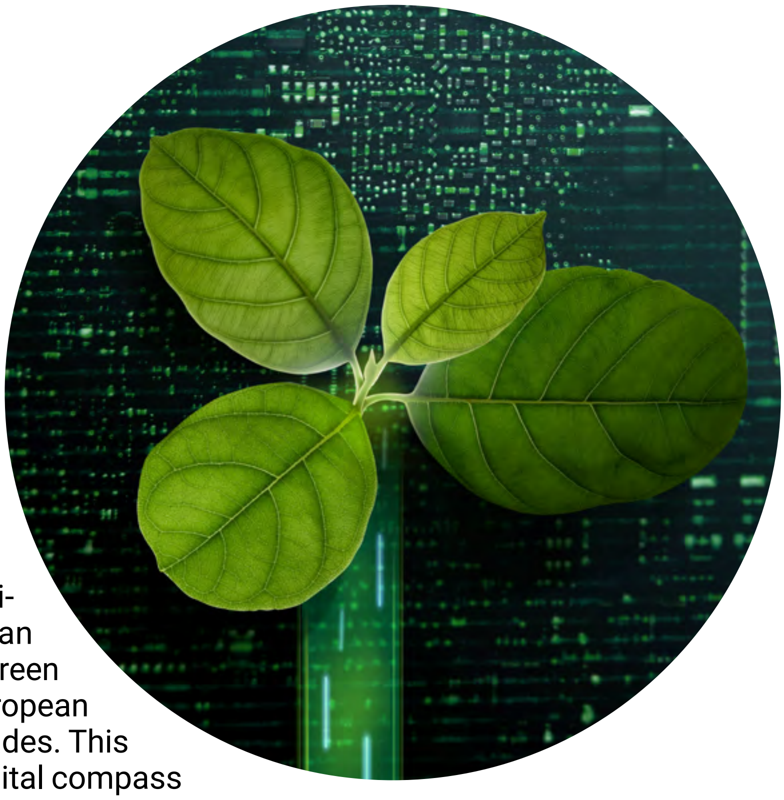
POLICY BRIEF
February 2023

FEPS
FOUNDATION FOR EUROPEAN
PROGRESSIVE STUDIES

CLIMATE MAINSTREAMING: CLIMATE AND DIGITAL POLICY



SUMMARY

The coming decades will be characterised by two major technology challenges: climate change mitigation and digitalisation. The technological transition associated with climate change follows clear and well-defined goals. In contrast, digitalisation does not follow a clear objective and is commonly understood as a self-driving process of technological progress. Within this context, the European Commission launched, in 2019, the European Green Deal which sets out the framework for the European climate policy response over the coming decades. This was followed by the launch, in 2021, of the Digital compass which sets out the guidelines for the digital transition in Europe.

Both climate change mitigation and digitalisation require political governance. With regard to climate action, it is imperative to accelerate the technological transition to a low-carbon economy, while bearing in mind that the effects of climate change are unjustly distributed. Hence, accelerating climate change mitigation ought to be inclusive, especially to the most vulnerable segments of society and those living in the most exposed countries and regions. As for digitalisation, guidance is necessary to avoid adverse side effects such as the threat of mass surveillance arising from data monopolies, and the unequal distribution of gains and access to digital technologies. Being a process of major technological changes that permeates almost every sector of our lives, digitalisation has a strong disruptive potential. Hence, its benefits and risks also interact with climate action. This policy brief identifies the positive and negative interactions across processes of technological advances involved in both climate change mitigation and digitalisation. It also shows how current EU policy strategies take account of these interactions. It proceeds by outlining 15 principles around which policies for climate change mitigation, adaptation, and compensation should be designed to ensure coherence and justice and to leverage the greatest synergies with the ongoing process of digitalisation.

AUTHOR

DR KERSTIN HÖTTE
Associate, Alan Turing Institute
& Academic Visitor,
Institute for New Economic
Thinking, University of Oxford

IN PARTNERSHIP WITH

FRIEDRICH EBERT STIFTUNG

TABLE OF CONTENTS

FEPS
FOUNDATION FOR EUROPEAN
PROGRESSIVE STUDIES

THE FOUNDATION FOR EUROPEAN PROGRESSIVE STUDIES (FEPS)

European Political Foundation - Nº 4 BE 896.230.213
Avenue des Arts 46 1000 Brussels (Belgium)
www.feps-europe.eu
@FEPS_Europe

FRIEDRICH EBERT STIFTUNG

FRIEDRICH-EBERT-STIFTUNG

EU-Office Brussels
Rue du Taciturne 38
BE-1000 Brussels (Belgium)
www.brussels.fes.de
@fes_brussels

This Policy Brief was produced with the financial support of the European Parliament. It does not represent the view of the European Parliament.

Introduction

The coming decades will be shaped by two major technology challenges: climate change mitigation and digitalisation. Climate change is probably the greatest economic and technological challenge we face today. Accelerating climate change mitigation is an imperative if we want to keep climate change impacts at a level that is still manageable for humans. Effective climate change mitigation requires radical reductions in greenhouse gas (GHG) emissions while taking account of the other biophysical constraints of our planet, such as pollution, material and nutrient cycles, and biodiversity, to preserve it as a safe operating space for humanity (IPCC 2021, Rockström et al 2009).

Already today, the impacts of climate change are increasingly affecting our everyday lives: droughts, floods, and heatwaves have become more frequent and more extreme than ever before since the development of human civilisations. Climate research unanimously tells us that the impact of climate change will become even more extreme soon (IPCC 2022a). It is vital to adapt to these effects in order to reduce our vulnerability, to protect lives, and to prepare for life in a warmer world (EC 2021a).

“*The effects of climate change are inherently unjustly distributed: those having contributed the least are likely to be among those that will suffer the most*”

The effects of climate change are inherently unjustly distributed: those having contributed the least are likely to be among those that will suffer the most. These injustices shape the relationship between the global North and global South, but they also exist within countries: higher levels of income and socioeconomic status positively correlate with emissions (Chancel 2022) while the vulnerability is highest among those who are poor and who do not have the capacity to adapt (UNEP 2021). Climate compensation is a nascent policy area that seeks to establish mechanisms to take account of these injustices, mainly at an international level (UNFCCC 2016). Climate injustices arise as an intergenerational problem as the emitters from the past suffer less from the climate change impacts than the next generation (Knight and LeMerle 2022). In 2015 the Paris Agreement provided the roadmap for climate policy (UNFCCC 2016). It is now time to act.

While climate change is happening and requires urgent action, another process of large-scale technological transformation is also going on: digitalisation. Fast and ongoing progress in the computer industry has made digital applications and services widely accessible. As a general-purpose technology, digitalisation has the potential to reshape our economy as radically as previous technological revolutions, such as the diffusion of electricity at the beginning of the 20th century. In contrast to climate change mitigation and adaptation, digitalisation can be considered as a self-driving process fuelled by ongoing technological advances that continuously expand the scope of digital applications, enabling them to permeate almost every sector of the economy (Jovanovic and Rousseau 2005).

Digitalisation as a process of major technological change has the potential to radically disrupt existing production and business models, as well as patterns of consumption. It may render whole industries, business models, and occupations obsolete, and is associated with the large-scale reallocation of jobs across industries and occupations. It is also associated with changing skill and task contents within existing jobs. The policy challenge in digitalisation is the alleviation of adverse side effects such as income polarisation, an increasing concentration of economic and political power, and mass surveillance along with threats to privacy (EC 2020a, 2021b, D4S 2022).

Both the climate transition (to a low-carbon, more resource-efficient and sustainable economy) and the digital transition (to a world with ever more digital applications) require political governance: the climate transition needs to be accelerated and digitalisation needs guidance to avoid adverse side effects to ensure that no one is left behind. In 2019, the European Commission (EC) launched the European Green Deal (EGD) which sets out the framework for the European climate policy response over the coming decades. This framework covers a wide range of areas for action – from nature restoration and fighting pollution, to circularity in industrial production, clean energy and transport, buildings, and sustainable agriculture (EC 2019). Two years later, the Commission launched the Digital Compass setting out the guidelines for the digital transition in Europe along four focal dimensions: skills and labour, industrial transformation, digital public administration, and secure digital infrastructure (EC 2021b).

