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Twin Transitions? Implementing Climate Policies in the European Union through Digital Transformation

OTTAVIO QUIRICO AND WALTER F. BABER

11.1 Introduction

'Digitalisation' is the process of running a company through procedures that take place in digital format.[1] It involves the 'digitisation' of data and is at the basis of 'digital transformation', that is, the progressive digitalisation of business, which is a major societal challenge in our times. Because of its manifold implications – for instance, as regards our capacity to make informed decisions – digitalisation has been associated with the green transition, along the lines of the ideas of 'digital sustainability' and the 'twin transitions'.[2]

While the green transition and digital transformation have been traditionally pursued as part of separate policy areas, the United Nations (UN) has long underscored the need for States to adopt technologies that enable environmental sustainability and low-emission pathways.[3] Along these lines, in 2014 Singapore launched the Smart Nation Vision, a holistic policy aiming to achieve, inter alia, climate sustainability.[4] The programme includes a high-speed broadband network, establishing sensors across the island for monitoring purposes and training public agents in data science. To this end, a special regulatory framework has also been established to foster investment outside existing regulations. Concretely, the State makes water usage data readily accessible to residents for easy management of water consumption,[5] a technique that is considered to have wide positive impacts on climate.[6] Advanced urban congestion pricing has also been combined with a global navigation satellite system, allowing constant monitoring of traffic flow and improvement of traffic conditions. Testing projects co-ordinated by different government agencies helping to assess charging technologies and cybersecurity eventually led to the extensive adoption of electric cars and buses.

Particularly since 2015, the EU has started to promote the implementation of a joint approach, underscoring the beneficial outcomes expected from a digital policy designed to

[1] M. E. Mondejar, R. Avtar, H. L. B. Diaz, et al., Digitalization to achieve sustainable development goals: steps towards a smart green planet. *Science of the Total Environment* 2021, 794: 1483539, at p. 2.
[2] Y. K. Dwivedi, L. Hughes, A. K. Kar, et al., Climate change and COP26: are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action. *International Journal of Information Management* 2022, 63: 102456, at p. 3.
[3] UNDP, Handbook for Technology Needs Assessment for Climate Change (UNDP, 2010), p. 4.
[4] SmartNation Singapore. www.smartnation.gov.sg.
[5] SmartNation Singapore, Smart water meter. www.smartnation.gov.sg/initiatives/urban-living/smartwatermeter.
[6] Dwivedi et al., Climate change and COP26, p. 4.

face environmental and climate issues. As pointed out by the Council of the EU in its conclusion on the Digitalisation for the Benefit of the Environment, information and communication technologies are fundamental tools for implementing environmental protection and tackling hazardous climate change. On this basis, the Council invited the Commission to adopt initiatives that aim at combining the European digital strategy with the objectives of the European Green Deal.[7] The benefits of a harmonised ('twin') strategy seem to be confirmed by pilot projects and studies highlighting how digital technologies and data analytics within residential buildings, in energy production processes as well as in the transport and agricultural sectors, can contribute to a significant reduction of greenhouse gas emissions.

Considering relevant cases, this chapter explores critically the potential of an integrated and co-ordinated approach between digitalisation and sustainability. First, the chapter illustrates the EU roadmap to make digitalisation and the green transition converge. Second, the chapter explores the pros and cons of the twin transitions. On the one hand, the chapter explores the role that diverse digital technologies can play in accelerating the transition towards a circular economy with net-zero emissions. This part of the research considers the possibility of exploiting digital technologies, such as artificial intelligence, the 'Internet of Things', and so-called 'big data', to achieve the sustainable development goals included in the UN's 2030 Agenda and, more specifically, the EU's binding goal of climate neutrality by 2050. On the other hand, the chapter considers the need to limit the adverse environmental effects deriving from the development and increased use of digital technologies. On this basis, the chapter develops several key suggestions for a better co-ordination of these twin transitions.

11.2 The European Union Roadmap to Digitalisation for Sustainability: A Holistic Approach

The EU has been particularly proactive in prompting the implementation of digital technologies for climate policies. In 2015, the European Commission adopted the Digital Single Market Strategy, which is one of the 10 political priorities of the Union.[8] The Strategy aims to join Member States' digital markets as one, complementing the monetary union and single market, and facilitating seamless access to digital services and the digital economy to bolster the free movement of capital, goods, services and persons. This is a cornerstone of sustainability, as an essential step to achieving climate neutrality by 2050.[9] Indeed, the Strategy is based on three pillars, encompassing: (1) access, (2) secure and trustworthy infrastructures, and (3) maximising the growth potential of the European digital economy.

[7] European Commission, European Green Deal, striving to be the first carbon-neutral continent. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal-en.

[8] European Commission, A Digital Single Market for Europe, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. 6.5.2015COM(2015) 192 final, p. 8.

[9] European Commission, A Europe fit for the digital age (2024). https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age_en.

