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Review article

THE INTERSECTION BETWEEN ARTIFICIAL INTELLIGENCE AND SUSTAINABILITY: CHALLENGES AND OPPORTUNITIES*

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ABSTRACT

The development of the digital revolution facilitates innovative models that generate new markets and business opportunities. The reappearance of artificial intelligence (AI) has created further potentials and types of market participation. AI is understood as a cutting-edge technology and a key driver of the transition of our economy into the digital economy.

It is important to recognize and constantly bear in mind that artificial intelligence systems provide certain benefits but are associated with certain risks and potential negative effects. The European Commission, in its Ethical Guidelines for Trustworthy Artificial Intelligence (2019), emphasizes ethical principles and associated values that must be respected in the development, introduction, and use of artificial intelligence systems: respect for human autonomy, prevention of harm, fairness, and explainability.

The question arises as to whether the emerging fundamental ethical principles and regulatory policies concerning AI systems require certain adaptations when it comes to the application of AI technology in connection with the sustainable development goals. The development of artificial intelligence systems compatible with the goals of sustainable development, as defined in the 1987 report of the UN Brundtland Commission as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs", is encouraged. Sustainability or sustainable development is defined in the literature as a concept based on three pillars - encompassing social, economic, and environmental aspects. The European Commission highlights that sustainable development is a fundamental principle of the Union Treaty and a priority goal of Union policies, along with digitization and a robust single market.

In recent years, doctrine has sought to bridge the gap between the two disciplines by introducing the term "Sustainable AI". The aim of the paper is to understand the development of AI that is

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compatible with sustainable goals. To understand this, it is necessary to comprehend the basic concepts of artificial intelligence systems and explore the sociological, ecological, and economic implications of these systems, all with the aim of finding ways to achieve the goals of sustainable development and the sustainability of AI systems themselves. These are closely tied to adhering to the highest ethical principles with the responsible use of artificial intelligence systems.

***Keywords**: EU, artificial intelligence, sustainability*

1. INTRODUCTION

The development of the digital revolution facilitates innovation models that generate new markets and business opportunities. The reappearance of artificial intelligence (AI) has created further potentials and types of market participation. AI is understood as a cutting-edge technology and a key driver of the transition of our economy into the digital economy. It is part of the fourth industrial revolution, which is "characterized by a range of new technologies that are fusing the physical, digital, and biological worlds, impacting all disciplines, economies, and industries, and even challenging ideas about what it means to be human".[1]

AI, as one of the key technologies, has already become part of our everyday life, from the traffic sector, climate sector, energy, agriculture, as well as financial markets and the data-driven economy.[2] Although AI systems provide benefits, certain risks and potential negative effects might arise. It is necessary to understand and analyze possible negative consequences of enabling AI systems.

The unprecedented growth of new technologies poses difficulties in understanding their impact on the future of society. While some risks are apparent at the outset, some of them may occur in the future. Especially true with societal and ethical risks, some of them concern data protection, privacy matters, opacity, bias, and unforeseeability, but also manipulation, hate speech, and fake news.[3] It is necessary to consider the ethical and human goals of new technologies together with the environmental and economic costs of training such models.

The pace at which AI develops is so fast that it is almost impossible to govern AI systems. Understanding complex systems will help us in predicting and avoiding

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1 Schwalb, K., *The Fourth Industrial Revolution*, World Economic Forum, Cologny/Geneva, 2016, p. 1.

2 European Commission (2018a) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, Artificial Intelligence for Europe, 25. 4. 2018 COM(2018) 237 final (European Commission (2018a)).

3 Hacker, P., *Sustainable AI Regulation,* (June 1, 2023), [https://ssrn.com/abstract=4467684 or http://dx.doi.org/10.2139/ssrn.4467684], Accessed 20 February 2024, p. 3.

possible failures of AI systems.[4] Ethics, efficiency of systems as well as sustainability issues are crucial in the assessment of AI systems.[5]

These topics are at the heart of the European Union. The European Union aims to be a leader in this sector, so it published a Communication on Artificial Intelligence for Europe[6] in 2018, along with the accompanying document on Liability for Emerging Digital Technologies.[7] The Commission believes that the way we approach AI will define the world we live in.[8] The development of AI systems with humans in the loop must benefit people and society. Basically, the idea is to try to understand complex interactions and technology underpinning it, so the possible risks to the whole society can be diminished. If we want to offer possible solutions it is necessary to understand the basic structure of the system. The problem with new technology is that the technological revolution is moving so fast and it is usually quite ahead of the legislator. The regulation is needed, but with a caveat that any regime adopted must be in line with new developments. So, the emerging fundamental ethical principles and regulatory policies concerning AI systems require certain adaptations when it comes to the application of AI technology to sustainability issues.

On the one side we have the fast and unprecedented development of AI systems along with certain risks and on the other side the necessity to incorporate sustainable development goals encompassing social, economic, and environmental aspects. The AI system can be seen as an enabler, as well as impediment of the sustainable development goals.

In recent years, doctrine has sought to bridge the gap between the two disciplines by introducing the term "Sustainable AI". The aim of the paper is to understand the development of AI that is compatible with sustainable goals. To understand this, it is necessary to comprehend the basic concepts of AI systems and explore the sociological, ecological, and economic implications of these systems, all with the aim of finding ways to achieve the goals of sustainable development and the

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4 Wilson, C.; van der Velden, M., *Sustainable AI: An integrated model to guide public sector decision-making*, Technolgy in Society, Vol. 68, 2022, p. 1.

5 Vinuesa, R. *et al., The role of artificial intelligence in achieving the Sustainable Development Goals*, Nature Communications, Vol. 11, 2020, p. 5.

