Is the future of AI sustainable? A case study of the European Union

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Abstract

Purpose – The purpose of this paper is to raise awareness on the need for a more comprehensive approach on the interdependence between artificial intelligence (AI) and environmental sustainability. It provides an overview of existing sustainable AI policy initiatives at the national and regional level. More precisely, it discusses whether existing European Union (EU) environmental policies are suitable for the AI era or whether new regulations are needed in this field. Finally, this paper assesses cross-fertilisation opportunities between the EU and non-EU countries.

Design/methodology/approach – This study is based on a qualitative analysis of sustainable applications of AI and the sustainability of AI. Emphasis is laid on the latter, and a "sustainable by design" approach is proposed, which in essence is a prerequisite for transparent, responsible and human-centred AI systems. The analysis primarily focuses on environmental sustainability.

Findings – The majority of studies focus on how to use AI to protect the environment with very little attention paid to sustainable design of AI. On the other hand, the EU's comprehensive approach towards sustainable AI is closest to promoting "sustainable by design" AI. Several ways have been identified in which the EU's actions can be translated beyond its borders.

Research limitations/implications – One of the largest limitations of this study is its moderate scope. This paper is confined to the EU and as such provides a limited assessment of global policies and measures on the interplay between sustainability and AI. Consequently, the paper did not provide an in-depth analysis of environmental policies worldwide that could help provide a better picture of possible cooperation areas or common grounds. Another limitation of this study is that it primarily focuses on environmental aspects and as such accords little attention to the economic and social pillars of sustainability.

Social implications – With less than 10 years to go before reaching the sustainable development goal deadline, this study can help stakeholders better understand what is being done worldwide in terms of sustainable AI. Moreover, given that the technology is still in its early phase, this study can inspire a "sustainable by design" approach to the development of AI technologies.

Originality/value – All national AI strategies published by 1 June 2021 were analysed to identify whether and to what extent they prioritise the interplay between environment and AI. Furthermore, the authors also looked at the EU policy and how it aims to address AI from a sustainable perspective.

Keywords Artificial intelligence (AI), EU, Sustainability, Environmental policy, Green deal, Circular economy, National strategies

Paper type Research paper

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1. Introduction

In a few years' time, artificial intelligence (AI) has revolutionised a range of industries, and, although recent studies indicate no increase in AI adoption (McKinsey, 2020), it continues to make headlines across the world. Academic institutions, the private sector and also governments worldwide have begun to weigh the pros and cons of the latest technological advancements. While attention has, so far, been paid to the development and use of AI in the domain of health care, the future of work and defence, to name a few, the interplay between intelligent systems and sustainability is gaining traction. From a practical standpoint, it can serve as an enabler and transformational agent of sustainable development, be it in the context of a circular economy or smart cities. At the same time, sustainable AI can be an end in itself.

However, the vast majority of academic articles and policy documents alike fail to give notice to the profound environmental impact of AI. The very design and development of AI solutions are environmentally unsustainable.

This paper, therefore, aims to shed light on how policy documents address the issue of AI sustainability. It will provide an overview of the current governance of AI, placing emphasis on the growing number of national AI initiatives and their review of the sustainability issue. The paper will then focus on the role of the European Union (EU) in the field of AI sustainability as the EU is one of the actors that has been positioning itself in this area. Its overall AI agenda makes reference to sustainability issues, whereas its Green Deal expresses commitment to exploring the impact of emerging technologies on the environment (European Commission, 2019a, p. 9). Lastly, the paper will discuss the possibilities of cross-fertilisation and cooperation between the EU and other state and international actors on the sustainability of AI.

The following study will address both the sustainable applications of AI, i.e. AI as an enabler of environmental sustainability, and the sustainability of AI. However, we lay emphasis on the latter and propose the "sustainable by design" approach, which in essence is a prerequisite for transparent, responsible and human-centred AI systems. Furthermore, while sustainability is a broad concept and encompasses social, economic and environmental domain, our analysis will primarily focus on environmental sustainability.

This paper will be based on a qualitative study of sustainable AI as well as sustainable applications of AI technologies. A qualitative overview of national EU policies and actions on AI will also be presented. To that end, primary sources, namely, official government and EU documents, will be examined. Particular attention will be paid to national and EU AI strategies. Strategies provide an excellent starting point for insights on the interplay between AI and sustainability, and offer details on specific objectives and planned activities to move the needle on sustainable AI development and implementation. The study includes all official national AI strategies published until 1 June 2021, by looking into AI policy repositories such as the Future of Life Institute's repository of national and international AI strategies as well as the OECD AI Policy Observatory. This, to the best of the authors' knowledge, amounts to a total of 38 national AI strategies. The study does not take into consideration other national AI policies, programmes and initiatives.

