

Policy Paper

A European Way to our Common Digital Future

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Summary

The new European Commission president has announced a Green Deal for Europe. This can only succeed if opportunities and risks of digitalization for a fundamental transformation of the economy and society are taken into account. In this paper, the WBGU develops cornerstones of a European way to a common digital future. The EU's cross-cutting sustainability policy needs an implementation strategy for the SDGs and an 8th Environmental Action Programme that exploits digital technologies for its objectives and minimizes the risks associated with them. The EU's digital policy should implement ecological and social objectives in addition to economic ones and therefore demand, for example, the provision of data by companies and sustainability-oriented AI. Public-service digital infrastructures and services should also be guaranteed. Research and innovation policy should strategically promote digital technologies to achieve sustainability goals. In this way, the EU can become an international role model in interlinking digitalization and sustainability.

With her Green Deal for Europe, Ursula von der Leyen, as the new European Commission president, aims to achieve the goals of the Paris Climate Agreement. The European Union (EU) has furthermore committed itself to the 17 UN Sustainable Development Goals (SDGs) of the 2030 Agenda. Digital change offers great opportunities, but also poses new challenges, in the implementation of these objectives. Although digitalization also has a high priority for the new Commission, the work programme planned so far does not establish sufficient links between the Green Deal, sustainability and digitalization. Digitalization has not been sufficiently placed at the service of a Transformation towards Sustainability, nor has a sustainability-oriented design of digital and digitalized technologies and applications. Furthermore, there is no convincing alternative to the primarily market-controlled, possibility-driven process of digitalization that is ongoing e.g. in the USA and partly in Europe, or to the use of digital instruments to exercise authoritarian state power, e.g. in China. Building on its flagship report 'Our Common Digital Future' (WBGU, 2019b), the WBGU aims to stimulate the EU to develop such an alternative in order to systematically combine digital change with the Transformation towards Sustainability. This 'European way' corresponds to the EU's normative foundations, which define economic, ecological and social sustainability as its objective.

Particularly during its presidency of the Council of

the EU in 2020 and together with its trio presidency partners Slovenia and Portugal, Germany's Federal Government should work towards a close integration of digital change and the Transformation towards Sustainability under the motto 'Digitalization for Sustainability'. The new EU Parliament and the new European Commission should also pursue this goal. The WBGU's recommendations on a European way to digitalization involve sustainability policy, digital policy, research and innovation policy, as well as EU foreign policy:

1. *Integrate the opportunities and risks of digitalization into EU sustainability policy:* The EU needs an implementation strategy for the SDGs that also places digital technologies at the service of sustainability and addresses its risks. In the same way, digitalization should be embedded in the 8th Environmental Action Programme from 2021 onwards. Digital change creates solutions and new challenges, both in cross-cutting policy orientation and strategy development and in individual policy areas (e.g. energy, industry, mobility, agriculture, urban development), which should be systematically integrated. The basis for this is a reliable, broad and shared digital database at all levels of governance to strengthen policy planning and implementation. In addition, digitalization-specific dynamics should be included in the further development of the sustainability agenda.