The first pillar seeks to implement better access for consumers, including individuals and corporations, to digital services across Europe. This necessitates the harmonisation of regulation on matters such as copyright, non-discriminatory contracts, and value-added taxation *vis-à-vis* digital data consumers.[10] The second pillar aims at creating trustworthy digitalised networks and a level playing field for network operators, through regulation ensuring competitiveness and data privacy across the borders.[11] The third pillar fosters investment in information and communications technology (ICT) infrastructures and techniques, such as cloud computing and Big Data, and inclusiveness.[12] This third pillar in particular is underpinned by the idea of ensuring that European industries are at the forefront of industrial processes for a sustainable economy.[13]

Within this framework, the EU has adopted a variety of regulatory tools, whereby climate change and sustainability emerge as core objectives. In particular, in March 2021 the Commission adopted a Communication on the Digital Compass 2030,[14] which affirms the necessity of a sustainable and energy-efficient digital environment and EU leadership in evolving technologies such as 6G and quantum in the fight against climate change and environmental challenges.[15] Indeed, the Communication underscores the centrality of digitally enabled green solutions, including the institution of a European digital product passport to disseminate information on sustainable value chains and the necessity of massively investing in developing a digital technology industry in the EU.[16]

Along these lines, in 2020 the European Commission adopted a Communication on a new industrial strategy.[17] This instrument seeks to leverage the internal market to make the EU a leader in industrial value chains across the spectrum, whereby energy-intensive sectors have a key role to play in reducing the Union's carbon footprint. Such a transformation is underpinned by the enhancement of critical digital infrastructure, notably via the implementation of highly secured and state-of-the-art 5G and 6G networks.[18] More specifically, 'smart sector integration' and 'trans-European energy networks' emerge as core vehicles for achieving energy efficiency and creating new markets for climate neutral and circular products, such as steel and basic chemicals.[19] Digitalisation is therefore key to the aim of 'modernising and decarbonising energy-intensive industries' as 'a top priority', which necessitates 'novel industrial processes' as well as 'more clean technologies to reduce costs and improve market readiness'.[20] The EU Emissions Trading System Innovation Fund is thus envisaged as an instrument to deploy 'large-scale innovative projects', such as the Comprehensive Strategy for Sustainable and Smart Mobility, and for integrating 'clean products in all energy-intensive sectors'.[21]

On 23 February 2022, the Commission put forward a proposal for a Regulation on data, which is seen as 'a core component of the digital economy, and an essential resource to

[10] Ibid. at p. 4. [11] Ibid. at p. 9. [12] Ibid. at p. 13. [13] Ibid. at 14.
[14] European Commission, 2030 Digital Compass: The European Way for the Digital Decade, 9.3.2021 COM(2021) 118 final, Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.
[15] Ibid. at pp. 1, 3 and 19. [16] Ibid. at pp. 3–4.
[17] European Commission, A New Industrial Strategy for Europe, Communication to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, 10.3.2020, COM(2020) 102 final.
[18] Ibid. at p. 4. [19] Ibid. at p. 8. [20] Ibid. at p. 7. [21] Ibid. at p. 8.

secure the green and digital transitions'.[22] Grounded in article 114 of the Treaty on the Functioning of the European Union (TFEU), which allows the approximation of rules for the establishment and functioning of the internal market, the regulation aims to allow 'a greater and fairer flow of data in all sectors', spanning business-to-business, business-to-government, government-to-business and government-to-government interaction.[23] The Regulation thus provides an obligation for the producer to make available to the consumer and, upon request, to third parties, data related to a product in business-to-business and business-to-consumer relations (chapter II). Similarly, in case of need, a data holder must make available data to public institutions, for instance, when necessary to respond to emergency situations or for the fulfilment of public tasks (chapter III). For the purposes of ensuring competitiveness and flexibility, chapter VI establishes rights such as the possibility of terminating a data-processing service contractual agreement, after a maximum notice period of 30 calendar days. To ensure interoperability, chapter VIII establishes that operators of data-processing spaces ensure that data set content, use restrictions, licences, data collection methodology, data quality and uncertainty be sufficiently outlined to allow the recipient to find, access and use data. Procedurally, Member States are requested to designate adequate independent authorities to monitor the implementation of the regulation, with broad competence spanning the investigations of alleged violations and the monitoring of technological developments relevant to the availability and use of data (chapter X).

On 14 December 2022, the Parliament, Council and Commission adopted Decision 2022/2481, confirming the Digital Decade Policy Programme 2030, aiming to make digital infrastructure and technology more sustainable, resilient and energy- and resource-efficient and contributing to a sustainable circular and climate-neutral economy and society along the lines of the Green Deal.[24] The programme harmonises national policies via Member States' digital decade strategic roadmaps and co-operation between these and the Commission, in consultation with stakeholders (articles 7 ff.). The day after, this was followed by the solemn proclamation of the Declaration on Digital Rights and Principles.[25] The Preamble to the Declaration not only acknowledges that the digital transformation affects every aspect of peoples' lives, and offers significant opportunities for sustainability (per paragraph 2), but also challenges fundamental rights (per paragraph 3). The aim is to establish a model of digital transformation that 'strengthens the human dimension of the digital ecosystem with the Digital Single Market at its core', ensuring that 'technology assists in addressing the need to take climate action and protect the environment' (preamble, paragraph 5). Besides the essential right to the protection of personal data under chapter II, in line with article 7 of the EU Charter of Fundamental Rights, the Declaration embeds an entire chapter (VI) on sustainability. This provides that, in the context of a circular economy, digital products and services should be produced, used, repaired, recycled and disposed of so as to mitigate their negative impact on the environment, avoiding premature obsolescence and implementing