The study will also examine qualitative secondary sources, including scientific articles and working papers from prominent authors as well as newspaper articles for a better showcasing of latest trends and developments in the domain.

2. Concepts

As a scientific discipline, AI first appeared in 1956 at the Dartmouth workshop organised by an American mathematician John McCarthy. To this day, no universally accepted definition

of this general-purpose technology has been agreed upon, thus making its regulation difficult. A wide variety of definitions, at times, also consider AI in terms of mechanical replication, non-naturally occurring systems or a process of simulation (Grewal, 2014).

The absence of a commonly agreed definition has not prevented scientists from distinguishing between narrow, general and super AI. Narrow AI encompasses algorithms that specialise in a single task such as image recognition and chatbots. This type of technology is already in widespread use. General AI could potentially mimic human behaviour, including understanding, learning, thinking and ultimately performing human-like tasks, while the super AI is expected to exceed human cognitive capacities.

The concept of sustainability is better defined. In the contemporary day and age, it first gained traction in the 1987 Brundtland Report – "Our Common Future" (World Commission on Environment and Development, 1987). The study defined sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). Unlike AI, this definition of sustainability is widely accepted.

As of the late 1980s, the concern for sustainability issues such as climate change and environmental degradation continued to increase. The culmination was the Earth Summit held in Rio de Janeiro in 1992 that led to the establishment of the United Nations Framework Convention on Climate Change (UNFCCC), but also to the signing of the Convention on Biological Diversity. The summit also resulted in the adoption of Agenda 21 that endorses a global partnership for sustainable development (United Nations Conference on Environment and Development, 1992).

While this paper will mostly consider the environmental interpretation of sustainability, over the years, the term was expanded to other pressing socio-economic matters. To illustrate, the UN Millenium Declaration endorsed the notion of sustainability in terms of natural resources, but also global challenges such as poverty and hunger. Building on these efforts, the report from the 2002 World Summit on Sustainable Development highlighted the importance of three pillars of sustainable development: environmental, economic and social (World Summit on Sustainable Development, 2002). This expanded interpretation of sustainability received further impetus with the adoption of the 2030 Agenda for Sustainable Development.

The reason why this paper focuses on the environmental facet of sustainability is because AI is more often covered from the economic and social angle, including the impact of AI on the global economy, automation of work as well as threats posed by intelligent technologies to human rights. In addition, the vast majority of policy documents, including the national AI strategies, discuss the issue of sustainability from the economic and societal angle, thus failing to address the environmental implications of the emerging technology. While the aforementioned topics certainly merit attention, according to the Global Risks Report 2021, "climate action failure and other environmental risks" (World Economic Forum, 2021, p. 7) feature amongst the highest risks for the next decade. As such, it is worth exploring how AI technologies can help address environmental challenges and promote sustainable practices.

2.1 Dual relationship between artificial intelligence and sustainability

Researchers have only recently started exploring how new technologies such as AI could be used to advance sustainable development. One result of this line of work is the emergence of sustainable AI defined by van Wynsberghe as "a movement to foster change in the entire lifecycle of AI products (i.e. idea generation, training, re-tuning, implementation, governance) towards greater ecological integrity and social justice" (van Wynsberghe, 2021).

The relationship between AI and sustainability is twofold. On the one hand, AI can act as an enabler of sustainable development by, for instance, increasing awareness of climate change and reducing its adverse impact. This is what van Wynsberghe (2021) refers to as AI for sustainability.

In discussions on the role of AI in accelerating sustainability, one ought to take into consideration not only the latter stage, where already developed technologies are used in improving environmental sustainability, but also the process of how these technologies came into existence. Van Wynsberghe (2021) calls this second aspect the sustainability of AI. In this paper, however, we prefer to use the term "sustainability by design" given that, like "privacy by design" or "responsibility by design", it implies the integration of sustainability principles in the development of AI technologies.

2.2 Artificial intelligence as an enabler of environmental sustainability

Research on sustainable application of AI models focuses mainly on the role of intelligent technologies in implementing the 2030 Agenda for Sustainable Development (Pedemonte, 2020). With less than ten years left to achieve the sustainable development goals (SDGs), AI-based solutions have indeed great potential to accelerate the realisation of 17 goals. In fact, a study conducted by Vinuesa *et al.* (2020) shows that AI can enable the realisation of 79% of targets across all SDGs. More particularly, in the case of environmental goals (SDGs 13, 14 and 15), the authors note that AI can act as an enabler for 92% of targets (Vinuesa *et al.*, 2020).