6 European Commission (2) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, Artificial Intelligence for Europe, 25. 4. 2018 COM(2018) 237 final, (European Commission (2018a)).

7 European Commission (2018b) Commission Staff Working Document, Liability for emerging digital technologies, 25. 4. 2018 SWD(2018) 137 final.

8 European Commission (2018a), *op. cit.,* note 6, para 1.

sustainability of AI systems themselves. It means respecting highest ethical principles and the responsible use of AI systems.

2. THE NOTION OF AI

AI encompasses variety of different technologies and sub-areas. The diversity of areas presents a definition challenge that has implications for doctrine and regulation.[9] AI is usually explained as a collection of technologies that combine data, algorithms, and computing power.[10] There are various definitions proposed in doctrine, ranging from simple definitions of AI as "intelligent machines" or at least "machines acting in ways that seem intelligent" to more complex and comprehensive ones, referring to AI as "an umbrella term embracing computer (machine) vision, natural language processing, virtual assistants and bots, robotic process automation, machine learning (including most advanced techniques like deep learning) and cognitive processes in organizations".[11] In the sea of so many proposed definitions, the one suggested by the Policy Department for Economic, Scientific, and Quality of Life Policies best explains the complex notion of AI as a "branch of science and as such it can be defined as a set of computational technologies that are inspired by the ways people use their nervous systems and bodies to sense, learn, reason, and take action".[12] It is wide, easy to understand, and flexible enough to adjust to rapid technological developments.

Russel and Norvig in their seminal textbook organize different definitions of AI along four different axes, depending on the approach taken, i.e. whether the accent is on thinking humanly, acting humanly, thinking rationally or acting rationally.[13] The European Commission underlines that "AI refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goal".[14] It is actually a collection of technologies that combine data, algorithms and computing power.[15] AI

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9 Mazzucato, M. *et al., Governing artificial intelligence in the public interest*, UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2022-12), [https://www.ucl.ac.uk/bartlett/public-purpose/wp2022-12.], Accessed 2 February 2024, p. 2.

10 European Commission, White Paper on Artificial Intelligence – A European approach to excellence and trust, COM(2020) 65 final, Brussels, 19. 2. 2020, p. 2 (White Paper).

11 European Parliament (2019a) State of the art and future of artificial intelligence, [https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/631051/IPOL_BRI(2019)631051_EN.pdf], Accessed: February 29, 2024.

12 *Loc. Cit.*

13 Russel, S. J.; Norvig, P.: *Artificial Intelligence: A Modern Approach*, 4th Ed., Pearson, 2022, p. 19-22.

14 European Commission (2018a), *op. cit.*, note 6, p.1

15 White paper, *op.cit.,* note 10, p. 2

can be purely software based or can be embedded in hardware devices.[16] The proposed AI act[17] opted for a definition that encompasses previous mentioned models as "a machine-based system designed to operate with varying levels of autonomy and that may exhibit adaptiveness after deployment and that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments" (art. 3).

The definitions evolve over time and depend on the level of technological advancement, so the temporal element is crucial. Finding an appropriate definition is necessary in order to understand legal, social and ethical implications associated with AI. In order to effectively govern the technology, there is a need of uniformly accepted definition.[18] Since AI-based solutions may be applied and used in very different economic and societal sectors, only an interdisciplinary approach may offer acceptable results.

3. THE ROLE OF AI IN ACHIEVING SUSTAINABILITY DEVELOPMENT GOALS

Sustainability, as AI, is a term that everyone knows something about it but without uniform definition. Nearly, every discourse on sustainability issues begins with the landmark Brundtland Report from 1987, which defined sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs."[19] The nexus of technological advancements and economic growth holds the potential to promote sustainable development as a global benchmark and standard for all policy areas.

In the realm of doctrine, sustainability is perceived as a concept, a goal, a policy objective, a guideline, an ideal, a meta-principle, a weak norm of international law, a concept or principle of customary law, depending on the author's perspective.[20]

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16 European Commission (2018a), *op.cit.,* note 6

17 In this paper we refer to the European Parliament legislative resolution of 13 March 2024 on the proposal for a regulation of the European Parliament and of the Council on laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union Legislative Acts (COM(2021)0206 – C9-0146/2021 – 2021/0106(COD)), (AI Act).

18 Mazzucato, M., *et all., op. cit.*, note 9, p. 2.

19 Brundtland Report (1987) Report of the World Commission on Environment and Development, Our Common Future, [https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf], Accessed 1 June 2023, p. 16.

20 Verschuuren, J., *The growing significance of the principle of sustainable development as a legal norm,* in: Fisher, D. (ed.), Research Handbook on Fundamental Concepts of Environmental Law, Cheltenham, UK –Northhampton, MA, USA, Edward Elgar Publishing, p. 276.

Over the years, it has become evident that sustainable development extends beyond environmental protection; it is inseparably linked with a sustainable economy. Promoting sustained, inclusive, and sustainable economic growth, with decent work for all, stands as one of the UN Sustainable Development Goals.[21] This framework lists 17 sustainable development goals with 169 targets, all interlinked and interdependent. The concept is also known as "3D Sustainability" which attempts to translate environmental, social, and economic capital and (carrying) capacity realities into practically applicable new sustainable regulation and governance solutions.[22] All three pillars must be developed to achieve sustainability principles. The economic principle refers to guaranteeing sustainable and feasible economic growth, which can be achieved by responsible resource management using renewable energy and promoting fair trade practices. The social aspect focuses on improving the quality of life, with an emphasis on human rights, gender equality, and access to services. The environmental pillar promotes the preservation of natural resources with their responsible usage.[23]

However, misunderstandings and overuse of the term pose difficulties in its definition. According to Montini, there is an incorrect replacement of the term sustainability with the term sustainable development, resulting in a greater focus on economic development that can later achieve social and environmental goals.[24]

In recent decades, the European Union has steadily progressed its efforts towards achieving sustainable, fair, and inclusive growth by creating and adopting political, legal, and financial preconditions fit for this purpose. The Sustainable Development Goals are proclaimed to be "at the heart of EU's policymaking and action"[25], and the transformation to a sustainable economy is the EU's key political priority,

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21 United Nations (2015) Transforming our world: the 2030 Agenda for Sustainable Development, Resolution adopted by the General Assembly on 25 September 2015, [A/RES/70/1 https://sdgs.un-.org/2030agenda], Accessed 29 February 2024.