22 European Commission, Proposal for a Regulation of the European Parliament and of the Council on Harmonised Rules on Fair Access to and Use of Data (Data Act), COM(2022) 68 final 2022/0047 (COD).
23 Ibid. at p. 2. 24 See article 3(h).
25 European Commission, European Declaration on Digital Rights and Principles for the Digital Decade (2022). https://digital-strategy.ec.europa.eu/en/library/declaration-european-digital-rights-and-principles#Declaration.

effective universal access to information to allow responsible choices (per paragraphs 24–25). For this purpose, the EU particularly commits to promoting innovative digital technologies with a positive effect on the environment and climate, accelerating the green transition (per paragraph 25).

This brief overview of EU regulatory initiatives shows that the Union takes a holistic approach to the 'twin' transitions. Digitalisation is thus comprehensively embraced as a key means, if not the fundamental panacea, to achieve the objectives of the Green Deal and ultimately climate neutrality by 2050. While regulatory initiatives and studies commissioned by EU institutions,[26] notably the Declaration on Digital Rights and Principles, indicate that the EU is fully aware of regulatory problems raised by the necessity of achieving digital harmonisation in the common market, for instance, as concerns competitiveness and cybersecurity,[27] the idea is essentially that smart grids are the way forward to achieve the green transition.

11.3 Digitalisation and Climate Change

11.3.1 Digital Transformation and Sustainability

Digitalisation entails business procedures that take place in digital format. It therefore involves digitisation, to the extent that information stored in non-digital format – including images, words, sound and signals – is fundamentally captured as a digital representation. This is based on binary numbers, facilitating processing by computer machines. Digital business resulting from digitalisation involves both digital and physical activity, with the digital format at its core. Thus, for example, social media, manufacturing and monitoring take place in dual format.

Although other features are also important, it is predominantly the Internet, blockchains, and the Internet of Things which are crucial to the digital world. Digitalisation involves several advantages, as it accelerates activities, facilitating data processing, storage, and transmission. Digital data can thus be processed and transmitted indefinitely without degradation, at high speed and negligible cost. The Internet can be defined as a global system of interconnected computer networks, that is, a set of networked electronic, wireless and optical technologies.[28] Within the Internet framework, blockchains are distributed ledgers involving expansive lists of records (that is, the 'blocks') that are interconnected via cryptographic hashes.[29] In a broad sense, the Internet of Things defines the material technology, including items such as computers and mobile devices, that are necessary to the functioning of the digital world, while in a narrow sense it indicates the connection of the Internet to the real world via sensors.[30] Everyday items such as home appliances, cars and

[26] See, for instance, European Commission, Five Digital Solutions for a Greener Europe (2022). https://joint-research-centre.ec.europa.eu/jrc-news/5-digital-solutions-greener-europe-2022-07-05_en.
[27] S. Muench, E. Stoermer, K. Jensen, et al., *Towards a Green and Digital Future: Key Requirements for Successful Twin Transitions in the European Union* (Publications Office of the European Union, 2022).
[28] OECD, Definition of Electronic Commerce Transactions and Guidelines for Their Application (2022).
[29] E. Barteková, P. Börkey, Digitalisation for the transition to a resource efficient and circular economy. OECD Environment Working Papers No. 192, 2022, pp. 58–59.
[30] Ibid. at p. 56.

electricity grids are indeed connected to communication networks, delivering a range of services.[31] Naturally, the Internet facilitates the exchange of digitalised data by connecting private, public, academic, business and government networks on a local and global scale. For instance, a document transmitted in digital format can be communicated via the Internet to the other side of the world much quicker than in hard copy via courier. It is considered that Internet traffic has tripled over the past five years and more than three and a half billion people – that is, essentially half of the global population – currently use the Internet, in an upward trend from only half a billion in 2001.[32]

For the reasons above, among others, the digital transformation has unique and significant potential to foster sustainable development. According to the World Economic Forum, digital technologies can reduce global greenhouse gas emissions by 15%, that is, a third of the reduction needed by 2030 to achieve the objectives of the Paris Agreement.[33] In the agricultural sector, mobile devices and drones are used to facilitate the monitoring of soil conditions and field spraying, as well as in collecting data on promising crop varieties and field-specific sustainable agricultural practices.[34] In the area of transport, digital technologies improve efficiency in cargo transportation and facilitate managing traffic data, thus, for example, alleviating or obviating traffic jams, inefficient fuel consumption and polluting greenhouse gases. Moreover, the implementation of digital conferences and emails significantly contributes to reducing travels and thus carbon emissions.[35] As paper is made out of wood, digitalisation can help to save paper consumption, and thus forests as a core carbon sink. Blockchains and the Internet of Things can meaningfully contribute to protecting biodiversity. For instance, blockchains are useful to track practices such as deforestation and overfishing. Big data collected via Earth remote sensing through satellites can be relied upon to monitor phenomena such as marine, soil and air pollution, fishing, bushfires, floods, earthquakes, hurricanes and droughts, thus facilitating the planning of mitigation measures and the implementation of adequate adaptation policies.[36] For example, sensors connected to the Internet ('Internet of the environment') can contribute to controlling deforestation, which is responsible for around 15% of greenhouse gas emissions worldwide.[37] Last, but not least, digitalisation facilitates disseminating information about sustainability – it contributes in this way to creating and sharing knowledge among businesses and individuals.[38]