Applications of AI to advance sustainability are versatile. They range from natural language processing and image recognition to data analytics and pattern recognition (Sharma *et al.*, 2020). For instance, AI algorithms could be used to identify endangered species by gathering and analysing data such as animal footprints. AI can also be used to advance "smart energy solutions" (Sokołowski, 2020) that optimise energy consumption and manage energy inefficiencies. For example, in respect to electricity systems, AI tools can be used to anticipate the evolution of electricity prices on the grounds of electricity supply and demand projections and thus help facilitate electricity trade in real time (Niet *et al.*, 2021). Studies also indicate that AI technologies and robots will increasingly be deployed to maintain and manage energy plants (Chawla *et al.*, 2022). In the context of the circular economy, AI could help design and sustain circular products by, for instance, increasing the usability of electronics through predictive maintenance or ensuring better e-waste management with the help of image recognition. There are many other possible sustainable applications of AI, including land-use planning, forecasting of environmental risks, waste management as well as geoscience (Sharma *et al.*, 2020).

While AI can serve as a transformational agent of sustainability, the technology itself is far from sustainable. Data suggests that the training of a single AI model emits roughly 626,000 pounds of CO_2 that equates to lifetime emissions of five American cars (Hao, 2019). Similarly, the training of Google's chatbot Meena is said to have consumed around 96 metric tons of carbon dioxide, which is equivalent to powering more than 17 homes for a year (Khan, 2021). Much of the CO_2 consumption is attributed to data centres that store data ultimately fed into AI. At present, such centres account for 2% of global electricity use (Elegant, 2019) and forecasts show that by 2030, over 6% of global energy will be consumed by data centres (Dickson, 2020). The environmental implications of AI are therefore far from negligible. Other examples of unsustainable AI include unintended consequences of seemingly sustainable application of this technology (McClelland, 2020). For instance, an AI model can be focused on a single metric such as CO_2, but ignore or even aggravate other environmental risks such as ocean plastic (McClelland, 2020).

As the demand for AI continues to increase, the environmental consequences are equally bound to amplify. It is therefore essential to address such implications in a timely manner to ensure that sustainability by design becomes one of the key drivers of AI development.

3. Governance of sustainable artificial intelligence

Realising the transformative potential of AI, governments and international bodies have released principles or established projects that should guide the development and implementation of AI. In theory, the objective of these different AI governance initiatives is to "provide regulations and standards and represent the goals and expectations of society based on human values, ethics and social norms" (Wirtz *et al.*, 2020, p. 2). The ITU, for instance, has established a focus group on environmental efficiency aimed at working on technical reports and standardisation to develop a sustainable approach to AI (International Telecommunication Union, 2019, p. 29).

The OECD Council Recommendation on Artificial Intelligence, adopted in May 2019, identifies key principles for responsible stewardship of trustworthy AI that should be implemented by all stakeholders. These include, among others, the principle of inclusive growth, sustainable development and well-being, stipulating that "stakeholders should proactively engage [...] in pursuit of [...] sustainable development and well-being" (Organisation for Economic Co-operation and Development, 2019). However, the recommendation fails to address the sustainable design of AI models.

A surge in national AI initiatives has also swept the globe. In early 2017, Canada was the first country in the world to publicise an AI strategy. In the coming months, only a handful of nations, mainly the most technologically advanced countries such as China, United Arab Emirates, France and Germany drafted their national AI strategies. The vast majority of national initiatives came in between 2018 and 2020, with the rise in academic (Perrault *et al.*, 2019) and newspaper (Sun *et al.*, 2020) articles tackling AI-related challenges and opportunities.

The strategies approach the issue of sustainability from two angles. They address, in van Wynsberghe's (2021) words, the significance of AI for sustainability, as well as the sustainability of AI. These two aspects of the intersection of AI and sustainability through the lens of national AI strategies will be addressed in greater detail below.

The documents focus primarily on the social and economic domains of sustainability. Luxembourg, for instance, lays emphasis on international and regional cooperation and knowledge sharing on AI-solutions that will ultimately contribute to the eradication of extreme poverty and promote sustainability (The Government of the Grand Duchy of Luxembourg, 2019). Second, AI is considered to play a major role in increasing economic productivity. India's strategy stresses the paramount role of AI in helping solve pressing issues across agriculture value chains and increasing agricultural productivity globally (NITI Aayog, 2018).