2. *Actively shape digital policy in line with sustainability goals:* Digitalization can help overcome path dependencies and thus replace unsustainable behaviour patterns and business models. However, this is not an automatic process. Economic aspects still dominate in the promotion and use of digital technologies – also in competition with China and the USA. Ecological and social aims that can be reached through digitalization should be pursued with equal emphasis, e.g. via the European Digital Agenda, the European Commission's Strategy for Artificial Intelligence (AI), or measures within the framework of the Digital Europe programme. Negative (side) effects should be identified and minimized at an early stage. For example, new digital mobility solutions should be derived not so much from what is technically feasible, but systematically from a people-centred guiding concept for sustainable mobility.
3. *Involve the private sector more in the provision of data:* Up to now, EU data policy has concentrated on the protection of personal data and the use of data from public authorities. This does not go far enough: accessibility to, and the re-use of (non-personal) private-sector data should also be improved in order to create data that can be used for the common good and digitalized (knowledge) assets. This is fundamental for welfare-enhancing knowledge growth and sustainability policy and promotes economic competition, which limits market power. Already today, EU data policy allows Member States to regulate access to the data of private companies. Germany should play a pioneering role in this context.
4. *Develop and apply artificial intelligence in a sustainable way:* The EU should be consistent in following its value-based approach in the application and development of AI systems: fundamental rights, human dignity, environmental and sustainability principles are the normative foundation of the EU and non-negotiable. There is an urgent need for (framework) legislation on the development and handling of AI, since ethical guidelines and debates alone are not enough to ensure a corresponding development and application. In addition, research on explainable and secure, i.e. reliably verified and validated, AI should be promoted and used to ensure trustworthy, fair and accountable procedures.
5. *Ensure access to digital commons and basic services through public-service information and communication technology (ICT) infrastructures:* Individual inclusion, personal development, environmental protection, fair competition and a functioning digital public sphere require access to data and services such as cloud services, mobility platforms or a search index. Their almost exclusively private-sector provision is not always in the interests of the common good. Our understanding of services of public interest in the Digital Age should therefore be broadened: the EU's task should be to create or ensure public-service digital and digitalized infrastructures to make data and information accessible for the common good and to offer alternative (basic) services under public law.
6. *Gear EU research policy and promotion of innovations consistently towards sustainability goals:* Responsible Research and Innovation (RRI) should be applied as an overarching concept of European research and innovation policy in order to explicitly embed the orientation towards sustainability goals and to avoid unintended impacts. The high levels of protection of the environment, consumers and occupational health and safety in the EU must not be weakened by the innovation principle currently under discussion. Horizon Europe's missions should aim to integrate digital change and the Transformation towards Sustainability and strengthen transformative and transformation research. Open Science should be expanded and a sustainability-oriented, EU-wide innovation management system introduced, especially for projects with public participation.
7. *European digitalization model as a priority in foreign policy:* The EU should also promote the integration of sustainability and digitalization internationally. It should initiate a summit on 'Sustainability in the Digital Age', e.g. for 2022, symbolically 30 years after the Earth Summit in Rio, to set the course for the necessary continuation of the sustainability agenda until 2030 and beyond (WBGU, 2019b).

Introduction: Digitalization for sustainability!

Ursula von der Leyen has announced a Green Deal for the first 100 days of her European Commission presidency aimed at making Europe the first climate-neutral continent by 2050 (von der Leyen, 2019). By this she is confirming the climate-policy vision of the last Commission (European Commission, 2018c). The pursuit of this goal urgently requires “rapid and far-reaching system transitions in energy, land, urban-infrastructure [...] and industrial systems” (IPCC, 2018). This can only succeed if the climate-policy Green Deal is combined with a comprehensive alignment of EU policy with sustainability goals, and a corresponding transformation is initiated (WBGU, 2011). At the same time, digitalization – i.e. the development and application of digital and digitalized technologies that augment and dovetail with all other technologies and methods (WBGU, 2019b) – is penetrating and changing more and more areas of life and society. Alongside resolute action in ‘classic’ policy areas, shaping digital change is therefore a necessary condition for achieving the internationally agreed climate goals and the 17 SDGs; in addition, however, it can also play a positive key role. The European Commission should therefore work cooperatively on climate, sustainability and digitalization issues in order to overcome three challenges: placing digitalization at the service of sustainability policy across sectors, shaping digital policy towards sustainability, and making greater use of research and innovation policy to support sustainable development in the Digital Age. There has been no integrated approach for this until now. Based on its flagship report ‘Our Common Digital Future’ (WBGU, 2019b), the WBGU outlines in this policy paper the cornerstones of a European way towards sustainability-oriented digitalization that should be taken by the EU and its Member States.

Many descriptions of digital change emphasize – based on the competition between Europe, the USA and China – its enormous, primarily economic potential. By contrast, the ecological and social potential of the core characteristics of the Digital Age – digital interconnectedness, cognition, autonomy, virtualization and knowledge explosion (WBGU, 2019b: Section 3.4) – are not yet being sufficiently exploited. At the same time, digital devices and infrastructures consume large amounts of energy and are dependent on (in some

cases) conflict-ridden, non-renewable resources (Köhler et al., 2018). The often expressed hope that digitalization might more or less ‘automatically’ contribute significantly to decoupling the development of prosperity from the pressure on ecosystems in many parts of the economy and society has not been fulfilled. Although information and communication technologies’ (ICT) share in the economy has grown rapidly over the past two decades, human pressure on local and global ecosystems has continued to grow, as shown by alarming reports on climate change (IPCC, 2018) and the loss of biodiversity (IPBES, 2019). Against this background, there is a danger that digitalization might become a ‘fire accelerator’ for unsustainable, linear economic activity instead of initiating a reversal of such trends. Also due to further systemic risks in the Digital Age – the disempowerment of the individual, the undermining of democracy and deliberation, the dominance of digital corporations and disruptions on the labour markets – an approach is required that places digitalization at the service of sustainability, resolutely exploits digital opportunities, systematically reduces risks (WBGU, 2019b: Box 9.3.1-2), and thus offers positive prospects for individuals and society. The challenges of such a digitalization for sustainable development that will shape sustainability policy in the 21st century can be systematized with the help of three Dynamics of the Digital Age (Box 1; WBGU, 2019b: Chapter 7).