31 Mondejar et al., Digitalization to achieve sustainable development goals, p. 2.
32 Cisco, Visual Networking Index: forecast and methodology, 2016–2021 (2018). https://library.cyentia.com/report/report_001291.html; ITU, Measuring digital development: facts and figures 2022. www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx.
33 B. Ekholm, J. Rockström, Digital technology can cut global emissions by 15%. Here's how (2019). www.weforum.org/agenda/2019/01/why-digitalization-is-the-key-to-exponential-climate-action; World Economic Forum, Five ways digitalization can help build global resilience in 2023. 13 January 2023. www.weforum.org/agenda/2023/01/5-ways-digitalization-can-help-build-global-resilience-davos2023.
34 Mondejar et al., Digitalization to achieve sustainable development goals, p. 3.
35 See, for example, S. Griffiths, Why your internet habits are not as clean as you think. BBC (6 March 2020). www.bbc.com/future/article/20200305-why-your-internet-habits-are-not-as-clean-as-you-think.
36 S. N. Bobylev, O. Yu. Chereshnya, M. Kulmala, et al., Sustainability indicators for digitalization of sustainable development goals in PEEX program. *Geography, Environment, Sustainability* 2018, 11(1): 145–156, at p. 149.
37 A. Ryzhenkov, L. Burinova, Current issues of using digital technologies for environmental protection: legal aspect. *SHS Web of Conferences* 2021, 109: 01033, at p. 3.
38 E. Barteková, P. Börkey, Digitalisation for the transition to a resource efficient and circular economy. OECD Environment Working Papers no. 192 (2022), p. 16.

11.3.2 Digitalising the Energy Sector

The most promising sector for matching digital transformation and climate sustainability is that of energy. Fundamentally, the current energy cycle is based on the extraction of fossil fuel, which directly powers the bulk of global industry, transport, and buildings. Indirectly, fossil fuel *or* low-carbon energy sources – particularly solar and wind energy – are used to generate electricity, which further powers industry, transport and buildings.[39] Since the 1970s, the energy sector has been a pioneer in digital technologies and the pace of digitalisation is increasing, with investment in digital technologies by energy companies on the rise. Indeed, digitalisation can improve the efficiency and cost-effectiveness of energy production, transmission, distribution and consumption.

From the standpoint of energy production and delivery, the oil and gas sector has traditionally relied on digital technologies, particularly in the upstream value chain. Digitalisation also has the capacity to optimise production processes related to coal. For instance, big data sets obtained via seismic surveys of land and oceans contribute to outlining reservoirs and oil, gas and coal extraction. Prospectively, miniaturised sensors can improve the extraction of coal, oil and gas from reservoirs. In fact, companies rely on digital technology for activities such as modelling and automating the exploration and production of oil and gas and to operate grids. Drones and other digital techniques can be deployed to monitor the functioning of remote pipelines and prevent or repair malfunctioning; this is particularly important for low-cost detection of methane emissions potentially occurring at any stage of oil and gas production and transportation. Sensors can also help to provide information on the state of transmission and distribution in electricity networks and blockchains are particularly efficient in simplifying a decentralised management of energy resources. Furthermore, digitalisation facilitates the integration of electricity produced via renewable energy sources into electricity markets. For instance, smart grids allow the matching of demand and electricity, with consumers also exporting electricity to the grid when equipped with solar panels,[40] whereby the use of blockchain technology facilitates peer-to-peer electricity trading.[41] It is calculated that improving electricity storage can lead to avoiding around 30 megatonnes (Mt) of carbon dioxide (CO_2) emissions within two decades.[42] Thus, for example, investment in digital electricity infrastructure and software has increased by more than 20% yearly since 2014.[43]

At the intersection between energy and other industrial sectors, on the consumption side, industry accounts for about 38% of global final energy consumption and 24% of CO_2 emissions.[44] It is considered that the industry sector is currently undergoing the fourth industrial revolution (industry 4.0), which relies on digitalisation rather than automation, including the modular production of smart objects via smart factories.[45] Internally, digitalisation can lead to energy savings via improved production process control, supporting

39 IEA, *Digitalization and Energy* (IEA, 2017), p. 85.
40 Mondejar et al., Digitalization to achieve sustainable development goals, p. 10.
41 A. D. Andersen, On digitalization and sustainability transitions. *Environmental Innovation and Societal Transitions* 2021, 41: 96–98, at p. 97.
42 IEA, *Digitalization and Energy*, p. 83, Dwivedi et al., Climate change and COP26, p. 7.
43 IEA, *Digitalization and Energy*, p. 25. 44 Ibid.
45 Mondejar et al., Digitalization to achieve sustainable development goals, p. 13.