22 Mauerhofer, V., *Sustainable Development Law in (Only) One World: Challenges and Perspectives for Governance and Governments*, in: Mauerhofer, V.; Rupo, D.; Tarquino, L. (eds.), Sustainability and Law, General and Specific Aspects, Springer, Cham, 2020, p. 17.

23 Medeot, T., *Artificial Intelligence and Sustainability: How AI can improve sustainable decision – making in modern organizations*, International Journal for Regional Development, Vol. IV, 2023, p. 133.

24 Montini., M., *Designing Law for Sustainability*, in: Mauerhofer, V.; Rupo, D.; Tarquino, L. (eds.), Sustainability and Law, General and Specific Aspects, Springer, Cham, 2020, p. 17.

25 European Commission (2019a) Communication from the Commission to the European Parliament, the Council, the European Central Bank, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, Annual Sustainable Growth Strategy 2020, COM(2019) 650 final, Brussels, 17. 12. 2019, p. 2, (European Commission (2019a)), p .2.

as it is "essential for the wellbeing of our society and our planet"[26], and for the development of "an innovative and sustainable society".[27]

Sustainability is part of the EU's constitutional legal framework (art. 3 Treaty on European Union (TEU)[28]; art. 21 TEU and art. 11 Treaty on the Functioning of the European Union (TFEU)[29]). When it comes to the specific legal basis in primary law for the Union's environmental policy (art. 191 TFEU), there is no explicit mentioning of sustainable development among the objectives or among the principles upon which this policy is based. On the other hand, seeking to promote "balanced and sustainable development" as a continued task of the EU is mentioned in the preamble of the Charter of Fundamental Rights of the EU[30], and its art. 37 on environmental protection explicitly refers to the "principle of sustainable development", requiring that a high level of environmental protection and the improvement of the quality of the environment must be integrated into the policies of the Union and ensured in accordance with the principle of sustainable development.

Although mentioned in EU primary law, sustainable development is not defined in EU primary law. Despite this, TFEU codifies principles through which sustainability is achieved. One example is the principle of integration from art. 11 TFEU. This is a horizontal clause that requires the integration of environmental protection requirements into the definition and implementation of the Union's policies and activities, in particular with a view to promoting sustainable development. It supports the integration and translation of sustainable development into more concrete commitments.[31]

Sustainable development takes into account environmental concerns but also digital transformation, innovation, the use of new technologies, as well as social concerns. It is not a goal in itself but rather a process, whereas sustainability is an objective. If we change our point of view, we can ask ourselves, how can AI and new technologies help in achieving sustainability development goals?

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26 *Ibid.*, p. 1 .

27 Ecco-Innovation Observatory (2020) EIO Biennial Report 2020: Eco-Innovation and Digitalisation, Case studies, environmental and policy lessons from EU Member States for the EU Green Deal and the Circular Economy, [https://ec.europa.eu/environment/ecoap/sites/default/files/eio5_eco-innovation_and_digitalisation_nov2020.pdf], Accessed 15 January 2024, p. 6, (Ecco-Innovation Observatory).

28 Treaty on European Union, (consolidated version 2016), OJ C 202, 7. 6. 2016.

29 Treaty on the Functioning of the European Union (consolidated version 2016), OJ C 202, 7. 6. 2016.

30 Charter of Fundamental Rights of the EU, OJ C 202, 7. 6. 2016.

31 Nowag, J., *Environmental Integration in Competition and Free-Movement Laws*, Oxford University Press, Oxford, 2016, p.1.

Sustainability issues must be at the heart of digital transformation. "Green" and "digital" or "twin" transitions are key enablers of the transformation towards a sustainable economy or competitive sustainability, as Europe's new growth paradigm. All EU actions and policies have to contribute to the European Green Deal. It is a document promoting the transformation of the EU "into a fair and prosperous society, with a modern, resource-efficient and competitive economy".[32]

Digital technologies are critical enablers for achieving sustainability goals[33]. The Commission will explore measures to ensure that digital technologies such as AI can accelerate and maximize the impact of policies to deal with climate change and the protection of the environment.[34] Since 2020, sustainability is integrated into the European Semester process, thus making it an economic and employment policy priority for the EU.[35]

The transformative power of AI systems will contribute to the accomplishment of the green transition. Sustainability must be the core point of departure for the development not only of AI technologies but also a digitalized society in general. The idea is to develop environmentally sound technologies. Building on the ideas developed in the previous sustainable development strategies, European Commission sets out a long-term strategy for a sustainable Europe. Initiatives su ch as the New Circular Economy Action Plan[36] the Biodiversity Strategy for 2030[37] and the

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32 European Commission (2019b) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, The European Green Deal, COM(2019) 640 final, Brussels, 11. 12. 2019, p. 1, (Green Deal).

33 *Ibid.*, p. 9.

