of subjective interpretation of the criteria set out in Article 7 of the AI Act. An artificial intelligence system is assessed in relation to its context of use or the sector it serves, through the lens of potential harm, and not directly with regard to its potential environmental impacts.

In other words, it is possible that an AI system will not be classified as high-risk and, therefore, will not even be subject to reporting requirements, requirements which, in any case, already prove to be rather vague in relation to the obligation to specify resource consumption.

A potential solution to this shortcoming can be found in the *European Parliament Resolution of 20 October 2020 containing recommendations to the Commission on a framework of ethical aspects of artificial intelligence, robotics and related technologies*[7].

The mission of environmental protection is also reflected in the preamble to the resolution, under the section "Environment and Sustainability." In paragraphs 51 and following, it is stated that: *"Governments and businesses should use artificial intelligence, robotics and related technologies to benefit citizens and the planet, to contribute to the achievement of sustainable development, environmental conservation, climate neutrality and the circular economy; the development, deployment and use of these technologies should contribute to the green transition, conserve the environment and minimise any environmental harm throughout their life cycle and across their entire supply chain, in line with Union law."* Furthermore, in view of their significant environmental impact, the development, deployment and use of artificial intelligence should be subject to continuous assessment by the relevant sectoral authorities; such an assessment could include an estimate of the impact of material extraction, energy consumption and greenhouse gas emissions resulting from their development, application and use.

The resolution also emphasises that, despite the current high levels of carbon emissions generated by the development, deployment and use of artificial intelligence, robotics and related technologies—including automated decision-making and machine learning—these technologies can nonetheless contribute to reducing the existing environmental footprint of the ICT sector. It underlines that these technologies and other related technologies, when properly regulated, should make a substantial contribution to achieving the objectives laid down in the Green Deal, the United Nations Sustainable Development Goals, and the Paris Agreement across multiple sectors, and should enhance the impact of environmental protection policies, for example through policies aimed at reducing waste and environmental degradation.

Article 11 of the European Parliament Resolution of 20 October 2020, entitled *Environmental Sustainability*, provides that artificial intelligence, algorithms, and data

[7] European Parliament (2020) European Parliament resolution of 20 October 2020 with recommendations to the Commission on a framework of ethical aspects of artificial intelligence, robotics and related technologies (2020/2012(INL)). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020IP0275 (Accessed: 30 August 2025).

used or generated by such technologies shall be assessed by the national supervisory authorities referred to in Article 18, or, where appropriate, by other national or European sectoral supervisory bodies, in order to determine whether they are environmentally sustainable. It requires that measures be taken to mitigate and remedy their overall impact on natural resources, energy consumption, waste generation, carbon footprint, the urgency of climate change, and environmental degradation, with the aim of ensuring compliance with applicable Union or national legislation, as well as with other international commitments undertaken by the Union in the field of environmental protection.

Yet even in this case, the premise of evaluation is the classification of the technology as high-risk. According to Article 6 of the European Parliament Resolution[8], the provisions of the first chapter apply only to artificial intelligence and related technologies—including software, algorithms, and data used or generated by such technologies—that are developed, deployed, or used within the Union and are considered to present a high level of risk. Furthermore, pursuant to Article 4(e), "high risk" is understood as a significant risk arising from the development, deployment, and use of artificial intelligence, robotics, and related technologies of causing harm or damage to individuals or to society through the violation of fundamental rights and safety standards, as laid down in Union law, taking into account their specific use or purpose, the sector in which they are developed, deployed, or used, and the severity of the harm or damage that may occur. In other words, before any control mechanisms can be applied, the technology must first be classified according to its level of risk. This requirement itself may represent a vulnerability in the fight against climate change.

3.3. The Compliance Burden

As previously noted, under the AI Act, applications of artificial intelligence in critical infrastructure (for example, in transport, water, gas, heating, and electricity) are classified as high-risk AI systems. Nevertheless, these sectors often provide significant potential (Creutzig, 2019) for the use of artificial intelligence in mitigating and adapting to climate change.

Meeting the requirements of the AI Act may prove costly, particularly for small enterprises, which may struggle to access the resources needed for compliance. With reference to start-ups, one can imagine how such a complex legal framework may be discouraging for innovation, as navigating it requires skilled legal departments. On the other hand, the development of artificial intelligence depends on large quantities of data, and the strict requirements of the GDPR may restrict access to the datasets necessary for algorithm training.

From the perspective of global competition, these European regulations appear particularly stringent compared to those developed by competitors. The United States and China have adopted more flexible approaches, granting a major competitive advantage to companies developing these technologies.

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[8] European Parliament (2020) European Parliament resolution of 20 October 2020 with recommendations to the Commission on a framework of ethical aspects of artificial intelligence, robotics and related technologies (2020/2012(INL)). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020IP0275 (Accessed: 30 August 2025).