In contrast, while the majority of countries recognise the significance of AI to the environment, only a few go beyond the well-known statement that AI has the potential to help solve ecological challenges. Several countries, such as Hungary (Ministry for Innovation and Technology, 2020) and Germany (The Federal Government, 2018) briefly refer to the role of AI in mitigating the negative impacts of climate change. Others were more specific in assessing the role of AI in tackling ecological problems. The USA, for instance, aims to improve predictions of hurricanes and severe storms by increasing investments in AI research and development, as well as data and computing infrastructure (The White House, 2019). The Chinese strategy calls for the setting up of "intelligent

monitoring of large data platforms and systems covering the atmosphere, water, soil, and other environmental areas" (Chinese State Council, 2017, p. 20).

In spite of some of the above-mentioned intentions to use AI to pursue environmental objectives, only a couple of countries acknowledge the environment as one of their priority areas. To this end, Egypt designates agriculture, environment and water management as priority areas (Ministry of Communications and Information Technology, 2019) whilst Qatar sees the environment as one of the four main pillars, along with human, social and economic (Qatar Center for Artificial Intelligence, 2020). France, conversely, devotes an entire part of its strategy to the relationship between AI and the environment and highlights its intent to develop natively ecological AI (Villani, 2018).

Government initiatives define sustainable AI as analogous to responsible AI built on ethical foundations. To this end, the Swedish and Lithuanian strategies call for common rules, standards and ethical principles to guide development of ethical and sustainable AI (Ministry of Enterprise and Innovation, 2019; Ministry of the Economy and Innovation, 2019). Estonia, on the other hand, underscores the technical dimension of sustainability, "making technical requirements for sustainability a condition for funding the development of AI solutions" (Ministry of Economic Affairs and Communications, 2019, p. 5). Only a few countries such as Japan recognise the need for using big data in an environmentally friendly manner, pointing to the necessity of environmental maintenance of data owned by industry, academia and government (Strategic Council for AI Technology, 2017).

However, with the exception of France and Japan, almost no strategy recognises that the development of sustainable AI solutions are only feasible if those solutions are sustainable by design, i.e. developed in a manner that mitigates the environmental costs related to the development and application of AI technologies.

4. European Union: the actor of sustainability

The EU's commitment to sustainable development is longstanding. Its sustainability journey began with policies on environmental issues. Following the 1972 Earth Summit in Stockholm, the European Council that same year called for "the need for a community environment policy" (European Parliament, 2021). In 1987, the Single European Act took strides towards the first common European environmental policy with the intention to preserve the quality of the environment, protect human health and ensure the rational use of natural resources (European Parliament, 2021). Environmental issues were officially integrated as a policy priority in the 1993 Treaty of Maastricht that called for the "sustainable and non-inflationary growth respecting the environment" (European Union, 2012a, p. 11).

Several years later, the Treaty of Amsterdam introduced environmental protection requirements into the definition and implementation of other community policies (Farmer, 2012). As a result, today, the EU's environmental policy covers issues pertaining to air quality, sustainable energy, water pollution and waste management, to name a few. This merging was further strengthened by the Treaty on the Functioning of the European Union, which noted that environmental protection requirements must be integrated into the definition and implementation of the Union's policies and activities (European Union, 2012b).

In addition to approaching sustainability issues from an environmental prism, the EU also has a dedicated sustainable development strategy (SDS). Adopted for the first time in 2001 (European Commission, 2001), reviewed in 2006 (Council of the European Union, 2006) and 2009 (European Commission, 2009), it provides a "framework for a long-term vision of sustainability in which economic growth, social cohesion and environmental protection go

hand in hand and are mutually supporting" (European Commission, 2009, p. 2). The SDS was further enhanced in 2016, with the adoption of the "Next steps for a sustainable European future – European action for sustainability" that highlights the EU's commitment to the 2030 agenda and that drafts out the steps the EU intends to take to achieve the 17 SDGs (European Commission, 2016).

In spite of being relatively comprehensive, it is important to note that the previous EU environmental and sustainability frameworks paid little attention to digital transformation. This, however, does not mean that they are inadequate for the digital age.

Considering that the majority of European initiatives on sustainability and AI are fairly new, the next few lines will specifically address the emergence of the combined approaches.