This policy brief identifies negative and positive interactions between the processes of technological change involved both in climate change mitigation and in digitalisation, and it shows how current EU policy strategies take account of these interactions. It outlines 15 principles around which policy should be designed to ensure coherence and justice, while maximising the scope for synergies between digitalisation and climate change mitigation, adaptation, and compensation.

Scoping

Climate change demands urgent action. If existential climate risks are to be alleviated, we must radically change the way we produce, live, and consume. Major areas of mitigation are energy, agriculture, mobility, housing, and clean production. Mitigation policy often focuses on technological solutions in a broad sense – that is, the replacement of existing emission-intensive technologies and infrastructure with climate-friendly alternatives. Behavioural change may play a decisive role in accelerating this process of replacement. Political measures address both the technology supply and the demand side. For example, targeted R&D policy, investment loans, and tax allowances stimulate the development and diffusion of green technologies among producers. Carbon taxes, public procurement, subsidies for green consumer durables, labelling, and information campaigns can all stimulate the demand for low-carbon goods and services, because they provide an additional market incentive for suppliers to serve these market needs (EC 2019, IPCC 2022b).

Over the decades, the technological challenge has changed, and it differs by area of mitigation. In the 1990s, many of the technological solutions were unknown, were not ready for scaling up, or were prohibitively expensive. This is no longer true for most technologies and the challenge today is a matter of diffusion associated with qualitatively different problems. For example, a major barrier to the current large-scale diffusion of renewable energy, renovation of buildings, and clean production processes is the lack of availability of qualified labour with relevant green skills (ILO 2019, EC 2020b). Another major difficulty lies in the societal dimension of change, namely resistance to change by those who fear losing their well-paid jobs in the fossil fuel industry, and those who are unwilling to abandon resource-intensive lifestyles such as meat consumption, long-distance tourism, living in large houses, and driving private cars (IPCC 2022b).

Climate change imposes a second challenge: massive adaptation efforts are needed to cope with changing climatic conditions such as rising temperature levels, changing precipitation patterns, and the increased exposure to extreme events such as heatwaves, storms, heavy rainfalls, and droughts. Major areas for adaptation are agriculture, infrastructure resilience, human health, and water supply (IPCC 2022a).

Fighting against and coping with climate change require the rapid and consequent redirection of technological change towards carbon neutrality and climate resilience. Well-designed climate policy and smart-technology choices can harness synergies between both mitigation and adaptation. For example, thermal insulation in buildings does not only help improve the energy efficiency of buildings, which saves emissions, but it may also imply adaptation benefits if it helps to manage the temperature in buildings during heatwaves. Robust electricity grids do not only withstand extreme weather events but often also improve transmission losses and thereby contribute to energy efficiency (Hötte and Jee 2022). Sustainable consumption practices such as a reduced intake of meat-based protein prevent cardiovascular diseases which also strengthens the physical capacity of people to cope with heatwaves. Similarly, non-motorised forms of mobility such as cycling contribute to public health and therefore adaptation, but they also save emissions (Semenza 2021, Haas et al 2022).

Alongside climate change, the digitalisation of the economy is radically changing its nature. Consumer goods and services are losing their physical shape and are becoming increasingly digitised. Digital goods and services can be copied at zero cost, which is a driver of consumer welfare, but this comes with increasing returns that threaten market competition. Network effects reinforce the process of concentration of economic and discursive power in social media (D4S 2022).

Advances in robotics and Artificial Intelligence (AI) broaden the scope of automation to a rising number of tasks and jobs that may be performed by machinery instead of human labour. Automation offers efficiency gains, but many formerly well-paid employees see their jobs at risk, and massive retraining and reskilling programmes may be needed to facilitate their transition to alternative jobs (Hötte et al 2022). Small and medium sized enterprises (SME) find it increasingly difficult to keep pace with the rapid process of technological advancement, which may further undermine market competition. Large digital firms may behave as gatekeepers if they have a monopoly on relevant data sources and digital infrastructure. The collection and processing of data at almost zero marginal cost enables large tech-companies, economic giants in e-commerce, employers, and governments to install measures of mass surveillance and personal control (Nogarede 2021, D4S 2022).

“

Policy can steer the process of digitalisation by regulation to cope with the negative consequences of digitalisation that have already been realised, and to ensure that the future pathway of technological and economic development follows the right direction

”

Policy can steer the process of digitalisation by regulation to cope with the negative consequences of digitalisation that have already been realised, and to ensure that the future pathway of technological and economic development follows the right direction. Indeed, many policies are already in place or are in the pipeline. Major instruments of political governance include regulatory means to preserve competition and prevent market concentration, privacy regulation and data protection, labour market and educational policy, as well as public investment in digital infrastructure and data sharing obligations to break data monopolies (EC 2021b).

> *The technological transition associated with climate change follows clear and well-defined goals – namely mitigating as much climate change as possible and adapting to new climatic conditions. In contrast, digitalisation does not follow a clear objective and is commonly understood as a self-driving process of technological progress*

The technological transition associated with climate change follows clear and well-defined goals – namely mitigating as much climate change as possible and adapting to new climatic conditions. In contrast, digitalisation does not follow a clear objective and is commonly understood as a self-driving process of technological progress. The policy challenges for climate change and digitalisation are conceptually different. While climate policy aims to accelerate climate-friendly technological change as much as possible, digitalisation policy aims to alleviate the undesirable consequences of technological change. Digitalisation and the information and communications technology (ICT) revolution need guidance to be a just and inclusive process that leaves no one behind, and that avoids the concentration of economic and political power, ensuring the provision of individual and collective basic rights.

System and problem analysis

Both processes of technological change have already characterised the economic evolution since the 1990s and will become even more manifest in the coming years. The existing academic literature documents ambiguous interactions between both processes, which are to some extent recognised by policy. Current EU policies already take some account of the duality of the transition process. For example, the Digital Compass speaks of sustainable digital infrastructure (EC 2021b) and the EGD highlights the role of digitalisation as an enabler of change (EC 2019). In this section, a series of examples of negative and positive interactions between climate change and digitalisation are showcased.

Negative interactions between climate change and digitalisation

The most obvious potentially negative impact of digitalisation on climate policy is the energy-intensity of ICTs. This currently accounts for 5-8 per cent of electricity use and more than 2 per cent of global GHG emissions, which are projected to increase to 14 per cent if the current pathway of digital rollout proceeds as before (EC 2020). The emission-intensity of digitalisation is contingent on the carbon-intensity of the regional electricity supply, which varies strongly across member states. In some of the economically weaker member states in (South-)Eastern European regions (Poland, Bulgaria, and Estonia, in particular) the share of fossil fuels (especially coal) in electricity generation is high, which imposes a relatively higher burden to align digitalisation with climate change mitigation.

The energy-intensity of ICTs does not need to conflict with climate goals. Major tech-giants like Google or Amazon have become large-scale investors in renewable energy and storage, pledging to make their own ICT infrastructure climate positive soon (Pakulska and Poniatowska-Jaksch 2022), while also creating positive learning externalities for technology development and renewables rollout as a by-product.

However, this consideration is subject to two major caveats. First, electricity will become increasingly scarce if we roll out ambitious mitigation plans across the whole economy (at least during the transition phase). The key drivers of electricity demand are the electrification of transport and heating, and industrial processes switching to green hydrogen. Digitalisation built purely on renewables is certainly a desirable pathway, but its high energy-intensity imposes an additional challenge for the transformation of the rest of the economy.

Second, for some countries and firms it may be easier to run their ICT infrastructure on carbon neutral forms of electricity, which may exacerbate existing distributional injustices and drive market concentration. For example, tech-giants like Google and Amazon with carbon-neutral sources of electricity may find it easier to comply with climate policy compared to their competitors. Southern and Eastern European countries with coal-intensive energy systems may be the losers if the high carbon-intensive energy systems impose an unequally high burden to accelerate digitalisation.