a shift towards a sustainable business model.[46] For instance, 3D printing, also known as 'additive manufacturing', allows the production of both plastic and metal parts layer-by-layer,[47] leading to a reduction of wastage in the form of excess scrap materials, lower inventory costs and the possibility of delivering manufactured parts in shapes.[48] Externally, digitalisation enhances connectivity between producers in value chains, improving, for instance, the recycling of materials.[49]

In the building sector, which accounts for almost one-third of global final energy consumption and some 55% of global electricity demand,[50] digitalisation has the potential to cut energy use by around 10% by 2040.[51] Notably, smart energy management can contribute to ensuring that energy is consumed when and where necessary by improving the responsiveness of energy services to the environment, for instance, through reliance on technologies such as the use of smart sensors in lighting, heating and cooling. Smart energy management can also maximise efficiency in energy consumption by effectively predicting consumer behaviour and simplifying the monitoring of the energy performance of buildings, facilitating the identification of where and when maintenance is required, thus maximising investment.

Transport accounts for around 28% of global final energy demand, and roughly 23% of global CO_2 emissions from fuel combustion,[52] with a growth in energy consumption for transport of almost half to 165 exajoules expected by 2060. Digitalising the manufacturing process for electric- and hydrogen-powered modes of transport, including cars, ships and planes, would significantly reduce greenhouse gas emissions. Introducing viable hydrogen engines into widespread, mainstream production would lead to a significant reduction in greenhouse gas emissions and possibly to the end of the oil era – or, at the very least, to its sharp curtailment. Cars, trucks, planes, ships, trains and their supporting infrastructure are indeed becoming smarter and more connected, improving energy efficiency and reducing maintenance costs. For instance, commercial aircraft and ships are progressively being equipped with sensors, generating big data that optimise route planning and reduce fuel consumption.[53]

11.4 Twin Transitions?

11.4.1 Digital Pollution

Systemic studies demonstrate that digitalisation has an overall positive impact on climate change and sustainability.[54] However, together with its significant advantages, the digital transformation also entails relevant shortcomings for the green transition. Some scholars

[46] A. Maffei, S. Grahm, C. Nuur, Characterisation of the impact of digitalisation on the adoption of sustainable business models in manufacturing. *Procedia CIRP* 2019, 81: 765–770, at p. 769.
[47] Barteková and Börkey, Digitalisation for the transition, p. 61.
[48] See, for example, Additive Engineering, About additive engineering, 2023. https://additiveengineering.com.au/about-additive-engineering.
[49] Dwivedi et al., Climate change and COP26, p. 12. [50] IEA, *Digitalization and Energy*, p. 42. [51] Ibid. at p. 29.
[52] Ibid. at p. 35. [53] Ibid. at p. 31.
[54] A. Burinskienė, M. Seržant, Digitalisation as the indicator of the evidence of sustainability in the European Union. *Sustainability* 2022, 14(14): 8371.

indeed speak of the 'false green label' of digital transformation, thus reaching the diametrically opposite conclusion that 'digital consumerism' is unsustainable.[55]

Fundamentally, while facilitating information transfer, the global digital data flow affects data protection, in turn affecting the reliability of the system in the eyes of the consumer. In particular, concerns are raised by personal data, which amount to about half of the data traded by companies, notably in the telecommunication, financial and business services sectors.[56] Moreover, the digitalisation of the economy raises the question of large companies, which can create monopolies and the corresponding risk of abusing dominant positions. Besides these problems of trust and market management, there is no agreement on the extent to which the digital transformation effectively contributes to the green transition. Thus, while some estimates determine savings triggered by a paperless environment at around 25%, others are far more sceptical, considering that most logging does not necessarily go into papermaking and is rather driven by mere economic considerations.[57]

In the energy sector, it is calculated that digitalisation, in conjunction with advances in electrification, might result in substantial greenhouse gas emission impacts, but estimates are uncertain, so much so that energy consumption in road transport might either drop by about half or double, particularly in the light of the interplay between policy and technology.[58] Notably, in the building sector, considerations of a technical and economic nature affect the consumer's choice as to whether to install control systems such as smart sensors and lighting, whereby financial incentive schemes play a critical role. The extent to which a company engages in digital production is volatile and depends on issues such as the flexibility of supply chains, the impact of digital technologies on employment and cybersecurity; thus, for example, in 2017 the functioning of a nuclear power plant in the United States was disrupted by phishing attacks. In this respect, governments can play a crucial role by supporting research and developments that mitigate investment risk. In the coal, oil and gas production sectors, projects usually take years to develop, whereas digital technologies evolve rapidly and it is therefore difficult to incorporate changes into conventionally defined, multibillion-dollar projects. Moreover, it is considered that the use of digital technologies has the potential to improve technically recoverable oil and gas by around 5% on a global scale, with particular regard to tight oil and shale gas production, that is, more than 10 years of current world oil and gas consumption.[59] Digitalisation also discloses the possibility of further improving geological modelling and mining for coal.[60] Extended exploitability of fossil fuel fosters linear growth and consumption and naturally contributes to an increase in greenhouse gas emissions.