34 *Loc. Cit.*

35 European Commission (2019a) Communication from the Commission to the European Parliament, the Council, the European Central Bank, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, Annual Sustainable Growth Strategy 2020, COM(2019) 650 final, Brussels, 17. 12. 2019, European Commission (2021a) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Building an economy that works for people: an action plan for the social economy, Luxembourg: Publications Office of the European Union, p. 3.

36 European Commission (2020c) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A new Circular Economy Action Plan for a cleaner and more competitive Europe, COM(2020) 98 final, Brussels, 11. 3. 2020.

37 European Commission (2020d) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, EU Biodiversity Strategy for 2030 Bringing nature back into our lives, COM(2020) 380 final, Brussels, 20. 5. 2020.

Zero Pollution Action Plan [38]together with other policy instruments create an intricate network of measures and targets in different fields to achieve this overarching common objective. The main focus is on the potential of AI systems and the role they might play in the transformation towards sustainable society. The Ecco-Innovation Observatory stresses strong links from digitalisation and a transformation towards an innovative and sustainable society in order to create preconditions and a framework for a "…sustainable and smart future".[39] The concept of sustainability has evolved from the idea of reducing environmental footprint to placing an accent on innovation and the overall impact. Sustainability is, and should be, simply "how […] business is done".[40]

The main dilemma is how new technologies, together with AI systems, contribute to the socio-ecological transformation of the economy. The uptake of innovative digital solutions can assist in achieving sustainability objectives in various sectors of the economy. There is a need to develop and shape AI capabilities together with technologies towards a sustainable, equitable, and green digital economy.[41] Besides the positive influence of AI systems in the development of sustainability goals, we must not forget that there are potential pitfalls of the digital transformation on sustainability, such as health and ecological impacts as well as adverse economic and social effects.[42]

The application of AI systems will produce novel forms of interaction between humans, machines, and the environment ecosystem. AI systems have at least three advantages that can help in achieving sustainability goals: automation of time-consuming tasks that allows humans to focus on complex tasks, shortening the process in analyzing massive amounts of data, and the possibility to solve complex problems.[43] The intersection of these elements can help in achieving the digitalised and transformative society.

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38 European Commission (2021d) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Pathway to a Healthy Planet for All, EU Action Plan: "Towards Zero Pollution for Air, Water and Soil", Brussels, COM(2021) 400 final, 12. 5. 2021.

39 European Commission (2020g) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Sustainable and Smart Mobility Strategy – putting European transport on track for the future, COM(2020) 789 final, Brussels, 9. 12. 2020, p. 2.

40 Chouinard, Y.; Ellison, J.; Ridgeway, R., *The Sustainable Economy*, Harvard Business Review, October 2011, [https://hbr.org/2011/10/the-sustainable-economy], Accessed 1 June 2022.

41 Mazzucato, M. *et al., op. cit.*, note 9, p. 1.

42 Ecco-Innovation Observatory, p. 7-8.

43 Nishant, R.; Kennedy, M.; Corbett, J., *Artificial Intelligence for sustainability: Challenges, opportunities, and research agenda*, International Journal of Information Management, Vol. 53, 2020, p. 2.

AI systems can help in achieving some sustainable development goals but also impede some.[44] There is an urgent need to set policies and regulation to open potential of AI systems to every sector with particular focus in achieving sustainability development goals.[45] Moreover it is necessary to think of sustainable deployment of AI systems as well.[46] The later will be further discussed.

There is a growing need to understand AI for sustainability. But how can it be defined? What does it consist of? Sustainability must be at the central point of departure for the development of not only AI technologies but a digitalised society in general. A more holistic approach is needed. Interdisciplinary research is essential to gain a greater understanding of how to develop sustainable AI.

It is obvious that there are numerous positive effects that AI systems bring to our society (for example, mitigating global warning and climate change) but also we must not forget negative effects on society. Wynsberghe distinguishes three waves of AI ethics: the first is the study of ethical and social effects that influence developers and users of AI systems, the second one is more focused on practical questions in terms of explainability of AI systems and the last one analyses environmental aspects of the impact of AI systems.[47] The idea is to put sustainability at the core of AI systems. As Mazzuacato and authors rightly point out, machine learning as a subfield of AI can accelerate the achievement of sustainable development goals. They offer example of smart electric grids and use of AI in healthcare.[48]

It is obvious that AI can be enabler of sustainable development goals, but it is necessary to analyse precisely the techniques in doing so. One study shows that AI may act as facilitator of 134 targets but also inhibitor of another 59 targets.[49] For example, AI can improve societal outcome like no poverty, quality education, clean water and sanitation, clean energy, sustainable cities, identify areas of poverty by satellite images but also negative effects can be perceived from different cultural values and wealth. AI is trained by the data that is harvested in countries in which it is developed. In the situation where the ethical and human rights are less developed, it may enhance bias outcomes. Cryptocurrency applications are using as much electricity as the total national electrical demand of some countries. Green growth of ICT technology is our future. AI can have a positive impact on

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44 Vinuesa, R. *et al., op. cit.,* note. 5, p. 1.

45 *Ibid*, p. 6.

46 Wynsberghe, A., *Sustainable AI: AI for sustainability and the sustainability of AI*, AI and Ethics, Vol. 1, 2021, p. 213.