The energy-intensity of digital processes may also undermine climate change adaptation if heat losses from servers and digital equipment increase the demand for cooling during heatwaves. Energy-intensive cooling technologies like air-conditioning exacerbate the problem of energy consumption, while the effectiveness of energy-saving cooling options such as thermal insulation may not work in places with heat-producing digital equipment indoors.

Furthermore, the increasing depth of digitalisation comes along with a higher reliance on a functioning electricity grid. The more digitalisation progresses, and the more essential services are digitalised, the more vulnerable the functioning of the society becomes to blackouts. Climate change projections warn us about an increased exposure to extreme weather events like storms, and temperature extremes and precipitation, which increase the risk of the physical infrastructure for electricity supply breaking down. This is particularly problematic in regions where adaptation capacities for investment in infrastructure robustness are limited or where the awareness for adaptation needs is lacking. The risks are disproportionately higher for the most vulnerable in our society, who lack the capability to help themselves. For example, if the digitalisation of health services and personal assistance proceeds, those who are dependent on these services due to their age or unfavourable health conditions might lose their access to essential services if the electricity system breaks down.

A related negative impact of digitalisation on climate change mitigation is the so-called rebound effect whereby technical advances in digital technologies offset efficiency gains in the production of goods and services, and reduce consumer prices at large scale. Efficiency gains would principally be beneficial for the climate if they reduced material and energy consumption. However, empirically, we observe the opposite. Efficiency gains do not in fact lead to reduced total energy and material use because – historically – these gains have been more than offset by an increased level of consumption, which was stimulated by the reduction in prices and by higher levels of disposable income arising from the productivity enhancements beforehand (Berkhout et al 2000, Fouquet and Hippe 2022, Lange et al 2020).

The increased affordability of digital technologies is desirable from a distributional justice perspective if it gives access to digital tools for the poor including those living in developing countries – which may then open up new pathways of technological leapfrogging and development (UN 2015).

Yet the digitalisation-enabled efficiency gains do not come for everybody's benefit because digital technologies may lead to radical workplace transformations. Indeed, an increasing number of work tasks can now be executed by computers and robots, and entirely new business models in digital services emerge, while other previously well-paid occupations become obsolete (Frey 2019). This comes to the detriment of workers who lack digital skills and whose tasks performed on the job can be automated with the help of digital technology, which then increases a company's income and thus job market polarisation (D4S 2022). This creates job uncertainty and comes with the deprivation of social status for those losing their jobs. It also creates income polarisation. The implementation of climate policy is dependent on public support, which may be negatively affected if the job polarisation effects of digitalisation undermine important support factors such as social trust and perceived justice (Drews and van den Bergh 2015, Frey et al 2018).

The efficient widespread use of digital technology relies on a stable and predictable supply of electricity. This may come to the detriment of system resilience, if increasingly more processes and essential services become digitalised in times of accelerating climate change and increased exposure to extreme weather events. This problem is not only related to electricity (which may be alleviated by an improved use of energy storage and decentralised supply), but also to the resilience of the infrastructure of communication networks if essential components are outsourced. Digitalisation enables communication and collaboration independent of physical borders, which creates efficiency gains through a better matching of tasks and people – but it also increases the vulnerability if the functioning depends on the network infrastructure. Furthermore, digital products are highly complex and assembled from material and intermediate products with origins across the globe. The supply chain disruptions in the wake of Covid-19 clearly revealed the vulnerability of complex production systems (EPRS 2021). These properties make the digital economy vulnerable not only to extreme weather events, but also to disruptions resulting from social instability and conflicts which may be triggered by increasing environmental pressure (IPCC 2022a).

Positive interactions between digitalisation and climate policy

As well as imposing challenges for climate policy, digitalisation can also boost technological and social action in many areas, offering solutions to some of the most urgent problems.

Digitalisation can deliver efficiency gains which allow the same outcomes to be achieved with a lower number of inputs, while reducing energy and material throughput. For example, smart manufacturing technologies and computer-aided design technologies enable producers to improve the precision of material and energy input by tying it exactly to the minimum requirements in a production routine. In agriculture, precision farming relies on drones, enhanced meteorological and physiological monitoring tools, and software, which help reduce the input of fertilisers and water – with this input being exactly tied to the needs of the plants. In transportation, digital technologies help optimise the navigation and logistics of road, rail, and air transport. Meanwhile, automated driving technologies help automatically control the optimal speed and thus reduce fuel and energy use. In passenger transportation, digitalisation helps with the pooling of mobility needs, which thus reduces the requirement for individual mobility while achieving the same level of services provided. Digital platforms not only enable the sharing of mobility, but also of consumer durables, tools, and clothing, which may further help reduce the material dimension of consumption (D4S 2022, EC 2019).

However, this great potential comes with two caveats. First, due to the rebound effect mentioned above, climate-positive efficiency gains have not yet been realised. Second, the capabilities to harness efficiency gains may be unequally distributed. For example, large corporates benefit from returns to scale when investing in digitalisation at the firm-level while this proves more challenging for SMEs (D4S 2022). The unequal distribution may also exhibit a geographical dimension if access to web services for business and consumers is constrained by an unequal network coverage, for example to the detriment of rural regions.

Digitalisation may be a driver of structural change from goods production to an increasing reliance on services. This happens at the extensive and intensive margin: across industries, an increasing amount of production activity is relocated from manufacturing and goods production to services; and within industries and firms, an increasing share of work and output is shifted towards services. Services are – in most cases – less material, energy, and emission-intensive.

Examples can be found in many industries. Large manufacturers such as IBM, Siemens, and Caterpillar have followed servitisation pathways since as far back as the 1990s, when they began shifting their value creation from the production of goods to services. Digitalisation enables the spread of servitisation to an increasing range of industries (Favoretto et al 2022). For example, in the transport sector, major car producers increasingly develop a second pillar of their businesses in the provision of mobility services. Digital technologies boost the productivity and user-friendliness of these services, thus driving the diffusion of them.

A more comprehensive vision of servitisation for sustainability is connected to the concept of a circular economy, which relies on the reuse, remanufacturing, and recycling of every material component in final and intermediate goods. The major value creation relies on services for customers, repair and remanufacture, and the matching of suppliers and processors of used material. Circularity not only contributes to mitigation by improving the climate footprint of industrial production, it also closes supply chains to regionalised circles – which can contribute to climate change adaptation through an enhanced resilience against climate shock-induced supply chain disruptions.

“

Digitalisation may be also a driver of innovation in climate relevant technologies

”

Digitalisation can be a facilitator in achieving the circular economy. Indeed, digital technologies can be of great help in reducing information asymmetries in materials for the needs of suppliers and customers, facilitating the matching between them. For example, Digital Product Passports can help trace the material footprint of goods, which is a prerequisite of recycling; and it can help the decentralised matching of businesses providing recycling services and those offering the material (Pietron et al 2022).

However, accelerating the transition to the service economy comes with drawbacks, as it imposes transformative pressure on existing jobs in the production sector. The reskilling and retraining requirements for employees are already considered in many digital policies (EC 2021b) but this is only partially aligned with our climate goals.

Digitalisation may be also a driver of innovation in climate relevant technologies. For example, smart grids and smart metering improve the technical efficiency of renewable energy technologies. Weather forecasts aided by computer and sensor technology help manage the feed-in of electricity from fluctuating renewables such as solar and wind energy, which helps integrate them into the energy supply. Computers also accelerate technological progress in the biotechnology sector, where many complex analyses are not possible without digital analysis tools. On the climate change mitigation side, biotechnologies play a decisive role in material sciences and chemistry. These advances are relevant for recycling, and for agriculture, and they help address urgent environmental pollution problems – for example through the development of environmentally friendly materials. Furthermore, digitalisation also facilitates social innovation, such as consumer sharing models (Sareen and Haarstad, 2021). On the climate change adaptation side, various water supply technologies such as wastewater recycling or desalination rely on biochemical processes. In agriculture, biotechnology helps to develop new plants with a higher resilience against extreme weather. Climate change likely increases human exposure to infectious diseases, and biotechnology for testing, immunising, and curing can help cope with them.