Furthermore, the digital transformation itself is (invisibly) polluting.[61] On the one hand, there are indirect emissions triggered by the production of digital devices, such as mobile phones and computers, that is, the Internet of Things *lato sensu*, involving the extraction of

[55] J. Yanes, Digital technologies: the climate impact that hardly anyone talks about (2022). www.bbvaopenmind.com/en/science/environment/climate-impact-digital-technologies.

[56] F. Casalini, J. L. González, Trade and cross-border data flows. OECD paper, 2019, p. 33.

[57] J. Achieng Owuor, L. Giessen, L. C. Prior, D. Cilio, G. Winkel, Trends in forest-related employment and tertiary education: insights from selected key countries around the globe. European Forest Institute report (2021). https://efi.int/publications-bank/trends-forest-related-employment-and-tertiary-education-insights-selected-key.

[58] IEA, *Digitalization and Energy*, p. 29. [59] Ibid., p. 17. [60] Barteková and Börkey, Digitalisation for the transition, p. 40.

[61] Ryzhenkov and Burinova, Current issues of using digital technologies for environmental protection, p. 4.

materials such as cadmium, which contribute to greenhouse gas emissions. For instance, mobile phones have a manufacturing phase that accounts for between 85% and 95% of their carbon footprint.[62] Moreover, the use of digital devices leads to the production of about 50 million tons of so-called 'e-waste' on a yearly basis, mostly in developing countries, around only 20% of which is recycled, the remainder being dumped into the subsoil in developing countries.[63] Recycling is particularly complex because e-waste involves common elements, such as lead and chromium, as well as rare minerals, such as scandium and lutetium, which are highly polluting and demonstrably harmful to health.[64]

On the other hand, there are direct emissions from digital activities, as the functioning of the digitalised world entails massive electricity consumption. This leads to a predicted use by ICT networks at about 20% of total world electricity consumption by 2025, and consequent greenhouse gas emissions.[65] Thus, improved product efficiency is largely offset by increased overall use because of the so-called 'behavioural response'. According to some estimates, digital technologies emit around 2% of global emissions, but with a significant increase expected in the mobile communication sector.[66] Other estimates determine the share of global emissions from digital technologies between 3% and 4% by 2020, increasing from 1.5% in 2007.[67] Indeed, global email usage generates as much CO_2 as seven million cars and each email user in the UK sending one less email a day would lead to reducing emissions by 16,433 tons of CO_2, the equivalent of 81,152 flights from London to Madrid.[68] So too, message services and video-streaming have a carbon footprint: considering that using a mobile phone over one hour generates 1.25 tons of CO_2, it is estimated that using a mobile device for 10 years would equal 85–95% of the carbon footprint in the production phase. On average, though, mobile devices have a serviced life of roughly two to three years, following the marketing of new models, according to a system that is profitable to business and increases emissions in the production phase. The European Environmental Bureau considers that extending the use of electronic devices by one year would save the EU a total amount of carbon emissions equivalent to those produced by two million cars.[69] Even devices on standby have a carbon footprint, which a study sets at around 23% of household electricity consumption,[70] whereby it is calculated, for instance, that the largest share of a computer's global warming potential is due to non-use phases.[71] Indeed, electronic devices such as televisions and computers count for half of the idle load of a household, and appliances such as washers and fridges with electronic controls and improved Internet connectivity add around 1300 kilowatt-hours – that is, US$165 on current exchange

[62] L. Belkhir, A. Elmeligi, Assessing ICT global emissions footprint: trends to 2040 & recommendations. *Journal of Cleaner Production* 2018, 177: 448–463.
[63] Ryzhenkov and Burinova, Current issues of using digital technologies for environmental protection, p. 4.
[64] European Environmental Bureau, Cool products don't cost the Earth (Report Briefing, 2019).
[65] Dwivedi et al., Climate change and COP26, p. 7.
[66] A. Fehske, G. Fettweis, J. Malmodin, G. Biczok, The global footprint of mobile communications: the ecological and economic perspective. *IEEE Communications Magazine* 2011, 49(8): 55–62.
[67] Belkhir and Elmeligi, Assessing ICT global emissions footprint, p. 448.
[68] H. Evangelidis, R. Davies, Are you aware of your digital carbon footprint? 2021. www.capgemini.com/gb-en/insights/expert-perspectives/are-you-aware-of-your-digital-carbon-footprint.
[69] European Environmental Bureau, Cool products don't cost the Earth.
[70] P. Delforge, L. Schmidt, S. Schmidt, Home idle load: devices wasting huge amounts of electricity when not in active use. NRDC Issue Paper, 2015, p. 4.
[71] European Environmental Bureau, Cool products don't cost the Earth.

rates– to a household's electricity bills.[72] According to the International Energy Agency, 50% of household electricity demand for appliances by 2040 will come from connected devices – on the one hand, creating opportunities for smart responses, but increasing consumption of standby power on the other.[73]