47 *Loc. Cit.*

48 Mazzucato, M. *et al., op. cit.*, note 9, p. 2.

49 Vinuesa, R. *et al., op. cit.,* note. 5, p. 2.

achieving economic outcomes. The study has identified benefits from AI on 42 targets while negatives have been found in 20 targets. Increased productivity is one of the main advantages but, on the other side, it raises inequalities. It deepens the so-called economic gap. Technology rewards the educated as more jobs with sophisticated skills will be needed. Benefits of using AI systems in the field of environment were identified in 25 targets. One relates to the ability to analyze a huge amount of data in a short time that can direct actions aimed to preserve the environment. It can support low-carbon energy systems to improve renewable energy and energy efficiency. Marine pollution is one of the possible areas of benefit. AI safety research is needed. The investigation shows that many AI applications are biased towards sustainable development issues and are relevant to those nations where AI researchers work and develop systems.[50]

According to the Commission, there is a need for continuous work in the area of effective application and enforcement of existing EU and national legislation. The limitations in the scope of the existing EU legislation should also be tackled. Good regulatory response is needed. AI systems have been at the forefront of the political agenda in the EU in the last few years. In 2017, the European Council called on the Commission to develop a European approach to AI. In 2018, the Commission published a Communication with the aim "to boost the EU's technological and industrial capacity, prepare for socio-economic changes and ensure an appropriate ethical and legal framework".[51] It has often stressed that possible regulatory proposals must take into consideration the fact that any misplaced regulation has the potential to stifle innovation in every sector, especially the AI sector.

In the last few years in the EU, we have witnessed legal initiatives concerning AI. The picture in the EU was fragmented. The discussion centred on whether any regulation is needed at all. In other words, do we have to regulate AI systems or not? The Commission started its path toward regulation form the White paper on artificial intelligence that stressed the need to maintain scientific discovery, preserve the EU's technological leadership while improving the lives of its citizens and the development of AI based on European values. The White paper calls for a European approach that will diminish national fragmentation of rules and develop an ecosystem of trust and excellence.[52] The Commission also stressed the need to assess the environmental impact of AI throughout its lifecycle and its supply chain. In order to enhance trust, the Commission issued the Ethics Guide-

50 *Ibid.*, p. 6.

51 European Commission, *op.cit.*, note 6, 2018a.

52 White paper, *op.cit.,* note 10, p. 1-3.

lines for Trustworthy AI in 2019.[53] The accent is on the trust in the development, deployment, and the use of AI systems as an essential part of every regulation aimed at establishing lawful, ethical, and robust AI systems. It is one of the clearest demonstrations of the EU's ambition to become a leader in ethical AI. The Guidelines cover different chapters that are focused on AI compliance with fundamental rights, technical and non-technical methods to implement trustworthy AI together with assessment lists and case studies. EU values and fundamental rights are at the forefront of AI, as AI systems should not be an aim in themselves, but rather a tool to increase human wellbeing. Guidelines set ethical principles that practitioners should always adhere to: respect of human autonomy, prevention of harm, fairness, explicability, accountability, and traceability. They point out that AI systems can facilitate the achievement of the UN's Sustainable Development Goals, such as promoting gender balance and tackling climate change, rationalizing our use of natural resources, enhancing our health, mobility, and production processes, and supporting how we monitor progress against sustainability and social cohesion indicators.[54]

AI applications that address sustainable development goals should carefully take into consideration ethical principles. According to Guidelines, "AI systems promise to help tackling some of the most pressing societal concerns, yet it must be ensured that this occurs in the most environmentally friendly way possible. The system's development, deployment and use process, as well as its entire supply chain, should be assessed in this regard, e.g. via a critical examination of the resource usage and energy consumption during training, opting for less harmful choices".[55]

Developing responsible AI, with a human-centric approach, is the ultimate objective and a bottom line of all policy and regulatory initiatives in this area. Disruptive technologies, such as AI, require timely and appropriate regulatory response. The result of the ongoing legislative process for the adoption of the Artificial Intelligence Act will show whether the EU will succeed in finding the right balance between the interest of establishing and preserving the EU's technological leadership, on the one hand, and the protection of Union values, fundamental rights, and principles to the benefit of its citizens, on the other. The proposed solution from the AI Act has caused both excitement and criticism in the legal doctrine and industry. It contains a uniform set of horizontal rules for the development, marketing, and use of AI systems in conformity with the Union values, applying

[53] Independent High-Level Expert Group on Artificial Intelligence (HLEG): Ethics Guidelines for Trustworthy AI, [https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai], Accessed 17 January 2024 (Ethics Guidelines).

[54] *Ibid.*, p. 4 .

[55] *Ibid.*, p. 19.

the proportionate risk-based approach. The aim is to avoid regulatory friction and fragmentation, and to create a well-functioning internal market for AI systems and technologies. One of the proposed solutions that try to incorporate the innovative or experimental approach to law-making, is the introduction of AI regulatory sandboxes. This is a novel regulatory regime and a policy instrument, aimed at fostering innovation by allowing the development and testing of AI systems under strict regulatory oversight before these systems are placed on the market (art. 57-63). AI regulatory sandboxes can be used to measure the achievement of sustainable development goals.

To ensure that AI systems lead to socially and environmentally beneficial outcomes, Member States are encouraged to support and promote research and development of AI solutions in support of socially and environmentally beneficial outcomes, but without precise instructions on how to achieve them. It is a pity that the legislator focused more on transparency obligations of the developer and deployer of AI systems, thus ignoring sustainability issues.

4. MOVING FROM AI FOR SUSTAINABILITY TO SUSTAINABLE AI

There has been much discussion on how to steer AI and new technologies towards achieving economic, social, and environmental targets. However, there's a lack of analysis on the deployment, training, and implementation of sustainable AI.[56] Both aspects are interconnected and mutually enforceable, and need further clarification.

The financial and environmental costs of developing AI systems are substantial. For instance, by 2027, the total energy consumption of AI is projected to match the energy demand of countries such as the Netherlands or Argentina.[57] Developing and promoting sustainable AI systems should also be considered and made transparent to AI deployers, users, as well as policy makers. Sustainable AI is hidden part of the development process.