"it is crucial to ensure effective and equal access to these technologies, which not only implies off-the-shelf access, but also affordability and the technological capacity of potential adopters to make effective use of a technology"

However, it is crucial to ensure effective and equal access to these technologies, which not only implies off-the-shelf access, but also affordability and the technological capacity of potential adopters to make effective use of a technology. This implies skills to understand, operate, adapt, maintain, and regulate it (Hötte and Jee 2022). Ideally, it also implies the human capacity for adaptation and self-innovation to overcome technological laggardness. A higher pace of technological progress in climate-relevant technologies stimulated by digitalisation may make it challenging for technological laggards to keep pace.

The interaction between digitalisation and the pace of innovation is certainly a desirable feature to accelerate the transition to a low-carbon economy, but it comes with the danger of leaving countries, regions, firms, and individuals behind. This matters within Europe, but even more at the global level if it increases the technological gap between the North and global South. Discussions about technology transfer in the context of climate change mitigation, adaptation, and compensation may need to take account of this challenge of leaving no one behind so that clean development can be enabled and climate justice ensured between the causers and victims of climate change.

Digitalisation offers great potential for climate change adaptation by improving our capacities to monitor and forecast climate events, to react to these events, and to cope with their impact. It thus enables detailed climate and weather monitoring at the regionally granular level. This informs agriculture, utility companies, infrastructure planners, and local policy about projected long-term climate changes and it enables them to incorporate the effects of these changes into their planning. Digitalisation thus facilitates easy access to relevant information and the sharing of this information. Monitoring and forecasting also help predict extreme weather events such as floods, storms, wildfires, and heatwaves, which enables local governments to issue warnings and to react in due time (EC 2021a).

Digitalisation can also help cope with the impact of climate change by facilitating behavioural adaptation to extreme weather. For example, remote work and access to digital services can help keep businesses going under extreme weather conditions and infrastructure disruptions. It also helps protect people from exposure to weather-related risks such as extreme heat or storms when essential services can be accessed and work can be done from home. Remote access to essential services such as medical consultations and e-commerce for necessities may be particularly relevant for those who are most vulnerable, such as the elderly or people with medical conditions. While the climate change adaptation benefits of digitalisation are promising, the access to these digital helpers is unequally distributed due to a lack of information and awareness, and due to a lack of skills and financial capacities. It is also due to practical constraints – for example, remote work is simply impossible or undesirable in certain occupations such as care or construction work.

Some of these barriers to access (for example those related to information and finance) can be addressed by policy. Others demand awareness and solidarity which take account of unequal digital adaptation capacities and seek non-digital adaptation alternatives, such as increased flexibility in working hours to minimise workers' exposure to extreme weather conditions on the way to their job and during their work.

Policy recommendations

The analysis above highlighted various negative and positive interactions between digitalisation and climate policy. Good policy design can reduce the negative interactions and leverage those that are positive to enhance the effectiveness of climate policy and to achieve coherence across different political goals. The following section discusses these policy options and outlines principles, examples, and proposals of how synergies between digitalisation and climate policy may be maximised along the three areas of climate action – mitigation, adaptation, and compensation. Each subsection begins with a description of the specific climate policy and its interaction with digitalisation, and concludes with a policy principle of how synergies between both fields can be achieved.

Mitigation

Climate change mitigation is the most prominent area of climate policy. In 2019, the European Commission launched an initial proposal for the European Green Deal (EGD) stating the ambition to achieve net zero GHG emissions by 2050. The EGD addresses eight key policy areas: Energy, Industry, Buildings, Agriculture, Pollution, Mobility, Biodiversity, and Sustainable finance (EC 2019).

Since its initial launch, the proposal has been extended by various detailed and area-specific implementation plans (for example, for green buildings, fighting pollution, protecting the ecosystem, alliances for batteries, hydrogen, and offshore wind energy). In response to the Covid crisis and energy price shock caused by the war in Ukraine, the EGD proposal has been supplemented by crisis response policies such as NextGenerationEU and REPowerEU, with implications for climate change mitigation and digitalisation. The focus here is on those parts of the EGD that overlap with digitalisation.

The rapid transition to clean energy is a bedrock of the EGD, which sets out intermediate targets of 40 per cent renewables in the European energy mix and of 36-39 per cent for energy efficiency improvements. Digitalisation can play a critical role for both the integration of renewables and the harnessing of energy efficiency gains. The high share of volatile renewable energy represents a challenge for the energy system, as the volatile supply patterns demand a high level of adaptive capacity of both the production and the consumption sides to achieve grid stability. At the same time, these new system requirements may also present a basis for novel start-ups entering the markets through innovative approaches of demand- and supply-side management. Smart electricity grids facilitate the load management, and the decentralisation of electricity generation offers scope for communities and start-ups to develop new market models, and for a democratisation of the energy system. Digitalisation plays a crucial role, not only by supplying the relevant technical tools but by providing access to centralised, standardised, and reliable information on energy demand and supply. This can promote entrepreneurial activity from small businesses and individuals.

The data may be aligned with the European digital strategy for European Green Deal Data Spaces (EC 2021b). The energy system data should cover a wide range of granular information, including detail on local supply and use patterns, environmental impacts, system constraints, and market information that takes account of the data needs of a wide range of potential users – from small businesses, to individual entrepreneurs, to large corporates, but also to organisations and individuals from civil society. To be effectively harnessed the data need to be standardised, and access rules must be clear and transparent to reduce market entry barriers for commercial and non-commercial inventors. Data sharing obligations also help break the competitive advantage of large data owners and allow data from various public and private sources to be combined for the public good, while simultaneously facilitating enforcement and control over compliance with data protection standards. Setting up the Green Data Spaces requires institutional support to solve legal hurdles, to build up and maintain the infrastructure, and to set the standards to make sure that data are shared and standardised in a way that facilitates effective reuse by third parties. The efforts to set up these structures are in their infancy and require significant investment, as well as the clarification of important design questions. The coherence with climate policy should be built in by design.

> **Principle 1: Increase the speed and depth of the energy transition by harnessing the potential of green data spaces to promote innovation, competition, and citizens' participation.**

One major obstacle to accelerating the low-carbon transition is the lack of skilled labour. The skill and labour needs cover a wide range of industries and occupations at different skill levels. For example, accelerating the rollout of renewables requires solar panel installers and wind engineers. The renovation of buildings demands contractors and installers with relevant knowledge about low-carbon heating systems and insulation technologies. Other key areas where green labour is needed are waste and water resource management, and consultancy services that guide businesses in agriculture and industry on their transition pathways (EC 2020b).

Strategies for re- and up-skilling programmes can be found in both the EGD and the Digital Compass (EC 2019, 2021a). Both the digital transition and the climate change mitigation transition have in common that they alter the types of skill required on the job and lead to cross-sectoral shifts of employment – for example, from coal mining to renewables, or from white collar administrative work to creative software design. An integrated policy approach should account for this commonality and seek alignment within a green and digital skills agenda. When re- and up-skilling workers whose previous skills become obsolete due to computerisation, for example, the skills demand of both the digital and the green economy should be taken into consideration for effective reschooling strategies. Furthermore, educational programmes should be designed, and budgets should be allocated, so that they simultaneously address the demand for green and digital skills.

Principle 2: Integrate the digital and the climate agenda for re- and up-skilling programmes to take account of the changing skill and labour demand in both areas: The digital and the climate transition.

Carbon pricing is one of the key policy tools to accelerate the phase-out of high-carbon sources of energy. However, carbon pricing is simple in theory but difficult in practice due to challenges related to the measurement and attribution of emissions. Currently, carbon pricing through the European Emissions Trading System (ETS) is only applied to a subset of sectors such as electricity and heat generation, energy-intensive production processes (eg, for steel, aluminium, cement) and commercial aviation. The ambition to expand the ETS to a wider range of industries is declared in the EGD (EC 2019).