In 2019, the EU Commission issued the "European Green Deal" that features as an indispensable element for the EU's approach to the 2030 Agenda. From a digital perspective, the Green Deal highlights the Commission's ambition to identify practices on how emerging technologies such as AI could "accelerate and maximise the impact of policies to deal with climate change and protect the environment" (European Commission, 2019a, p. 9). Going a step further, the EU Parliament published a study that specifically explores the role of AI in the Green Deal (Gailhofer *et al.*, 2021). The document is particularly important because it discusses digital EU programmes and policies that contribute to a sustainable economy, including, the European Data Strategy (Gailhofer *et al.*, 2021). As a crucial element to AI, the Data Strategy intends to establish a single European data space that does not harm the environment (Gailhofer *et al.*, 2021). The study also sheds light on international cooperation, noting that there are very few global AI initiatives that focus on the environmental aspect (Gailhofer *et al.*, 2021). Among other things, it recommends that the EU takes the lead to ensure that such factors are included, and calls on the Union to provide assistance to developing countries that lack capacity in the domain (Gailhofer *et al.*, 2021).

Similar commitments and objectives are set out in the EU AI strategic documents, including "Artificial Intelligence for Europe" that stipulates that the EU's sustainable approach to AI could provide the organisation with a competitive edge (European Commission, 2018). Along these lines, it confirms the EU's commitment to:

> Promote the use of AI, and technologies in general, to help solve global challenges, support the implementation of the Paris Climate agreement and achieve the United Nations Sustainable Development Goals (European Commission, 2018, p. 18).

To improve existing policies and support the realisation of the global energy and climate goals, it is also important to constantly monitor and learn from energy policy failures (Sokołowski and Heffron, 2022).

The "Ethics Guidelines for Trustworthy AI" also do not fail to mention sustainable AI. In line with the EU AI principles of fairness and prevention of harm, the Guidelines encourage the "sustainability and ecological responsibility of AI systems" (European Commission, 2019b, p. 19), promote the use and development of environmentally friendly and sustainable algorithms and highlight that AI technologies have great potential to contribute to the achievement of SDGs (European Commission, 2019b).

In April of this year, the European Commission issued a proposal for the so-called "Artificial Intelligence Act" where it particularly stresses that the right to a high level of environmental protection should be taken into consideration when examining the potential of AI systems to cause harm to human health and safety (European Commission, 2021b). The recommendations also encourage providers of non-high-risk systems to adopt measures for the development and use of AI that would ensure compliance with environmental sustainability (European Commission, 2021b).

From policy to practice, recently, a climate-neutral data centre pact endorsed by Europe's largest data centre operators has been signed ahead of the announcement by EU officials to adopt data centre sustainability laws (Sverdlik, 2021). Under the pact, operators have agreed to make data centres climate-neutral by 2030. Moreover, they committed to the objectives of the European Green Deal, i.e. using technology and digitalisation to make Europe climate-neutral by 2050 (Anonymous, 2020).

4.1 The way forward – the European Union to lead by example on artificial intelligence sustainability

The above analysis of the EU policies shows that sustainability and environmental protection are high on the EU agenda. Even though the EU policies on AI and sustainability are still in their infancy, they are timely considering that we are still at early stages of AI development. This proactive approach is in line with the EU agenda to regulate and advance "European solutions to digital problems" (Hobbs, 2020). In other words, by "leading by example", the EU attempts to incorporate its values and norms in the design and use of AI. On the other hand, efforts outside the Union remain rather shy and lack a comprehensive approach to the sustainability of AI. So, a question worth asking is the following:

Q1. How can the EU policies be replicated outside the Union?

Drawing from its experience with the general data protection regulation and as a major tech regulator, the EU can impose measures through its regulatory policies to ensure that AI solutions are "sustainable by design". More specifically, like the data regulation, EU AI regulations would also be applicable to non-EU companies operating in the EU.

The EU can also take advantage of its presence in international bodies such as the G20, the OECD and the UN, but also bilateralism to promote the sustainable development and use of AI. For instance, the European Commission holds annual ICT dialogues with external partners such as China and Japan (European Commission, 2021a), covering various digital policies on cybersecurity, privacy, digital economy as well as regulatory issues. Future dialogues could focus on the environmental impact of digital technologies, including AI.

The Union can also take advantage of existing partnerships on digital transformation with third parties such as the European Union-African Union Digital Economy Task Force to share knowledge, best practices and build capacity on sustainable AI of the private sector, civil society and other stakeholders.

Finally, and most importantly, the EU should develop a dedicated policy on AI sustainability analogous to other EU environmental policies such as the regulation on CO_2 emissions and passenger cars or the Ecodesign Directive, to ensure the sustainability of AI throughout its lifecycle.

5. Conclusion

This paper intended to shed light on sustainability issues pertaining to AI technologies. Our main takeaways are the following. Sustainable AI remains a relatively unexplored topic with the majority of studies focusing on how to use AI to protect the environment. A similar approach is taken by governmental and non-governmental actors when addressing the intersection between AI and sustainability. Therefore, researchers and policymakers alike should pay more attention to ways in which the design of AI models could be more sustainable.