A European way to digitalization in line with the Transformation towards Sustainability should address the challenges of all three Dynamics today. In the WBGU’s view, the following key points are important: greater consideration of digital change in EU sustainability policy, especially in the new EU implementation strategy for SDGs that is yet to be developed and in the 8th Environmental Action Programme; the shaping of a sustainable EU digital policy focusing on data policy, the value-based use of AI and public-service ICT infrastructures; a research and innovation policy geared towards sustainable digital development; and, in foreign policy, making the EU a role model in interlinking digitalization and sustainability.

With this policy paper, WBGU addresses the European Parliament, the Council of the European Union and the European Commission, who, as the new EU

Box 1

Three Dynamics of the Digital Age

The WBGU has distinguished three Dynamics to help a conceptual understanding of the Digital Age (WBGU, 2019b: Chapter 7, Figure 1). The *First Dynamic* is directly related to current sustainability challenges. Many sustainability goals, such as the decarbonization of the economy, can be achieved more efficiently and more quickly using digital solutions, e.g. in the field of mobility. However, digital technology can also fuel trends that run counter to sustainability. For example, rising energy consumption exacerbates existing environmental problems; economic inclusion is put at risk by differences in access to digital information and communication services (digital divide).

The *Second Dynamic*, which is evolving in parallel, is related to fundamental societal changes that digitalization generates. Digital change is impacting on more and more areas of society and having ever greater effects. Ideally, this opens up an opportunity to realize a humanist vision for an interconnected, sustainable world society in which human coexistence, self-determination and dignity are protected, and welfare is decoupled from resource consumption and environmental

destruction. But there is also a danger of massive inequalities, elite rule and loss of freedom. Democracies could be undermined and autocracies empowered by disinformation, surveillance and social control. Economic and societal actors, science and existing governance systems are not yet adequately prepared for these challenges.

Finally, the *Third Dynamic*, which is also emerging in parallel, is concerned with fundamental prospects of human development: the future of humankind, the relationship between technical and societal systems, and relations between humans and the Earth system. Questions arise that sound futuristic but must already be discussed today: What relationship will humankind develop with an environment that is being fundamentally transformed in the Anthropocene? How will humans in the Digital Age change through interaction with AI or the integration and fusion of the physical and the virtual world? What characteristics and decision-making skills do we want to concede to machines? How can societies address these fundamental questions about the future of *Homo sapiens*, consciously shape these developments, and contain them where they are undesirable?

A comprehensive explanation and derivation of the three Dynamics can be found in the WBGU's flagship report 'Our Common Digital Future' (WBGU, 2019: Chapter 7).