Digitalisation can be a facilitator in the technical implementation of the ETS. For example, improved sensor, monitoring, and supply chain management tools can facilitate the data collection, processing, and information provision of emissions data, which is a prerequisite of any carbon pricing mechanism. If effectively used, the improved monitoring and emissions assessment may also provide the pathway for expanding the carbon pricing mechanism over a greater set of sectors than currently under assessment.

Furthermore, transparent information about the emission-intensity of products, processes, and energy sources facilitates sustainable consumption, innovation, and finance – if consumers, innovators, and investors have access to transparent, standardised, and reliable environmental and climate-related information.

Principle 3: Harness the digital opportunities of emissions monitoring to roll out carbon pricing and sustainability labelling on a large scale.

Circularity should become the principle of industrial production in Europe. This ambition is specified in a new industrial strategy for a "competitive, green, digital Europe" which aims to "harness the […] significant potential in global markets for low-emission technologies, sustainable products and services" (EC 2020c). The overlap with digitalisation is highlighted because both digitalisation and climate change will be the key drivers of industrial transformation in the coming years. The transition to a circular economy is one of the key goals of the European industrial strategy. Digitalisation could be an enabler of this transition as the lack of product information and effective matching mechanisms is one of the key barriers to this circularity. A Digital Product Passport, for example, could collect all relevant information about a product's composition, its current state, and resource footprint. This would help inform users, sellers, repairers, and recyclers about the true value of the product at the end of its lifetime, based on its components and their capacity for reuse. This would facilitate trading and further use, for example through repair or through the decomposition and recycling of its components. The availability of reliable information in digital market platforms would also facilitate the matching of sellers of outdated products and potential repairers, recyclers, and remanufacturers. Ideally, policy should ensure that this information is made available in a transparent, standardised, and accessible way while respecting legal data protection requirements (Pietron et al 2022).

Principle 4: Support the circular economy through the provision of reliable product information, matching the platforms of users, sellers, repairers, and manufacturers. ensure data access through the Green Data space to promote innovation and entrepreneurship.

Digitalisation is a driver of servitisation and it could alter the face of industrial production as we know it today. Indeed, digitalisation is associated with an increasing relocation of labour from goods production to services, with changing skill requirements for employees; it enables new patterns of employment (so-called platform workers in the gig economy); and it can have an impact on the market structure as it is a driver of concentration arising from economies of scale in the platform economy. By contrast, digitalisation can also facilitate the entrepreneurial activity of SMEs, helping the matching and coordination between highly specialised suppliers and user needs. Whether it operates in favour of sustainability may be a question of policy design, broader market conditions, and the institutional framework. The provision of climate-relevant information – for example by means of a Green Data Space – facilitates the emergence of sustainable business models, and the increasing servitisation operates to the benefit of the climate. However, it is essential to carefully monitor potential rebound effects as these could offset the climate-positive impact of the transformation. In addition, the impact of digitalisation on labour markets, market structure, and the distribution of power is uncertain, but its impact may critically interact with the feasibility of climate policy and need to be carefully monitored – for example by extending the Transition Performance Index as part of the annual Eurostat Sustainable Development monitoring report (EC 2021d). Distributional injustices and the concentration of power may undermine the societal support that is needed for stringent climate policy. It is therefore vital to aim for an integrated approach to climate and digital policy.

Principle 5: Ensure the provision of climate relevant information through a green data space to enable and facilitate sustainable innovation and entrepreneurship in digital services. Establish institutional practices to monitor adverse side effects such as emission rebound effects, distributional injustices, market concentration, and polarisation.

‘Farm to fork’ describes the scope of the climate strategy for agriculture. Indeed, this strategy aims to reduce the environmental and climate footprint while ensuring food security and system resilience in the face of climate change and biodiversity loss. The strategy thus aims to lead a global transition to sustainable agriculture. This should be achieved by reducing and preventing food losses, and by sustainable production, processing, distribution, and food consumption (EC 2020d). Digitalisation could enable efficiency gains on a large scale because digitalised precision agriculture that relies on monitoring systems for weather conditions, pests, diseases, and soil and plant health enable a more targeted use of water, fertilisers, pesticides, and labour – which not only saves energy and resources but also comes with the benefit of reduced environmental pollution. Satellite monitoring further helps assess forest health, supporting reforestation and wildfire prevention.

Digital tools enable knowledge-sharing between farmers, foresters, and local communities to help share best practice. Digital platforms thus enable a better matching between seasonal agricultural production and environmentally motivated consumers, caterers, and restaurants. In addition, these platforms may facilitate the matching between primary organic food producers and processors, which often operate on a small scale and find it difficult to build up their supply chain. Product labelling and reliable certification can then help improve transparency about the ecological footprint and nutritional value of end products for final consumers.

Policy could promote the diffusion of climate-smart agriculture among farmers through the introduction of training programmes and financial investment support via tax credits (or other instruments from the Common Agricultural Policy) for technologies with an ecological benefit. A Green Data Space could be used as a platform for standardised geographical and environmental information to improve access to information for businesses and digital service providers that act as intermediaries between sustainable businesses vertically along the value chain, and between businesses and consumers to promote sustainable consumption. The environmental information could also help certification companies strengthen the reliability of their accreditation. Consumer protection organisations could use the information to navigate through sustainable food markets for product assessments.

> **Principle 6: Facilitate the sharing of data and best practice among farmers, distributors, and customers to facilitate sustainable consumption and production, and to avoid food waste. Green data spaces can be used to promote sustainable innovation and entrepreneurship along the whole supply chain.**

The large-scale rollout of energy-efficient buildings is one of the greatest challenges in the low-carbon transition. In 2020, the European Commission called for a "Renovation Wave" by setting a benchmark of 49 per cent of renewables in buildings by 2030 and requiring member states to renovate at least 3 per cent of public buildings annually, in order to increase the use of renewables in heating and cooling by 1.1 percentage points each year until 2030. These actions aim to tackle energy poverty and to achieve cost-effectiveness by prioritising the worst performing buildings. Given the labour intensity of the construction sector, the renovation plan comes with positive employment effects as a by-product. Construction services are often supplied by local SMEs, which could strengthen the local economy and help alleviate market concentration, as well as rural unemployment. This would be to the benefit of the economic recovery after Covid-19 (EC 2020e).

Digitalisation has great potential to improve the energy efficiency of buildings. Smart buildings equipped with control technology and sensors enable the targeted use of heating, lighting, and appliances such as fridges and washing machines. Given the volatile generation profiles of renewables, these technologies can contribute to the alignment of energy demand at the house, district, and city level – for example by smart control of heating or through the integration of charging infrastructure for electric vehicles. To track progress in this domain, the European Commission introduced a new Smart Readiness Indicator that labels buildings by their capacity to adapt smartly to the energy needs of the occupants. Labels and certificates thus inform consumers, homeowners, and contractors about the lifecycle energy and material performance of buildings. The obligation to label buildings with Energy Performance Certificates (EPC) is to be extended and the EPCs are to contain more and clearer information. This helps consumers make climate-sensitive choices and helps investors identify the greatest energy efficiency improvement potential. The easy and low-cost access to information should boost renovation. Renovation Passports and Digital Building Logbooks that integrate all building-related information should facilitate contractors to identify renovation needs but also to integrate the circularity concept if sufficient information about the recyclability and origin of materials is provided. Overlaps with the Digital Product Passports discussed above need to be considered. The Commission aims to establish a European Building Stock Observatory as a repository for reliable data on buildings, their energy performance, and design.

To achieve the greatest digitalisation benefits and promote innovation and entrepreneurship, the buildings data should be combined with the energy systems, mobility, and circular economy data – ideally within the scope of a Green Data Space. This requires common rules for the collection, standardisation, access, and protection of data.