To grasp any concept, first must be defined. However, there is a scarcity of literature and consistency in defining the term "sustainable AI". Most definitions portray it as "development, implementation, and utilization of AI in a manner that minimizes negative social, ecological, and economic impacts of the applied algorithms", "an approach where the positive and negative impacts of AI on people

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[56] Kindylidi, I.; Cabral, T. S., *Sustainability of AI: The Case of Provision of Information to Consumers*, Sustainability, Vol. 13, 2021, p. 1.

[57] Hacker, P., *op. cit.*, note 3, p. 3.

and society are as important as the commercial benefits or efficiency gains" or as a "movement to foster change in the entire lifecycle of AI products". Additionally, it is described as "change that is not harmful but beneficial for human life".[58]

The definition put forth by Wynsberghe appears to be the most persuasive. She characterizes sustainable AI as an umbrella term encompassing AI for sustainability and the sustainability of AI. It is a "field of research that applies to the technology of AI (the hardware powering AI, the methods to train AI, and the actual processing of data by AI) and the application of AI while addressing issues of AI sustainability and/or sustainable development".[59]

The development and use of AI systems must align with social, economic, and environmental pillars. However, there is a noticeable lack of studies on the sustainable use of AI systems. AI training consumes substantial energy and water resources. For instance, one investigation revealed that a conversation with ChatGPT consisting of 20-50 questions can evaporate the contents of a 500ml bottle of water![60] Moreover, according to another survey, Google's AlphaGO Zero generated 96 tonnes of CO2 over 40 days of research training, equivalent to 1000h of air travel or a carbon footprint of 23 American homes.[61] Additionally, computer and data centres' reliance on minerals for their batteries leads to carbon emissions. Electronic waste should not be overlooked, too. These situations are not merely abstract, but result in concrete emissions. Thus, the sustainability of developing and using AI models warrants examination and must be integrated into the regulation and implementation of AI systems.

The European Parliament has advocated for more stringent provisions regarding sustainability requirements. However, during negotiations on the adoption of the AI Act, it advocated for more environmental issues to be included, albeit everything remained within the realm of soft law rules. Consequently, the AI Act encourages providers and deployers of AI systems to adhere to additional guidelines on the trustworthiness of AI systems. The code of conduct should encompass specific questions assessing and minimizing the impact of AI systems on environmental sustainability, such as energy-efficient programming and techniques for efficient design, training, and use of AI (art. 95). It is noteworthy that these are voluntary codes of conduct that should be founded on clear objectives and indicators to measure their attainment. Nonetheless, the newly established AI Office has a task of encouraging and facilitating the drafting of codes of conduct intended to

58 Wilson, C., van der Velden, M., *op. cit.*, note 4, p. 4.

59 *Loc. Cit.*

60 Hacker, P., *op. cit.*, note 3, p. 5.

61 Wynsberghe, A., *op. cit.*, note 45, p. 214.

foster the voluntary application of AI systems other than high-risk AI systems.[62] As Hacker suggests, their value lies in gathering knowledge and expertise from various sectors of AI systems, enabling customized solutions and flexibility.[63]

It is crucial the switch from ethical inquiries to the practical application of AI systems with a focus on promoting environmental well-being.[64]

Achieving sustainability development goals entails risks and costs. Thus, it is essential to define parameters for measuring the sustainability of developing and using AI models.[65] Another potential concern stems from tuning the AI systems to be up to date and efficient. IT experts point these costs will be much higher than the development of systems. Collecting data entails large costs as MIT in a report said that the cloud has a larger footprint then entire airline industry. A single data center might consume the amount of electricity equivalent to 50 000 homes.[66] Environmental costs must be taken into account in the development and use of AI systems. They need to be integrated into the systems. The AI Act obliges providers of general-purpose AI systems to provide information on the energy consumption of those models (annex XI). Harmonised standards and standardisation deliverables on AI resource performance, such as the reduction of energy and other resource consumption of high-risk AI systems during their lifecycle, and on the energy-efficient development of general-purpose AI models, shall be developed (art. 40).

The developers of AI systems must uphold the development of AI systems compatible with sustainability goals. Sustainability must be at the core of the activities of every AI system. It is closely linked to the concept of robustness, which will become a key concept in developing and deploying AI systems. As already mentioned, the AI Act overlooked AI sustainability. It stresses that AI benefits a wide array of economic, environmental, and societal benefits across the entire spectrum of industries and social activities (recital 4). The compromise text highlighted that the Act includes a high-level statement that one of the purposes of the AI Act is to ensure a high level of protection of health, safety, and fundamental rights enshrined in the Charter, which includes democracy, rule of law, and environmental protection while boosting innovation and employment and making the Union a

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62 Commission decision of 24. 1. 2024 establishing the European Artificial Intelligence Office, Brussels, 24. 1. 2024 C(2024) 390 final.

63 Hacker, P., *op. cit.*, note 3, p. 21.

64 Wilson, C.; van der Velden, M., *op. cit.*, note 4, p. 2.

65 Wynsberghe, A., *op. cit.*, note 45, p. 214.

66 *The Staggering Ecological Impacts of Computation and the Cloud*, [https://thereader.mitpress.mit.edu/the-staggering-ecological-impacts-of-computation-and-the-cloud/], Accessed 20 February 2024.

leader in the uptake of trustworthy AI (art. 1). So, environmental protection is put on an equal footing with fundamental Union values and has become one of the criteria in the development and deployment of AI systems, but without clear tools on how to protect them. Understanding the technology life cycle is necessary, and certain support should be given to develop sustainable technology development. Kindylidi proposes incentives in the form of tax benefits and funding to undertakings developing sustainable AI.[67]

More should be done to understand how to develop and maintain sustainable AI. Besides promoting AI to achieve sustainable goals, the sustainability of AI addresses problems in measuring the carbon footprint and energy consumption of AI systems. These two systems are interconnected and should be examined together. In this regard, Ethics Guidelines encourage the sustainable and ecological responsibility of AI systems to benefit all human beings, including future generations. They point out that research has to be fostered into AI solutions addressing areas of global concern, such as the Sustainable Development Goals.[68]

Guidelines provide an assessment list as a tool to help AI practitioners to ensure compliance with non-legal standards. Some of the questions from the list ask: Did you establish mechanisms to measure the environmental impact of the AI system's development, deployment, and use (for example the type of energy used by the data centres)? and Did you ensure measures to reduce the environmental impact of your AI system's life cycle?[69] It is a clear example showing that the sustainability of AI is capturing more attention.