However, although in its infancy, the EU's approach towards sustainable AI can be regarded as the most comprehensive, defining priorities and focus areas in documents such as the European Green Deal and the Proposal for Harmonised Rules on AI. The EU's

approach is, therefore, closest to promoting "sustainable by design" AI. Finally, we have identified several ways in which the EU's actions can be translated beyond its borders.

One of the largest limitations of this study is its moderate scope. This paper is confined to the EU and as such provides a limited assessment of global policies and measures on the interplay between sustainability and AI. Consequently, the paper did not provide an in-depth analysis of environmental policies worldwide that could help provide a better picture of possible cooperation areas or common grounds. Another limitation of this study is that it primarily focuses on environmental aspects and as such accords little attention to the economic and social pillars of sustainability. That said, we have attempted to set the stage with a broad overview of the matter. The topic of this paper certainly merits more attention and we hope that this study will serve as a starting point for other researchers that could help us better understand developments in this area.

References

Anonymous (2020), "Climate neutral data centre pact", available at: www.climateneutraldatacentre.net/ (accessed 25 June 2021).

Chawla, Y., Shimpo, F. and Sokolowski, M.M. (2022), "Artificial intelligence and information management in the energy transition of India: lessons from the global IT heart", *Digital Policy, Regulation and Governance*, Vol. 24 No. 1, pp. 17-29.

Chinese State Council (2017), "A next generation artificial intelligence development plan", available at: https://na-production.s3.amazonaws.com/documents/translation-fulltext-8.1.17.pdf (accessed 25 June 2021).

Council of the European Union (2006), "Review of the EU sustainable development strategy (EU SDS)", available at: https://data.consilium.europa.eu/doc/document/ST-10117-2006-INIT/en/pdf (accessed 25 June 2021).

Dickson, B. (2020), "AI could save the world, if it doesn't ruin the environment first", available at: https://uk.pcmag.com/artificial-intelligence-2/125690/ai-could-save-the-world-if-it-doesnt-ruin-the-environment-first (accessed 18 February 2022).

Elegant, N. (2019), "The internet cloud has a dirty secret", available at: https://fortune.com/2019/09/18/internet-cloud-server-data-center-energy-consumption-renewable-coal/ (accessed 11 June 2022).

European Commission (2001), "A sustainable Europe for a better world: a European union strategy for sustainable development", available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52001DC0264&from=EN (accessed 11 June 2022).

European Commission (2009), "Mainstreaming sustainable development into EU policies: 2009 review of the European Union strategy for sustainable development", available at: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0400:FIN:EN:PDF (accessed 25 June 2021).

European Commission (2016), "Next steps for a sustainable European future – European action for sustainability", available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0739&from=EN (accessed 25 June 2021).

European Commission (2018), "Artificial intelligence for Europe", available at: https://digital-strategy.ec.europa.eu/en/library/communication-artificial-intelligence-europe (accessed 25 June 2021).

European Commission (2019a), "The European green deal", available at: https://ec.europa.eu/info/sites/default/files/european-green-deal-communication_en.pdf (accessed 25 June 2021).

European Commission (2019b), "Ethics guidelines for trustworthy AI", Technical report, High-Level Expert Group on AI, available at: https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai (accessed 25 June 2021).

European Commission (2021a), "Resources: EU digital dialogues with partners around the world", available at: https://ec.europa.eu/digital-single-market/en/resources-eu-digital-dialogues-partners-around-world (accessed 25 June 2021).

European Commission (2021b), "Laying down harmonised rules on artificial intelligence (artificial intelligence act) and amending certain union legislative acts", available at: https://eur-lex.europa.eu/resource.html?uri=cellar:e0649735-a372-11eb-9585-01aa75ed71a1.0001.02/DOC_1&format=PDF (accessed 25 June 2021).

European Parliament (2021), "Environment policy: general principles and basic framework", available at: https://www.europarl.europa.eu/factsheets/en/sheet/71/environment-policy-general-principles-and-basic-framework (accessed 25 June 2021).

European Union (2012a), "Consolidated version of the treaty on European Union", available at: https://eur-lex.europa.eu/resource.html?uri=cellar:2bf140bf-a3f8-4ab2-b506-fd71826e6da6.0023.02/DOC_1&format=PDF (accessed 25 June 2021).

European Union (2012b), "Consolidated version of the treaty on the functioning of the European Union", available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012E/TXT&from=EN (accessed 25 June 2021).