> **Principle 7: Facilitate technological, financial, and social innovation and investment in energy-efficient buildings by connecting the renovation wave with the energy systems, mobility, and circular economy transition.**

The future of mobility in Europe is to be sustainable, smart, resilient, and multi-modal. Policy actions include the build-up of faster rail connections for passenger and freight transport, improved service provision and the coupling of different transport modes with digital help, urban infrastructure projects to the benefit of walking, cycling, public transport and other forms of low-carbon mobility, zero-emission aircraft by 2035, and a higher share of freight transport by waterways. The European Commission aims to unleash the full potential of data and digitalisation – for example, digitalisation helps in logistics optimisation, improved customer services that enable easy ticketing and seamless multimodal passenger transport, paperless freight transport, and automated mobility solutions on a large scale (EC 2019).

Achieving these goals requires the collection of transport-related data on mobility supply and demand across different transport modes for long and short distances, covering both passenger and freight transport. This ranges from walking, cycling, different means of public transport, ride-hailing services, and private cars, to freight transport by road (including local deliveries by bike), rail, and waterways. Data enable the optimisation of logistics and help identify scope for innovation by mobility service providers. Open, free, and easy access to the relevant data and digital tools needs to be ensured in order to guarantee just access to mobility service providers. Data sharing and disclosure obligations may need to be investigated to leverage the scope of available data and break data monopolies. Open and free access to transport-related data may help prevent market concentration by digital mobility service providers, as it enables bottom-up innovation.

On the consumer side, it needs to be ensured that the digitalisation benefits in the transport system are accessible to all, irrespective of age, health, or geography. For example, elderly or disabled people may struggle to access digital tools for easy ticketing or may face health-related barriers in the use of public transport. Data-driven innovation may indeed be discriminatory if mobility data is non-representative (for example by poorly representing elderly or disabled people or by being biased by gender).

Implementing and accelerating the shift to digitally enhanced public transport should not come with a disadvantage for those who are less mobile today and who are therefore poorly represented in the data. Public transport needs to be inclusive. Furthermore, particular attention needs to be paid to economically weak rural areas where the market alone provides insufficient incentives for mobility service supply by private companies. These possible sources of market failure need to be carefully monitored and coping strategies need to be developed – for example, through public infrastructure investment and local service supply obligations to cover remote regions.

Principle 8: Push and support data sharing and use for innovation in services and logistics in sustainable, multi-modal, and user-friendly mobility. Sustainable mobility must be inclusive and regulatory guidelines are needed to make it accessible to all, irrespective of geography, age, and health.

The provision of information which is enabled by digitalisation offers great potential for the control of environmental pollutants. Environmental reporting should become mandatory for large companies with sufficient organisational capacity, and the data (including public data that is already collected) should be made accessible – for example in a Green Data Space. Transparent information provision enables citizens and environmental protection groups to claim their rights on a clean environment, and it helps citizens and local governments to act in response to pollutants. Reliable and transparent information helps raise societal awareness and political support for control measures. Policymakers can use the environmental monitoring information to identify high impact areas and sources of pollution, which facilitates targeted and effective policy measures instead of lump sum action.

Monitoring and data collection can also help protect biodiversity, as centralised, open, and standardised information can help identify areas with a high value for biodiversity.

Information initiatives to fight pollution and protect biodiversity should be aligned with other climate data initiatives, including those for the circular economy, in order to prevent the offsetting of harmful substances.

Principle 9: Use green data spaces to aggregate information on environmental pollutants of various forms to help civil society and local governments take action.

Taken together, digitalisation can greatly contribute to the provision of reliable and harmonised information, and it facilitates the matching of customers, suppliers, and other stakeholders by computational tools for processing and interpreting the data. These properties qualify digitalisation as a booster of sustainable finance. Until now the lack of credible information has been a key barrier to sustainable finance and non-standardised labels and certifications have been a door opener for green washing that has undermined the credibility of sustainable financial products (ESMA 2022, EC 2021c).

To harness the greatest benefits from the improved data availability through the Green Data Spaces, the data need to be credible and sufficiently detailed to be able to assess the sustainability of sectors, financial products, and firms meaningfully, while respecting confidentiality wherever required. Companies can be mandated to make their environmental and climate data and reporting outcomes available. Credibility may be achieved by transparency and by allowing third parties (especially researchers and non-governmental institutions) to access and verify the published data. This requires the traceability of processed data back to the raw data. It also requires transparency about the methods used to calculate certain performance indicators. Guidelines for reproducibility and transparency as established in various fields of scientific research offer a set of principles that can be useful for setting the transparency rules.

The improved access to climate-relevant data enables the sustainability rankings of firms and financial products. The data need to be sufficiently detailed and must allow for a disaggregation into relevant dimensions – for example, the level of detail needs to be higher than in the current EU taxonomy for sustainable activities in order to enable investors to identify controversial sectors such as gas and nuclear, and to distinguish them from renewable energy producers. The principles of the Task Force on Climate Related Financial Disclosures1 could serve as a guideline for the reporting standards. For subsequent use, it is vital to make this disclosure data publicly available in a standardised way that allows the data to be processed and compared across reporting units.

> **Principle 10: Use the framework of green Data Spaces to aggregate and standardise the climate-reporting of publicly listed companies to promote sustainable investment and mobilise private finance for the climate transition.**

Adaptation

Climate change adaptation is an imperative and is part of the EGD and European climate law, both of which aim for policy coherence between climate neutrality and resilience. In 2021, the European Commission launched a strategy to "Forg[e] a climate-resilient Europe" (EC 2021a). Given the systemic nature of adaptation, it is to be implemented in an integrated manner within other EGD initiatives, including those on agriculture, circular production, zero pollution, forest and soil strategies, mobility, and sustainable finance.

Digitalisation plays a role in various subfields of adaptation. It enables "smarter adaptation: [by] improving knowledge and managing uncertainty". There is an increased need to understand and monitor climate risks at the biophysical and asset level (eg, real estate, factories, buildings, agricultural land), and to gather and centralise information about adaptation strategies. Existing priorities to support research need to be adapted to these directions and to foster the sharing and dissemination of knowledge and experience about local adaptation plans (EC 2021a).

Digitalisation helps collect, process, manage, and distribute these data at any level of governance. It can thus inform individual businesses about adaptation needs and strategies. At the local level, digitalisation can help inform citizens about extreme weather events and coping strategies. At the regional, national, and supranational level, data and information help to coordinate action, share experiences, and develop long-term strategies to manage systemic risks. Furthermore, digitalisation also facilitates the checking of coherence of adaptation plans across different levels of governance, and the harnessing of potential synergies between these actions.

Effective use of the data requires steps of harmonisation, standardisation, and system integration, as well as the provision of data infrastructure and compliance with legal standards to ensure that data can be effectively used. With regard to climate change mitigation, synergies with the European Digital Agenda may be achieved through the integration of adaptation-related data within the framework of a European Green Data Space. This would not only help public decision-makers at different levels of governance to access climate-relevant information, but it would also stimulate private innovation and adaptation among businesses.

1 https://www.fsb-tcfd.org/about/

Principle 11: Use the framework of the Green Data Spaces to aggregate adaptation-related data on expected climate impacts, coping strategies, and experiences. these data should be structured by the types of impact and geographical distribution, and by the level of government to inform political decision-makers, citizens, and businesses about adaptation actions to be taken.

Climate insurance offers a wide scope for financial innovation in adaptation. The insurance industry would greatly benefit from improved data availability, and it is itself a possessor of great amounts of data. Within the lines of the European Data Act, data sharing obligations should be explored to break data monopolies, while simultaneously supporting the insurance industry and stimulating innovation and entrepreneurship through the availability of climate-related information. However, market-based adaptation solutions like insurance can only hedge climate risks if there is a business case. This is not the case if assets are almost certain to be lost or if the party to be insured cannot afford the fee. Data availability can be a key mobiliser of private finance and market-based solutions for adaptation, but it needs to be accompanied by non-market adaptation measures such as disaster aid or transition and relocation support for climate risks that cannot be insured through the market. Solidary financial support may be required for vulnerable people and regions that lack the financial means to afford insurance-based adaptation solutions themselves.

Principle 12: Improved data availability should be a driver of innovation for financial and market-oriented solutions for adaptation, as well as for solutions for adaptation that are not profitable in the market.