In sum, the current trend of digital consumption in the world is unsustainable.[74] In this context, most 'digital' greenhouse gas emissions come from developed countries, which raises questions of human rights implementation.[75] To make this situation more sustainable, we need to think about digitalisation as a constitutive element of transitions and a driver of sustainability in transitions, problematising implications for a just and low-carbon future.[76] Responsible consumption and production is at the core of the transformation and of the implementation of the UN Sustainable Development Goals, calling for industrial processes that implement an efficient use of natural resources, reduce waste generation and adequately manage polluting products.[77] Notably, responsible conduct by digital consumers is required, extending the life of computers and mobile devices as much as possible, turning off videos in online conferences and unsubscribing from mailing lists that are not of interest.[78] Policy and market design are core to achieving these objectives, thoroughly harnessing the potential of digital tools towards sustainability.[79]

11.4.2 Data Choices

Where the EU takes climate policy digitalisation from here may seem an entirely practical matter of how far that technical process can be stretched and at what marginal cost. But certainly, if the point is to improve our *understanding* of climate change and its impact on human concerns, we must at the very least recognise the existence of a broader normative context within which that question arises. Digitalisation, after all, is but one element in a larger process of reducing to numeric form elements of our shared experience that, heretofore, are encountered in some other form. This reductive process is premised upon several assumptions.

First, reducing all of human experience (or, as much of it as possible) to numeric form assumes that, in so doing, we increase humanity's information database. Of course, this does not mean that we actually know more at that stage of the process. It does, however, mean that more of what we know (or, think we know) can be transmitted electronically and can be 'processed' at high speed by artificial minds. This achievement, it is assumed, will ultimately allow us to create new knowledge by combining and recombining what we already know in new ways.

[72] Delforge et al., Home idle load, pp. 4 and 16. [73] IEA, *Digitalization and Energy*, p. 43.
[74] Shift Project, Rethinking the digitalization for low-carbon transition (2020). https://theshiftproject.org/en/article/implementing-digital-sufficiency.
[75] H. Dough, The Impact of New and Emerging Internet Technologies on Climate Change and Human Rights: Submission to the Advisory Committee to the UN Human Rights Council (2019), para. 2.
[76] S. Sareen, H. Haarstad, Digitalization as a driver of transformative environmental innovation. *Environmental Innovation and Societal Transitions* 2021, 41: 93–95, at p. 94.
[77] J. Martínez, R. Puertas, J. M. M. Martín, D. Ribeiro-Soriano, Innovation and environmental policies aimed at achieving sustainable production. *Sustainable Production and Consumption* 2022, 32: 92–100.
[78] Evangelidis and Davies, Are you aware of your digital carbon footprint?
[79] UNDP, Technology Needs Assessment for Climate Change (UNDP, 2010), p. 4.

A second assumption underlying numeric reductionism is that the new information it enables us to create has utility – that (in one way or another) it will prove to be of *value.* Now, there are many who will become wary at the first mention of value. And they will become more anxious still when reminded of Sir Francis Bacon's observation that knowledge is *power.*[80] But there is, of course, a third, less obvious assumption buried just beneath the surface of the second one. It is that whatever normative challenges may arise from the quantum leap in size that the human database takes as a consequence of digitalisation can be managed by the same technology that allowed us to do the leaping. After all, our cellular phones already sort out nuisance calls for us and either label them as spam or consign them to a subfile with an appropriately dismissive label – thereby giving us permission to simply ignore them.

Much of the information overload imposed on human beings by digitalisation is managed in just this way – the 'excess' material is simply ignored. That coping mechanism imposes costs of its own, of course – a fact with which everyone in complex organisations everywhere is thoroughly familiar. And one aspect of that familiarity is the sneaking suspicion that the organisations to which we 'belong' may be plotting our disposal in favour of a mechanised mind that has been taught to do our jobs. This suspicion, and the plotting that inspires it, is based upon the assumed identity of the mind and the brain. It is assumed that 'computer processes like searching, comparing, classifying, adding, and deleting are used by the brain to process information' and that what the human brain does is what we generally think of when we speak of making up our *minds*.[81] So, the next logical step in the process of digitalisation and the broader numerical reductionism of which it is a part is the development of artificial 'minds' that will compensate for human carelessness and sloth in the handling of our newly created information avalanche.

The development of artificial intelligence as a means for handling the information overload in governance is an ambition of longstanding.[82] The course of artificial intelligence's development has been structured by the problem of finding the things that a human mind can do that an artificial brain currently cannot and then teaching the computer that new skill. So, when confronted with the fact that no computer has ever become world chess champion, artificial intelligence developers will often respond with but a single word – 'yet'. And it is true enough that to conclude something cannot be done simply because it never has been is rarely warranted. In this field, as in so many others, embarrassing failures are often the precursors of dramatic breakthroughs. In the light of this, it might seem futile to problematise the role of artificial intelligence in complex governance contexts such as climate policy implementation. However, there may be some advantage to turning the artificial intelligence developer's motivating question on its head. Instead of asking what a human mind can do that an artificial brain cannot, perhaps there is value in asking what a computer *can* do that human beings *cannot*.

[80] *Meditationes Sacrae* (1597); J. Bartlet, *Familiar Quotations* (Little, Brown and Co., 10th ed, 2019), p. 168.
[81] W. F. Baber, The arts of the natural: Herbert Simon and artificial intelligence. *Public Administration Quarterly* 1988, 12(3): 329–347, at pp. 331–37.
[82] See, for example, H. A. Simon, *The Sciences of the Artificial* (MIT Press, 1969).