Farmer, A.M. (Ed.) (2012), *Manual of European Environmental Policy*, Routledge, London, available at: https://ieep.eu/uploads/articles/attachments/74389e41-868c-4906-9bdc-3f04addd0bf0/1.5_Environment_in_the_treaties_-_final.pdf?v=63664509873 (accessed 25 June 2021).

Gailhofer, P., Herold, A., Schemmel, J. P., Scherf, C., Urrutia, C., Köhler, A, R. and Braungardt, S. (2021), "The role of artificial intelligence in the European green deal", Policy Department for Economic, Scientific and Quality of Life Policies Directorate-General for Internal Policies, available at: www.europarl.europa.eu/RegData/etudes/STUD/2021/662906/IPOL_STU(2021)662906_EN.pdf (accessed 25 June 2021).

Grewal, D. (2014), "A critical conceptual analysis of definitions of artificial intelligence as applicable to computer engineering", *IOSR Journal of Computer Engineering*, Vol. 16 No. 2, pp. 9-13, doi: 10.9790/0661-16210913.

Hao, K. (2019), "Training a single AI model can emit as much carbon as five cars in their lifetimes", available at: www.technologyreview.com/2019/06/06/239031/training-a-single-ai-model-can-emit-as-much-carbon-as-five-cars-in-their-lifetimes/ (accessed 11 June 2022).

Hobbs, C. (2020), "The EU as a digital regulatory superpower: implications for the United States", available at: https://ecfr.eu/article/commentary_the_eu_as_a_digital_regulatory_superpower_implications_for_the_u/ (accessed 25 June 2021).

International Telecommunication Union (2019), "Turning digital technology innovation into climate action", available at: www.uncclearn.org/wp-content/uploads/library/19-00405e-turning-digital-technology-innovation.pdf (accessed 25 June 2021).

Khan, J. (2021), "A.I.'s carbon footprint is big, but easy to reduce, Google researchers say", available at: https://fortune.com/2021/04/21/ai-carbon-footprint-reduce-environmental-impact-of-tech-google-research-study/ (accessed 18 February 2022).

McClelland, J. (2020), "Are AI and sustainability the perfect match?", available at: www.raconteur.net/sustainability/ai-sustainability-for-against/ (accessed 18 February 2022).

McKinsey, (2020), "The state of AI in 2020", available at: www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/global-survey-the-state-of-ai-in-2020# (accessed 25 June 2021).

Ministry for Innovation and Technology (2020), "'Hungary's Artificial Intelligence Strategy 2020 – 2030", available at: https://ai-hungary.com/files/e8/dd/e8dd79bd380a40c9890dd2fb01dd771b.pdf (accessed 11 June 2022).

Ministry of Communications and Information Technology (2019), "National artificial intelligence strategy", available at: https://mcit.gov.eg/en/Artificial_Intelligence (accessed 25 June 2021).

Ministry of Economic Affairs and Communications (2019), "National artificial intelligence strategy for 2019-2021", available at: https://e-estonia.com/estonia-accelerates-artificial-intelligence/ (accessed 25 June 2021).

Ministry of Enterprise and Innovation (2019), "National approach to artificial intelligence", available at: www.government.se/4a7451/contentassets/fe2ba005fb49433587574c513a837fac/national-approach-to-artificial-intelligence.pdf (accessed 11 June 2022).

Ministry of the Economy and Innovation (2019), "Lithuanian artificial intelligence strategy", available at: www.government.se/4a7451/contentassets/fe2ba005fb49433587574c513a837fac/national-approach-to-artificial-intelligence.pdf (accessed 25 June 2021).

Niet, I., van Est, R. and Veraart, F. (2021), "Governing AI in electricity systems: reflections on the EU artificial intelligence bill", *Frontiers in Artificial Intelligence*, Vol. 4, pp. 1-7, doi: 10.3389/frai.2021.690237.

NITI Aayog (2018), "National strategy for artificial intelligence: #AI for all", available at: https://niti.gov.in/national-strategy-artificial-intelligence (accessed 25 June 2021).

Organisation for Economic Co-operation and Development (2019), "Recommendation of the council on artificial intelligence", available at: https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449 (accessed 25 June 2021).

Pedemonte, V. (2020), "AI for sustainability: an overview of AI and the SDGs to contribute to the European policy-making", available at: https://ec.europa.eu/futurium/en/system/files/ged/vincent-pedemonte_ai-for-sustainability_0.pdf (accessed 25 June 2021).