AI systems must focus not only on human rights and ethical issues, but also on the necessity to serve the needs of the environment, economy, and society.[70] Wynsberghe suggests that we must be really careful to choose the goals we will follow. One of them definitely is the development of AI systems with sustainable values. She suggests using a "proportionality framework" to assess whether the training of a particular AI is proportionate. The best practices should be encouraged. One proposal is to include AI for climate term.

Tuning a model is more expensive than training a model to begin with.[71] What will happen with old systems that will need continuous adaptation? Undertakings developing AI systems should deploy cost-benefit analysis to reduce energy

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67 Kindylidi, I.; Cabral, T. S., *op. cit.*, note 55, p. 9.

68 Ethics Guidelines, p.19.

69 *Ibid.*, p. 31.

70 Wynsberghe, A., *op. cit.*, note 45, p. 215.

71 *Ibid.*, p. 216.

consumption. Carbon emissions in the digital sector should be reduced. There is massive infrastructure behind AI systems. We cannot think of something happening in clouds or abstract. Exchanging views and best practices among stakeholders is crucial.[72]

Wynsberghe offers two tools to monitor energy consumption and carbon dioxide emissions of AI systems: "Carbontracker" and "Machine Learning Emissions Calculator". Another interesting proposal comes from Hacker that recommends including the sustainability by design concept to incorporate environmental consideration into the design and implementation of AI.[73] The AI Act obliges high-risk systems to establish and implement a risk management system for the whole lifecycle of the system (art. 9). Perhaps, also non-risk systems should be included, as their emission is not related to the level of risk to health, safety, or fundamental rights.[74]

5. CONCLUSION

The paper aims to bridge the gap between AI and sustainability by exploring the concept of "Sustainable AI", which encompasses two pillars: AI for sustainability and sustainable AI. The objective is to understand the development of AI that aligns with sustainable development goals. To achieve this, it is crucial to grasp the fundamental concepts of AI systems and their definition, as well as to examine the potential pathways for realizing the sociological, ecological, and economic implications of these systems, all with the overarching goal of advancing sustainable development objectives. Additionally, the paper seeks to address the challenges associated with developing, deploying, and using AI in a sustainable manner, which is closely intertwined with upholding the highest ethical standards in the responsible utilization of AI systems. The aim is to harness and transform AI systems for beneficial and sustainable purposes.

Sustainable development entails balancing environmental, social, and economic dimensions. As legal philosopher Westerlund stated "unless law is made sustainable, it will protect unsustainable conducts",[75] indicating that the regulatory framework must not overlook the social, economic, and environmental aspects of sustainable development. Therefore, sustainability considerations should be inte-

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72 Kindylidi, I.; Cabral, T. S., *op. cit.*, note 55, p. 10.

73 Hacker, P., *op. cit.*, note 3, p. 22.

74 *Ibid.*, pp. 23–24.

75 Westerlund 2008, p. 54 in: Montini., M., *Designing Law for Sustainability*, in: Mauerhofer, V.; Rupo, D.; Tarquino, L. (eds.), Sustainability and Law, General and Specific Aspects, Springer, Cham, 2020, p. 40.

grated into the development of AI systems alongside accompanying regulations. The regulatory framework should be crafted to promote sustainability, as failure to do so may perpetuate economic unsustainability. The concept of regulation for sustainability can be reframed as AI for sustainability, aiming to encourage activities that do not harm ecosystems.

In addition to offering benefits, AI systems consume significant amounts of water and energy. Sustainable AI must be integrated into the design and monitoring of AI systems throughout their lifecycle. Although the AI Act mentions environmental considerations, sustainability issues should be more concretely integrated with stronger enforcement mechanisms. Encouraging and promoting codes of conduct and best practices will be essential. Furthermore, sharing and collecting necessary information will be crucial for the future, along with the development of interoperability standards. Collaboration among all stakeholders involved in the lifecycle of AI systems will be vital for achieving sustainable AI. Interdisciplinary research analyzing different aspects of sustainability should be encouraged.

REFERENCES

BOOKS AND ARTICLES

1. Kindylidi, I.; Cabral, T. S., *Sustainability of AI: The Case of Provision of Information to Consumers*, Sustainability, Vol. 13, 2021, pp. 1-14
2. Mauerhofer, V., *Sustainable Development Law in (Only) One World: Challenges and Perspectives for Governance and Governments*, in: Mauerhofer, V.; Rupo, D.; Tarquino, L. (eds.), Sustainability and Law, General and Specific Aspects, Springer, Cham, 2020, pp. 15-31
3. Medeot, T., *Artificial Intelligence and Sustainability: How AI can improve sustainable decision – making in modern organizations*, International Journal for Regional Development, Vol. IV, 2022, pp. 132-146
4. Montini., M., *Designing Law for Sustainability*, in: Mauerhofer, V.; Rupo, D.; Tarquino, L. (eds.), Sustainability and Law, General and Specific Aspects, Springer, Cham, 2020, pp. 33-48
5. Nishant, R.; Kennedy, M., Corbett, J., *Artificial Intelligence for sustainability: Challenges, opportunities, and research agenda*, International Journal of Information Management, Vol. 53, 2020, pp. 1-6
6. Nowag, J., *Environmental Integration in Competition and Free-Movement Laws*, Oxford University Press, Oxford, 2016
7. Russel, S. J.; Norvig, P., *Artificial Intelligence: A Modern Approach*, 4th Ed., Pearson, 2022
8. Schwalb, K., *The Fourth Industrial Revolution*, World Economic Forum, Cologny/Geneva, 2016