As the digitalisation of climate policy implementation continues – as we reduce to numeric form more of what we experience and 'know' – the temptation will grow to use our information processing capacities not to expand our database so much as to sift, combine and recombine its contents in an effort to *interpret* that content. In short, our search for knowledge will drive a search for understanding. Here, the abilities that computers have that we poor humans lack can be significant. For instance, humans are generally incapable of 'processing' information that has no context. The human ability to interpret our experiences is culturally dependent in innumerable ways, while the computer's ability to process meaningless data is so well known that it has its own acronym: GIGO ('garbage in, garbage out'). Our inability to process data without clarity on its context (and, thus, its significance to us) is the primary reason that whereas a computer can always reach a *decision*, humans instead must often simply *choose.* This simple fact may mean that artificial intelligence will be incapable of answering our toughest questions 'because it is not in contact with the reality we all must live within' and, so, cannot help us with 'the dilemmas of cultural debate and hard personal choice'.[83] However, their ability to process gibberish may not be the weakest point in the armour of artificial intelligence. There may be another even more troublesome thing that computers can do which human beings cannot.

In the 1983 motion picture *War Games*, the defence of the United States has been consigned to an imponderably complex super-computer. The disaffected programmer who developed the computer has failed to communicate to it his central normative commitment on the subject – that nuclear wars have no winners. In this fraught moment, the computer is 'attacked' by a teenaged hacker in search of new and more challenging video games. The hacker inadvertently starts a countdown to Armageddon that is forestalled only when he is able to lock the computer into endless rounds of tic-tac-toe with itself. At length, the computer decides to give up both its games of tic-tac-toe and Global Thermonuclear War in favour of chess. The world was saved, and an aspiring young actor launched a successful career. But it remained unclear how the computer managed to grasp the logically difficult concept of unprovable truths. A mathematician confronted with Golbach's Conjecture (that every even number can be written as the sum of two prime numbers) must ultimately accept it as an act of faith, as an unprovable truth. They may offer any number of justifications for the choice of when to stop looking for a proof, but it is always a choice rather than a rationally explicable decision.

Confronted with such a problem, a computer would only be able to arrive at a decision if it had been provided with some bit of automatic program that imposed a limit on search functions with the substitution of some sort of probability algorithm. As a practical matter, the substitution of that kind of routine runs the risk of creating a 'technological black hole, in which humans will not be able to understand the reasoning behind computer results that make key decisions'.[84] But from a normative perspective, it reveals perhaps the most important thing that computers can do which human beings cannot. When pressed to explain one of its decisions, a computer would ultimately have to respond with some

[83] T. Roszak, *The Cult of Information* (Pantheon, 1986), at p. 133.
[84] D. Miche, Computers that learn could lead to disaster. *New Scientist* 1980, p. 160.

variation of 'because you told me to'.[85] Unlike humans, a computer *must* uncritically take a programmer's word for it. Humans must never do this. And, in particular, those humans involved in any form of climate governance can never do it because policy implementation in that field (to an even greater degree than most others) is a form of communicative action – a search for consensus among humans who ultimately must choose because they will never be able to genuinely decide. That search produces actionable results only in the form of 'moments of unconditionality' that embody 'criticisable validity claims' whose legitimacy lies in the 'conditions of processes of consensus formation' that produced them.[86] And, this kind of human action cannot be programmed for the same reason that Goldbach's Conjecture cannot be proven.

11.5 Conclusion

The EU has holistically embraced the digitalisation of the internal market as a priority and a key means towards the implementation of the Green Deal and climate policies. Digitalisation indeed provides several advantages in terms of climate change mitigation and adaptation, spanning smart grids, improved monitoring of environmental phenomena such as earthquakes and hurricanes, and limited pollution in extracting oil and gas. However, at the same time, digitalisation entails critical shortcomings, spanning increased greenhouse gas emissions from improved availability of oil and gas reservoirs to the heightened carbon footprint of digital devices actively operated or on standby and the difficulty of managing digital and climate choices. Advantages and shortcomings are strictly intermingled, and scholars are divided as concerns the viability of digitalisation for sustainable policies and the implementation of the European Green Deal, as proven by the experience of other jurisdictions.

While a holistic approach to digitalisation for sustainability seems a viable option, it is suggested that the EU couple this fundamental policy choice with a careful balance of pros and cons in outlining the prospective digital transformation of its economy for climate sustainability. In this sense, EU policies correctly aim to create a competitive playing field and promote adequate information among producers, service providers and consumers, within and outside the energy sector, to optimise the choice and use of digital technologies. Besides such measures, it is essential that the EU monitor the impact of digitalisation on overall energy demand, avoiding an excessive increase in energy consumption. For this purpose, EU policymakers might couple the holistic acceptance of digitalisation with a 'learn by doing' attitude, setting a variety of real-world experiments across supply chains to test the viability of its digital policy, in close collaboration with stakeholders.

[85] J. Weizenbaum, *Computer Power and Human Reason* (W.H. Freeman, 1976), p. 230.
[86] J. Habermas, *The Theory of Communicative Action: Vol 2 – Lifeworld and System: A Critique of Functionalist Reason* (Beacon Press, 1981), p. 399.