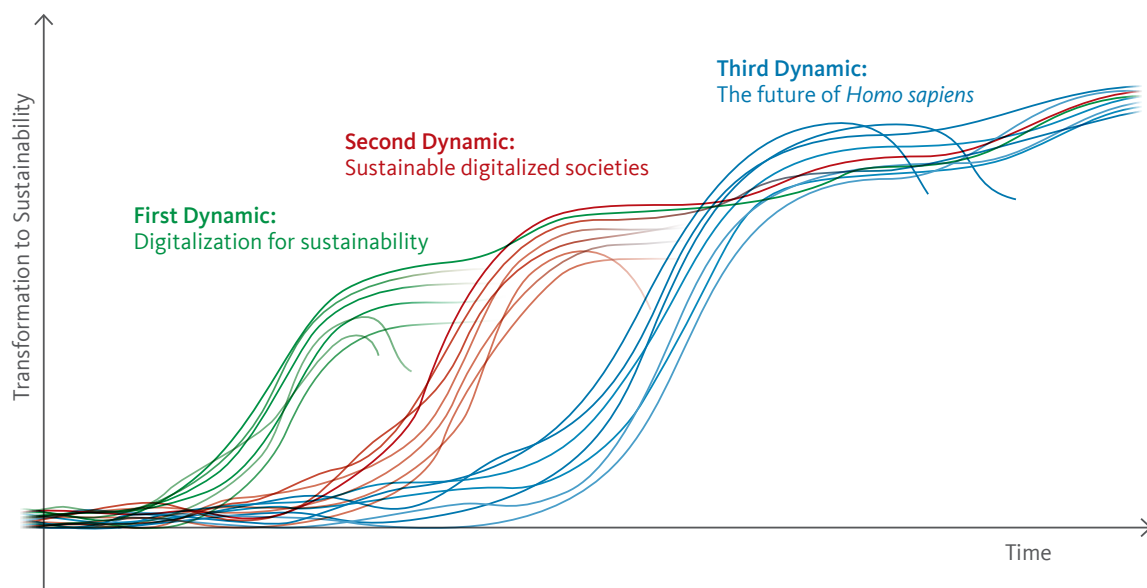


Figure 1

Three Dynamics of the Digital Age, here showing the positive case of a successful containment by means of goals and governance. All three Dynamics are already emerging in parallel today, albeit at different levels of intensity, i.e. without strict chronological sequence. Each Dynamic consists of different and separately evolving subpaths.

Source: WBGU; diagram: Wernerwerke, Berlin

parliamentary legislative period begins, can initiate an EU policy oriented towards the guiding concept of sustainability in all areas, including digital policy. Furthermore, it is addressed to Germany's Federal Government. Together with the trio presidency partners Slovenia and Portugal, and especially during its presidency of the

Council of the EU in 2020, it should forge ahead with framing EU-wide policy under the motto 'Digitalization for Sustainability!'.

Framework of a sustainability-oriented form of digitalization

Digital technologies and digitalized data are an essential resource of the Digital Age; the way in which they are handled varies greatly around the world. Regulatory strategies that allow digitalization to happen in a *laissez-faire* spirit (for example in the USA), or other that use digital instruments to exercise authoritarian state power (as in China), are not models that should be pursued in the EU: in deliberate contrast to this, the EU should use the guiding concept of sustainability as a benchmark for its digital future and thus as a framework for regulating digitalization.

As Federal Research Minister Karliczek (Karliczek, 2018) aptly put it: “Digitalization must not be presented as a target [...]. The purpose of what we do should be at the forefront of all policy areas. Improving living conditions [is] the reason for our actions, not reacting to trends, to the zeitgeist or to singular economic interests.” Since the state’s protective function and formative power can only be exercised in a strong community, Germany must “become the driver of digitalization in the EU” and turn “the old European Coal and Steel Community into a digital union.”

Federal Environment Minister Schulze has also pointed out that sustainable digitalization must be “a European one”: “As the world’s largest economic area, we must develop EU-wide standards that can assert themselves worldwide for a planet worth living on. [...] For it is unifying ideas that Europe now needs” (BMU, 2019).

The EU has always pursued a value-based technology and resource policy; this is part of the EU’s ‘founding DNA’. Established in 1952 as the European Coal and Steel Community, its initial aim was economic cooperation for the peaceful use of these strategic raw materials. The EU also has a long tradition of containing potentially useful but hazardous technologies, as demonstrated by the European Atomic Energy Community (EURATOM), set up in 1957 under the Treaty of Rome to control and coordinate the civilian use of nuclear energy, a high-risk technology. Shaping digital change with its economic, social and ecological potential and challenges in the spirit of common goals and values thus seamlessly follows EU traditions. Accomplishing this task can become part of a mobilizing European narrative, especially if it

is linked to the great challenge of the Transformation towards Sustainability.

Sustainability in the sense of the UN sustainability goals is now also part of the EU’s DNA. The EU is based on a canon of values that goes beyond economic prosperity and the preservation of peace in Europe: the EU is not only a legal and economic community, but also an environmental and social one. In the European Charter of Fundamental Rights (CFR) and the treaties on the EU (TEU) and its functioning (TFEU), which together form a kind of EU constitution, the principle of sustainability is enshrined as a constitutional principle (Article 3 (3) TEU; Article 37 CFR). It contains not only a progressive catalogue of human rights including, among other things, a right to the protection of personal data (Article 8 CFR, Article 16 (1) TFEU). Environmental protection goals (Article 37 CFR) and so-called horizontal clauses for environmental protection, equality, social protection, protection against discrimination, consumer protection and animal welfare (Articles 8-13 TFEU) are also laid down. They are intended to ensure that these common European goals are respected in all policy areas. It was only consistent that the EU recognized the UN’s 2030 Agenda with the 17 SDGs in 2015, and also ratified the Paris Agreement in 2016.