9. Verschuuren, J., *The growing significance of the principle of sustainable development as a legal norm,* in: Fisher, D. (ed.), Research Handbook on Fundamental Concepts of Environmental Law, Cheltenham, UK - Northhampton, MA, USA, Edward Elgar Publishing, 2016
10. Vinuesa, R., *et al., The role of artificial intelligence in achieving the Sustainable Development Goals*, Nature Communications, Vol. 11, 2020, pp. 1-10
11. Wilson, C.; van der Velden, M., *Sustainable AI: An integrated model to guide public sector decision-making*, Technology in Society, Vol. 68, 2022, pp. 1-11
12. Wynsberghe, A., *Sustainable AI: AI for sustainability and the sustainability of AI*, AI and Ethics, Vol. 1, 2021, pp. 213-218

EU LAW

1. Charter of Fundamental Rights of the EU, OJ C 202, 7. 6. 2016
2. Treaty on the Functioning of the European Union (consolidated version 2016), OJ C 202, 7. 6. 2016
3. Treaty on European Union, (consolidated version 2016), OJ C 202, 7. 6. 2016
4. European Parliament legislative resolution of 13 March 2024 on the proposal for a regulation of the European Parliament and of the Council on laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union Legislative Acts (COM(2021)0206 – C9-0146/2021 – 2021/0106(COD))

WEBSITE REFERENCES

1. Chouinard, Y.; Ellison, J.; Ridgeway, R., *The Sustainable Economy*, Harvard Business Review, October 2011, [https://hbr.org/2011/10/the-sustainable-economy], Accessed 1 June 2022
2. Hacker, P., *Sustainable AI Regulation,* (June 1, 2023), [https://ssrn.com/abstract=4467684 or http://dx.doi.org/10.2139/ssrn.4467684], Accessed 20 February 2024
3. Mazzucato, M., *et al., Governing artificial intelligence in the public interest*, UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2022-12), [https://www.ucl.ac.uk/bartlett/public-purpose/wp2022-12.], Accessed 2 February 2024
4. *The Staggering Ecological Impacts of Computation and the Cloud*, [https://thereader.mitpress.mit.edu/the-staggering-ecological-impacts-of-computation-and-the-cloud/], Accessed 20 February 2024

OTHER SOURCES

1. Brundtland Report (1987) Report of the World Commission on Environment and Development, Our Common Future, [https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf], Accessed 1 June 2023
2. Commission decision of 24. 1. 2024 establishing the European Artificial Intelligence Office, Brussels, 24. 1. 2024 C(2024) 390 final
3. Ecco-Innovation Observatory (2020) EIO Biennial Report 2020: Eco-Innovation and Digitalisation, Case studies, environmental and policy lessons from EU Member States for the EU Green Deal and the Circular Economy, [https://ec.europa.eu/environment/ecoap/sites/

default/files/eio5_eco-innovation_and_digitalisation_nov2020.pdf], Accessed 15 January 2024

4. European Commission (2018a) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, Artificial Intelligence for Europe, 25. 4. 2018 COM(2018) 237 final
5. European Commission (2018b) Commission Staff Working Document, Liability for emerging digital technologies, 25. 4. 2018 SWD(2018) 137 final
6. European Parliament (2019a) State of the art and future of artificial intelligence, [https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/631051/IPOL_BRI(2019)631051_EN.pdf], Accessed 29 February 2024
7. European Commission (2019a) Communication from the Commission to the European Parliament, the Council, the European Central Bank, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, Annual Sustainable Growth Strategy 2020, COM(2019) 650 final, Brussels, 17. 12. 2019
8. European Commission (2019b) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, The European Green Deal, COM(2019) 640 final, Brussels, 11. 12. 2019
9. European Commission, White Paper on Artificial Intelligence – A European approach to excellence and trust, COM(2020) 65 final, Brussels, 19. 2. 2020
10. European Commission (2020c) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A new Circular Economy Action Plan for a cleaner and more competitive Europe, COM(2020) 98 final, Brussels, 11. 3. 2020
11. European Commission (2020d) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, EU Biodiversity Strategy for 2030, Bringing nature back into our lives, COM(2020) 380 final, Brussels, 20. 5. 2020
12. European Commission (2020g) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Sustainable and Smart Mobility Strategy – putting European transport on track for the future, COM(2020) 789 final, Brussels, 9. 12. 2020
13. European Commission (2021a) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Building an economy that works for people: an action plan for the social economy, Luxembourg: Publications Office of the European Union
14. European Commission (2021d) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Pathway to a Healthy Planet for All, EU Action Plan: "Towards Zero Pollution for Air, Water and Soil", Brussels, COM(2021) 400 final, 12. 5. 2021

15. Independent High-Level Expert Group on Artificial Intelligence (HLEG): Ethics Guidelines for Trustworthy AI, [https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai], Accessed 17 January 2024
16. United Nations (2015) Transforming our world: the 2030 Agenda for Sustainable Development, Resolution adopted by the General Assembly on 25 September 2015, [A/RES/70/1 https://sdgs.un.org/2030agenda], Accessed 29 February 2024