Perrault, R., Shoham, Y., Brynjolfsson, E., Clark, J., Etchemendy, J., Grosz, B., Lyons, T., Manyika, J. and Niebles, J.C. (2019), "Artificial intelligence index report 2019", Stanford University, available at: https://hai.stanford.edu/sites/default/files/ai_index_2019_report.pdf (accessed 25 June 2021).

Qatar Center for Artificial Intelligence (2020), "Blueprint: national artificial intelligence strategy for Qatar", available at: www.motc.gov.qa/sites/default/files/national_ai_strategy_-_english_0.pdf (accessed 25 June 2021).

Sharma, G.D., Yadav, A. and Chopra, R. (2020), "Artificial intelligence and effective governance: a review, critique and research agenda", *Sustainable Futures*, Vol. 2, doi: 10.1016/j.sftr.2019.100004.

Sokołowski, M.M. (2020), *European Law on Combined Heat and Power*, Routledge, New York, NY.

Sokołowski, M.M. and Heffron, R.J. (2022), "Defining and conceptualising energy policy failure: the when, where, why, and how", *Energy Policy*, Vol. 161, doi: 10.1016/j.enpol.2021.112745.

Strategic Council for AI technology (2017), "Artificial intelligence technology strategy", available at: https://ai-japan.s3-ap-northeast-1.amazonaws.com/7116/0377/5269/Artificial_Intelligence_Technology_StrategyMarch2017.pdf (accessed 25 June 2021).

Sun, S., Zhai, Y., Shen, B. and Chen, Y. (2020), "Newspaper coverage of artificial intelligence: a perspective of emerging technologies", *Telematics and Informatics*, Vol. 53, doi: 10.1016/j.tele.2020.101433.

Sverdlik, Y. (2021), "Preempting regulation, EU operators strike green data center pact", available at: www.datacenterknowledge.com/energy/preempting-regulation-eu-operators-strike-green-data-center-pact (accessed 25 June 2021).

The Federal Government (2018), "Federal government's artificial intelligence strategy", available at: https://knowledge4policy.ec.europa.eu/publication/germany-artificial-intelligence-strategy_en (accessed 25 June 2021).

The Government of the Grand Duchy of Luxembourg (2019), "Artificial intelligence: a strategic vision for Luxembourg", available at: https://gouvernement.lu/en/publications/rapport-etude-analyse/minist-digitalisation/artificial-intelligence/artificial-intelligence.html (accessed 25 June 2021).

The White House (2019), "American AI initiative", available at: https://trumpwhitehouse.archives.gov/ai/ai-american-innovation/ (accessed 25 June 2021).

United Nations Conference on Environment and Development (1992), "Agenda 21", available at: https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf (accessed 25 June 2021).

Van Wynsberghe, A. (2021), "Sustainable AI: AI for sustainability and the sustainability of AI", *AI and Ethics*, Vol. 1 No. 3, pp. 213-218, doi: 10.1007/s43681-021-00043-6.

Villani, C. (2018), "For a meaningful artificial intelligence: towards a French and European strategy", available at: www.aiforhumanity.fr/pdfs/MissionVillani_Report_ENG-VF.pdf (accessed 25 June 2021).

Vinuesa, R., Azizpour, H., Leite, I., Balaam M., Dignum, V., Domisch S., Felländer, A., Langhans, S.D., Tegmark, M. and Nerini, F.F. (2020), "The role of artificial intelligence in achieving the sustainable development goals", *Nature Communications*, Vol. 11 No. 1, doi: 10.1038/s41467-019-14108-y.

Wirtz, B., Weyerer, J.C. and Sturm, B.J. (2020), "The dark sides of artificial intelligence: an integrated AI governance framework for public administration", *International Journal of Public Administration*, Vol. 43 No. 9, pp. 1-12, doi: 10.1080/01900692.2020.1749851.

World Commission on Environment and Development (1987), "Our common future", available at: www.are.admin.ch/dam/are/en/dokumente/nachhaltige_entwicklung/dokumente/bericht/our_common_futurebrundtlandreport1987.pdf.download.pdf/our_common_futurebrundtlandreport1987.pdf (accessed 25 June 2021).

World Economic Forum (2021), "The global risks reports 2021", available at: www.weforum.org/reports/the-global-risks-report-2021 (accessed 3 November 2021).

World Summit on Sustainable Development (2002), "Report of the world summit on sustainable development", available at: https://digitallibrary.un.org/record/478154 (accessed 25 June 2021).

Further reading

Government Offices of Sweden (2019), "National approach to artificial intelligence", available at: www.government.se/4a7451/contentassets/fe2ba005fb49433587574c513a837fac/national-approach-to-artificial-intelligence.pdf (accessed 25 June 2021).

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