In order to reach these clear international objectives and to do justice to the normative foundations of the EU, it will be imperative to use digital and digitalized solutions to achieve them and to place them at the service of sustainability transformation as part of a broader approach. The challenge of this transformation will not be met by digital technologies alone. It requires political negotiation processes and decisions in favour of socio-technical solutions. Digitalization offers *tools* that can be used to achieve societal goals if applied appropriately. At the same time, digitally supported waves of innovation are changing societies, to which a political response must be found. In this context, sustainability goals provide a direct orientation for shaping the future.

A European way of digitalization should thus be measured against the guiding concept of sustainability. For *sustainability policy*, this means that greater use should be made of digitalization to achieve the SDGs. Conversely, frameworks and measures in *digital policy*

should follow a guiding concept of balanced sustainability. The same applies to *research and innovation policy*, which should make optimum use of the potential of a digitally supported sustainability policy and support sustainability-oriented digital change.

The chances for a successful realization of this model in the EU are good. Due to the diversity, complementary strengths and competences of the Member States, sustainable and innovative digital and digitalized

solutions can be developed, implemented and sustainably applied. Instruments for exploiting such potential already exist: EU funding (e.g. the European Regional Development Fund – ERDF) extends to the municipal level and, together with funding instruments for digitalization-related projects at the national, regional and local level, can be geared to the guiding concept of sustainability-oriented digitalization. In addition, such a model supports the EU's cohesion objectives.

Place digitalization at the service of EU sustainability policy

An EU sustainability policy covering all sectors should embed climate- and environmental-policy programmes into a broader strategy to achieve the SDGs and combine them with the innovation dynamic of digital change. The EU has already taken important decisions on a Transformation towards Sustainability. In the field of energy and climate, the EU is currently pursuing the ambitious project of transforming the EU into an energy and climate union, although its competences are limited by the Member States (Article 194 TFEU; Leopoldina et al., 2018). Particularly in the field of environmental policy, in which it has extensive legislative competences (Articles 191, 192 TFEU), the EU has a formative influence on legal developments, for example in the context of the circular economy, energy efficiency, and habitat and species protection.

In all these areas, digital change plays a secondary role at best, which does not do justice to the opportunities and risks associated with it. In order to achieve the SDGs and climate goals, digitalization needs to be more stringently placed at their service in all areas; it furthermore needs to be understood as a challenge for the Transformation towards Sustainability. Two windows of opportunity are currently opening up in this context: the development of the EU's implementation strategy for the 2030 Agenda and the development of the 8th Environment Action Programme.

A European SDG implementation strategy for the Digital Age

In September 2015 in New York, the EU committed itself to the 17 SDGs, but has not yet adapted its sustainability strategy, last amended in 2006, to the 2030 Agenda. After several calls by various EU institutions to propose such a comprehensive SDG implementation strategy, the Commission submitted a Reflection Paper entitled 'Towards a Sustainable Europe by 2030' in January 2019 (European Commission, 2019e), which, however, only serves as a stimulus for discussion. On this basis, the new Commission should now rapidly draw up a comprehensive SDG implementation strategy supported by all European institutions (Box 2).

Recommendation 1

Digital change, with its key factors influencing the Great Transformation towards Sustainability (WBGU, 2011), should be enshrined fundamentally and strategically in EU sustainability policy, particularly in the overdue SDG implementation strategy and in the 8th Environment Action Programme that will apply from 2021. Furthermore, it should be systematically included in the individual policy areas (e.g. mobility, agriculture, urban development) as a solution approach and as a challenge. It is also important in this context to consider possible (negative) side effects of the use of digital and digitalized techniques. A reliable, high-quality, broad digital database that can be used jointly and conveniently by several levels of governance can also strengthen the planning, implementation, monitoring and adaptation of measures and thus strengthen the enforcement of sustainability policy as a whole. Furthermore, the EU should use its sustainability policy to take precautions with regard to future digitalization-specific dynamics (Box 1).

Unlike when the UN was developing the SDGs, the EU should consistently consider and integrate the potential benefits and challenges of digitalization in the development of the European SDG implementation strategy.