Deep digitalisation that permeates almost every sector of our lives comes with the risk of an increasing dependence on the functioning of physical network infrastructure. An increased reliance on digital tools for the provision of essential services (for example, those related to health, payment, and retail) comes with the risk of higher vulnerability to infrastructure disruptions. Coherence with adaptation should also be ensured in the European Digital Agenda to anticipate climate-related risks and to strengthen resilience. This may have different dimensions. The first is the physical dimension of the technical vulnerability of communication networks. The second dimension relates to the design of software and digital tools to make them resilient against short- to medium-term disruptions of the communication networks, and to enable principles of modularity to be adopted so that the breakdown of individual parts does not induce a collapse of the whole system – for example, decentralised solutions may be favourable and the availability of offline back-up solutions can contribute to the system's resilience. Back-up solutions should become part of the design to avoid data losses and to allow data access irrespective of the connection to the network. This also includes solutions for cases when the communication and electricity infrastructure are fully broken down.

Principle 13: Anticipate extreme climate events when rolling out digital infrastructure, designing software, and digital services. Avoid systemic risks through modularity and decentralised solutions, and embed back-up and offline solutions in the design of essential digital services.

Digital innovation can also provide very direct help for adaptation (including organisational innovations such as remote work, and product and process innovations such as data-aided irrigation in agriculture or insulation systems in buildings). Policy can help stimulate the diffusion of these digitally based adaptation strategies – for example, re-skilling and workplace regulation can explicitly take account of the potential of remote work to protect employees from exposure to heatwaves and extreme weather on their way to work, and can help firms run their business while reducing their exposure to extreme weather disruptions. Re-skilling and life-long learning programmes can explicitly take account of the potential of digital helpers for climate change adaptation and can make self-employed workers and citizens fit to adopt these tools.

> **Principle 14: Promote awareness for adaptation co-benefits in the implementation and design of digital reskilling programmes and workplace regulation.**

Compensation

Climate change compensation is the most nascent field of climate policy. It mainly concerns the debate of industrialised countries (mostly from the global North) acknowledging their responsibility for loss and damage in the global South. Although the policy area is nascent today, it is increasingly recognised that the impact of climate change is a driving force behind regional conflicts, and migration, and may be a threat to global political stability (IPCC 2022). Climate change compensation has not yet made it into concrete commitments2 by the EU despite commitments for Climate Finance and Technology Transfer within the framework of the Paris Agreement (UNFCCC 2016). Climate compensation is becoming an increasingly pressing issue on the agenda of international policy, not least because the lack of delivery on these financial and technological promises by Northern countries undermines international cooperation. Furthermore, advances in climate change attribution science and successful lawsuits put an increasingly legal weight on compensation liabilities. Finally, increased migration induced by climate change and the reliance on stable trade relationships make compensation increasingly important in international policy to alleviate global risks. Climate compensation also interacts with the European development policy and the EU's commitment to the Sustainable Development Goals (EU 2017, UN 2015).

Digitalisation is mainly factored into this process through the channel of technology transfer and technical aid in mitigation and adaptation. Furthermore, digitalisation enables technological leapfrogging (IPCC 2022b) – for example, mobile payment systems via a mobile phone enable payments without the requirement of building up a full financial infrastructure and banking system. Mobile phones also offer a window to the information available in the world. For example, farmers can adopt their agricultural practices in response to granular level weather forecasts, and students can access knowledge sources without the requirement of buying books.

While some of these digital technologies entail direct climate change mitigation or adaptation benefits (such as payment models that enable off-grid solar panel adoption or weather forecasts in farming or education for sustainable development), other tools operate indirectly. For example, a financial infrastructure is essential to implement adaptation measures such as climate insurance or to pay financial aid in response to a natural disaster.

The synergies between digitalisation and sustainable development should be considered in the design of policies that promote the transfer of digital and climate technologies. This can be

2 https://euobserver.com/green-economy/156336

reflected in the prioritisation of specific technologies or in the concrete provision of technical and practical assistance. For example, climate data, regional risk assessment tools and insights developed through the EU domestic adaptation plan should be openly shared with developing nations, and measures such as upskilling and technical assistance programmes should be taken to facilitate the adoption and effective use of these digital helpers. Climate finance can be directed to those areas that simultaneously promote both digitalisation and the fight against climate change.

Principle 15: Direct climate technology transfer and climate finance into those technologies that promise the greatest digitalisation-climate co-benefits. Promote effective knowledge and technology sharing, and contribute to building up capacities that are needed to adopt and use digital and climate technology effectively.

Conclusions and way forward

Climate change and digitalisation are the big technological challenges of the 21st century and both require political action. Climate action is needed to accelerate the technological transition to climate neutrality and resilience while leaving no one behind, including the poorest living in the most vulnerable countries and regions. Digitalisation is a self-driving process fuelled by ongoing technological advances. It needs to be guided to avoid adverse side effects arising from data monopolies which undermine competition, the threat of mass surveillance, and an unequal distribution of gains and access to digital technologies. This policy brief outlined the risks of how digitalisation may undermine the effectiveness of climate policy, and it proposed 15 principles for how both processes can be taken positively and for how synergies between digitalisation and climate policy can be created.

“Digitalisation is a general-purpose technology permeating almost every sector of our personal, economic, and social life. Its benefits and risks therefore interact with almost every climate action that needs to be taken”

Digitalisation is a general-purpose technology permeating almost every sector of our personal, economic, and social life. Its benefits and risks therefore interact with almost every climate action that needs to be taken, ranging from emission abatement policies in energy, buildings, transport, and agriculture, to leveraging technical tools for climate change adaptation, to technology transfer so as to enable sustainable development out of an awareness of our responsibility for climate compensation.

References

Allwood, G. (2022) 'The EU's Transition to Climate Justice & Gender Equality – How just and how equal?', Policy Brief, The Foundation for European Progressive Studies (FEPS), Brussels (https://feps-europe.eu/publication/the-eus-transition-to-climate-justice-and-gender-equality/)

Berkhout, P. H., Muskens, J. C. and Velthuijsen, J. W. (2000) 'Defining the rebound effect', Energy policy, 28(6-7), 425-432 (https://doi.org/10.1016/S0301-4215(00)00022-7)

Chancel, L. (2022) 'Global carbon inequality over 1990–2019', Nature Sustainability (https://doi.org/10.1038/s41893-022-00955-z)

Digitalization for Sustainability (D4S) (2022) 'Digital Reset. Redirecting Technologies for the Deep Sustainability Transformation', Berlin: TU Berlin (http://dx.doi.org/10.14279/depositonce-1618)

Drews, S. and Van den Bergh, J. C. (2016) 'What explains public support for climate policies? A review of empirical and experimental studies', Climate Policy, 16(7), 855-876 (10.1080/14693062.2015.1058240)

European Commission (EC) (2019) 'The European Green Deal', Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN)

European Commission (EC) (2020a) 'Shaping Europe's digital future' (https://ec.europa.eu/info/sites/default/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf)

European Commission (EC) (2020b) 'Green Growth, Jobs and Social Impacts Fact Sheet', DG ENV. F1–Dec 2020 (https://ec.europa.eu/environment/enveco/pdf/FACT_SHEET_ii_Green_Growth_Jobs_Social_Impacts.pdf)

European Commission (EC) (2020c) 'A New Industrial Strategy for Europe', Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0102)

European Commission (EC) (2020d) 'A Farm to Fork Strategy', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381)

European Commission (EC) (2020e) 'A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0550)

European Commission (EC) (2021a) 'Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=COM:2021:82:FIN&rid=3)

European Commission (EC) (2021b) '2030 Digital Compass: the European way for the Digital Decade', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52021DC0118)

European Commission (EC) (2021c) 'Strategy for Financing the Transition to a Sustainable Economy', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0390)

European Commission (EC) (2021d) 'Transitions Performance Index 2021. Towards fair and prosperous sustainability', European Commission, Directorate for Research and Innovation. https://data.europa.eu/doi/10.2777/09602

European Commission (EC) (2022) Commission Staff Working Document on Common European Data Spaces (https://ec.europa.eu/newsroom/dae/redirection/document/83562)