Accordingly, the barriers generated by legislation in these sectors must be addressed appropriately to ensure that they do not slow down efforts to mitigate and adapt to climate change, efforts which could greatly benefit from artificial intelligence. In the process of drafting the AI Act, compared to the initial version of the document, the academic community intervened and highlighted the need for a harmonised approach (Truby, 2022) with respect to controlled development environments (sandboxes).

Regulatory sandboxes generally refer to regulatory instruments that allow companies to test and experiment with new and innovative products, services, or business models under the supervision of a regulatory authority for a limited period of time. Accordingly, regulatory sandboxes fulfil a dual role: (1) fostering business learning, namely the development and testing of innovations in a real-world environment; and (2) supporting regulatory learning, namely the formulation of experimental legal regimes to guide and assist companies in their innovation activities under the oversight of a regulator. In practice, this approach seeks to facilitate experimental innovation within a controlled risk and supervisory framework, while also enhancing regulators' understanding of new technologies (Ranchordas, 2021).

Thus, in Article 57, the AI Act now regulates the concept of sandboxes, stipulating that each Member State of the European Union must establish at least one national artificial intelligence sandbox, which must be operational by 2 August 2026. In practice, this imposes the creation of controlled environments that encourage innovation and facilitate the development, training, testing, and validation of artificial intelligence systems at an early stage, prior to their placing on the market or being put into service.

As regards high-risk AI systems, by way of exception, Article 47 of the AI *Act (entitled Derogation from the conformity assessment procedure)* provides that, notwithstanding Article 43, any market surveillance authority may authorise the placing on the market or putting into service of certain high-risk AI systems within the territory of the relevant Member State, on exceptional grounds of public safety or the protection of the life and health of individuals, environmental protection, or the protection of essential industrial assets and infrastructure.

Thus, under certain conditions (Recital 130[9]), the rapid availability of innovative technologies may prove crucial for the health and safety of individuals, for environmental protection and climate change, as well as for society as a whole. Consequently, in duly justified situations, for exceptional reasons relating, inter alia, to environmental protection, market surveillance authorities may authorise the placing on the market and putting into service of artificial intelligence systems that have not undergone a conformity assessment. As suggested earlier, addressing climate change requires mitigation, namely the reduction of emissions, and artificial intelligence systems can support such changes from a technical perspective through optimisation in critical sectors such as electricity, transport, and industry.

[9]European Union (2024) Recital 130 – Artificial Intelligence Act. Available at: https://artificialintelligenceact.eu/recital/130/ (Accessed: 30 August 2025).

4. CONCLUSION

"The adoption of AI applications is beneficial for the environment[10]".

Certainly, artificial intelligence plays an important role in climate change and in achieving sustainability, and thus we may agree with this assertion. Nevertheless, the complexity of the phenomenon requires us to move beyond a unilateral analysis.

The *dialectic of remedy and poison* serves to illustrate the interdependence between benefit and danger, highlighting that the positive effects of new technologies and artificial intelligence are inevitably accompanied by risks.

In the foregoing, we have identified possible legislative vulnerabilities in the process of developing artificial intelligence systems in the context of combating climate change and concluded that the AI Act does not adequately address the climate risks generated by these systems (particularly with regard to greenhouse gas emissions). Even if a liberal vision appears essential in today's technological context, we would argue that it is equally necessary to assess the effectiveness of more stringent standards concerning environmental protection.

One initial step could be the revision of the technical file (Annex IV) to explicitly integrate a sustainability requirement from the very construction phase of AI systems. This would allow environmental considerations to be embedded from the design and implementation stage of AI models and machine learning practices.

On the other hand, a somewhat more intrusive (yet effective) regulatory mechanism could involve imposing restrictions on energy consumption. Of course, considering the balance referred to earlier, and in order not to create new barriers to system development, this discussion would need to be nuanced. A differentiation appears necessary: beyond risk-based classification, AI systems should also be categorised by the domain in which they are to be implemented (their degree of social utility). In other words, one might envisage certain consumption limits established according to the sector and the specific purpose of AI use, bearing in mind, as previously indicated, that many of the domains listed in Annexes II and III of the AI Act are precisely those social sectors in which AI could have the most significant positive impact in fulfilling environmental commitments.

Thus, to the question of how this pharmakon should be administered, recognising that the emergence of new technologies cannot be halted, but also that unreserved acceptance cannot constitute an adequate solution, the answer lies in a balanced approach, consistent with the aim of maximising benefits while minimising dangers, so as to tilt the balance between remedy and poison in favour of humanity.

Since there is no universal solution, we advocate for a multidisciplinary study, as only through such an approach could the vulnerabilities of the AI Act be corrected in order to establish a legal framework that both supports the development of new technologies in critical sectors and institutes a mechanism for assessing their environmental impact.

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[10] European Commission (2022) Proposal for a Directive of the European Parliament and of the Council on adapting non-contractual civil liability rules to artificial intelligence (AI Liability Directive) – Explanatory Memorandum. COM (2022) 496 final, 28 September. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX: 52022 PC04 96 (Accessed: 30 August 2025).

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