European Parliament Research Services (EPRS) (2021) 'Resilience of global supply chains – Challenges and solutions', Briefing PE 698.815, Author: Marcin Szczepanski (www.europarl.europa.eu/RegData/etudes/BRIE/2021/698815/EPRS_BRI(2021)698815_EN.pdf)

European Securities and Markets Authority (ESMA) (2022) 'Sustainable Finance Roadmap 2022-2024', ESMA30-379-1051 (www.esma.europa.eu/sites/default/files/library/esma30-379-1051_sustainable_finance_roadmap.pdf)

European Union (EU) (2017) 'The new European Consensus on Development – Our World, our Dignity, our Future', Joint statement by the Council and the representatives of the governments of the Member States meeting within the Council, the European Parliament and the Commission, Official Journal of the European Union, 2017/C 210/01 (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A42017Y0630%2801%29)

Favoretto, C., Mendes, G. H., Oliveira, M. G., Cauchick-Miguel, P. A. and Coreynen, W. (2022) 'From servitization to digital servitization: How digitalization transforms companies' transition towards services', Industrial marketing management, 102, 104-121 (https://doi.org/10.1016/j.indmarman.2022.01.003)

Frey, C. B., Berger, T. and Chen, C. (2018) 'Political machinery: did robots swing the 2016 US presidential election?' Oxford Review of Economic Policy, 34(3), 418-442 (https://doi.org/10.1093/oxrep/gry007)

Fouquet, R. and Hippe, R. (2022) 'Twin transitions of decarbonisation and digitalisation: A historical perspective on energy and information in European economies', Energy Research & Social Science, 91, 102736 (https://doi.org/10.1016/j.erss.2022.102736)

Haas, W., Lampl, C. and Schmidt, A. (2022) 'Mainstreaming climate – Climate and health policy', [forthcoming]

Hötte, K. and Jee, S. J. (2022) 'Knowledge for a warmer world: A patent analysis of climate change adaptation technologies', Technological Forecasting and Social Change, 183, 121879 (https://doi.org/10.1016/j.techfore.2022.121879)

Hötte, K., Somers, M. and Theodorakopoulos, A. (2022) 'The fear of technology-driven unemployment and its empirical base' (https://voxeu.org/article/fear-technology-driven-unemployment-and-its-empirical-base)

International Labour Organization (ILO) (2019) 'Skills for a greener future: a global view based on 32 country studies', International Labour Office, Geneva (www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_732214.pdf)

IPCC (2021) 'Climate Change 2021: The Physical Science Basis', Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J.B.R., Maycock, T.K., Waterfield, T., Yelekçi, O., Yu, R., and Zhou, B. (eds), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press (doi:10.1017/9781009157896)

IPCC (2022a) 'Climate Change 2022: Impacts, Adaptation, and Vulnerability', Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds), Cambridge, UK and New York, NY, USA: Cambridge University Press, 3056 pp (doi:10.1017/9781009325844)

IPCC (2022b) 'Climate Change 2022: Mitigation of Climate Change', Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds), Cambridge, UK and New York, NY, USA: Cambridge University Press (doi: 10.1017/9781009157926)

Jovanovic, B. and Rousseau, P. L. (2005) 'General purpose technologies' in Handbook of economic growth (Vol. 1, pp. 1181-1224), Amsterdam: Elsevier (https://doi.org/10.1016/S0169-7218(10)02002-2)

Knight, C. and Le Merle, K. (2022) 'Mainstreaming climate – Principles for climate justice', [forthcoming]

Lange, S., Pohl, J. and Santarius, T. (2020) 'Digitalization and energy consumption. Does ICT reduce energy demand?', Ecological Economics, 176, 106760 (https://doi.org/10.1016/j.ecolecon.2020.106760)

Nogarede, J. and Støstad, J.E. (2020) 'A Progressive Approach to Digital Tech. Taking Charge of Europe's Digital Future', A FEPS SAMAK report (https://feps-europe.eu/wp-content/uploads/downloads/publications/feps_samak a progressive approach to digital tech.pdf)

Nogarede, J. (2021) 'No digitalisation without representation – An analysis of policies to empower labour in the digital workplace', Policy Brief, The Foundation for European Progressive Studies (FEPS), Brussels (https://feps-europe.eu/publication/826-no-digitalisation-without-representation/)

Pakulska, T. and Poniatowska-Jaksch, M. (2022) 'Digitalization in the Renewable Energy Sector—New Market Players', Energies, 15(13), 4714 (https://doi.org/10.3390/en15134714)

Pietron, D., Staab, P. and Hofmann, F. (2022) 'Sustainable Digital Market Design – A data-based Approach to the Circular Economy', Policy Brief, The Foundation for European Progressive Studies (FEPS), Brussels (https://feps-europe.eu/publication/sustainable-digital-market-design/)

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. and Foley, J. (2009) 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity', Ecology and Society, 14(2) (www.jstor.org/stable/26268316

Sareen, S. and Haarstad, H. (2021) 'Digitalization as a driver of transformative environmental innovation', Environmental Innovation and Societal Transitions, 41, 93-95 (https://doi.org/10.1016/j.eist.2021.09.016)

Semenza, J. C. (2021) 'Lateral public health: advancing systemic resilience to climate change', The Lancet Regional Health–Europe, 9 (https://doi.org/10.1016/j.lanepe.2021.100231)

UN (2015) 'Transforming our World: The 2030 Agenda for Sustainable Development', A/RES/70/1, United Nations Sustainable Development Goals Knowledge Platform (https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf)

UNEP (2021) 'The Gathering Storm – Adapting to climate change in a post-pandemic world', Adaptation Gap Report 2021, United Nations Environment Programme (UNEP), UNEP DTU Partnership and World Adaptation Science Programme (WASP) (www.unep.org/adaptation-gap-report-2021)

UNFCCC (2016) 'Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015', Decisions adopted by the Conference of Parties, United Nations Framework Convention on Climate Change, Conference of Parties (COP) 21 (https://unfccc.int/sites/default/files/resource/docs/2015/cop21/eng/10a01.pdf)

About the author

DR KERSTIN HÖTTE

Dr Kerstin Hötte is an Associate at the Alan Turing Institute and an Academic Visitor at the Institute for New Economic Thinking at the University of Oxford.

She studied economics at the Universities Tübingen and Bonn in Germany, and obtained her PhD in a joint degree programme from the universities Paris-1 Sorbonne-Panthéon and Bielefeld.

Her research focuses on the economics of technology transitions when an incumbent technology is replaced by an entrant alternative.

In her PhD, she developed the theoretical foundations of a macroeconomic transition model and technological learning dynamics using agent-based simulations. In subsequent projects, she works on the empirical foundations of technology-specific capabilities, learning and industrial evolution.

Her empirical work builds on the interactions between science, technology and input-output networks. A major application of her work is the transition to climate-friendly technology.

About Friedrich-Ebert-Stiftung

The EU Office of the Friedrich-Ebert-Stiftung (FES), with its headquarters in Brussels and activities in Brussels and Strasbourg, was opened in 1973. The EU Office participates in the European integration process, backs and accompanies the interests of the Federal Republic of Germany in Europe and contributes to shaping the external relations of the European Union.

www.brussels.fes.de | Twitter: @FES_Brussels | Instagram: FES_Europe | Facebook: @FESonline

About FEPS

The Foundation for European Progressive Studies (FEPS) is the think tank of the progressive political family at EU level. Its mission is to develop innovative research, policy advice, training and debates to inspire and inform progressive politics and policies across Europe.

FEPS works in close partnership with its 68 members and other partners -including renowned universities, scholars, policymakers and activists-, forging connections among stakeholders from the world of politics, academia and civil society at local, regional, national, European and global levels.

European Political Foundation - Nº 4 BE 896.230.213 | Avenue des Arts 46 1000 Brussels (Belgium)

www.feps-europe.eu | Twitter/Instagram: @FEPS_Europe | Facebook: @FEPSEurope

Cover photo: © Shuttertock

ON SIMILAR TOPICS