➤ *Enshrine digitalization in the overall concept:* In the discussion on sustainability-relevant focus topics and in the deduction of the respective fields of action, as mirrored in the EU Reflection Paper, an explicit connection is too rarely established to the upheavals caused by digital change, to the need for

Box 2**Need and opportunity for a European SDG implementation strategy**

The SDGs are suitable in principle as a guiding concept for internal and external European policy, and in particular for the coordination and integration of different policy areas such as the environment, transport or agriculture. An SDG implementation strategy at the EU level should be designed as an overarching framework in a correspondingly prominent manner. The SDGs are universal in character, i.e. the EU has committed itself not only to supporting their implementation in developing countries through international cooperation, but also to achieving them within Europe by 2030. Many of the SDGs also

affect policy areas which are particularly strongly influenced by EU law, such as fisheries policy (SDG 14: Conservation and sustainable management of the oceans), or foreign trade and agricultural policy (SDG 2: Zero hunger; SDG 12: Sustainable consumption and production). An EU strategy does not replace national, regional and local strategies, which are better at taking into account specific characteristics at the respective level, but complements them. A comprehensive and common European SDG implementation strategy is crucial for identifying and resolving any conflicting objectives and political differences between the various sectoral policies and the Member States at an early stage, thus ultimately making it possible to implement the sustainable development goals decisively and prudently.

and possibility of governance, and to using digitalization to achieve sustainability goals. Although digitalization is placed together with education, science, technology, research and innovation as a horizontal factor of the Transformation towards Sustainability (European Commission, 2019e), no consideration is given to how digitalization also shapes the other horizontal factors, such as education, or to the dynamics in individual focus areas such as the implementation of environmental policy. As a result, digitalization's potential as a transformative factor is not sufficiently taken into account.

- *Realize the opportunities and risks of digitalization in individual policy areas:* The EU reflection paper recommends focusing sustainability measures "on production and consumption in the areas of materials and products, food, energy, mobility and the built environment", since "this is where sustainability changes are most needed and are potentially most beneficial [...] with strong positive global spill-over effects" (European Commission, 2019e: 15). As these fields are significantly affected by digital change, the importance and possibilities of using digital instruments should be identified for each policy area. In the EU reflection paper, such statements can only be found for the area of mobility (EU Commission, 2019e: 19f.). In its report 'Our Common Digital Future', the WBGU has drawn up selected analyses and recommendations on the potential benefits and risks of digitalization in various areas on the basis of 21 'Arenas of Digital Change', which are also fundamentally applicable in the EU context (WBGU, 2019b: Chapter 5). They deal, for example, with the effects of digitalization on production methods and the development of new forms of economic organization, the circulation of resources such as electronic waste, the international division of labour, consumer behaviour, online commerce, the future of work, agriculture, the decarbonization of energy systems, urban

mobility, smart cities, monitoring of ecosystems and biodiversity, education and gender equality.

- *Digital support for monitoring and impact measurement of the SDG implementation strategy:* In order to review the European SDG implementation strategy, the EU reflection paper stipulates a monitoring system that makes measurable objectives, steps towards achieving them, and the current status publicly available (European Commission, 2019e: 42). The WBGU recommends that the EU, together with the Member States, should not only set up an EU-wide monitoring system, but also work towards the development of a world-wide system of (meta-)data formats, processes, rules and infrastructures for digitally based SDG indicators that is interoperable and coordinated at UN level. The goal should be to enable and improve the topicality, transparency, comparability and verifiability of SDG reports and the EU's SDG implementation strategy (WBGU, 2019c: 13). The existing European Infrastructure for Spatial Information in the European Community (INSPIRE), which ensures the use of geo-information across national and administrative borders (EU, 2007), is already an important tool for the accessibility and re-use of environmental data. The EU geodata infrastructure still lacks further SDG-related data specifications, e.g. on the Urban Footprint, or the Human Settlement Layer, which should be supplemented (UN-GGIM Europe, 2016; Arnold et al., 2019). In addition, as part of a broader initiative to use privately collected data (see below), non-public data from the private sector (e.g. satellite data) or civil society (e.g. citizen science) should be specifically integrated into the EU geodata infrastructure. The basis for such broad monitoring in the environmental field is the expansion and development of digitally supported long- and short-range Earth observation and the infrastructure, equipment and sensors necessary for this, to achieve a reliable, comprehensive digital database that can be used jointly and easily by

several levels of governance. The EU should continue and strengthen the work started by the Copernicus Earth observation programme. To improve the level of detail and interoperability of European environmental data, infrastructures, equipment and sensors should be equipped for comprehensive and real-time monitoring of natural Earth systems, their condition and development (WBGU, 2019c:13). An EU-wide sustainability data infrastructure designed in this way could not only be internationally compatible, but also play a pioneering role worldwide.

- *Examine short- and long-term digitalization-specific sustainability challenges:* It is not enough to think about sustainability policy only up to 2030; nor is it sensible to plan an implementation of the SDGs that does not take digital change into account. For a successful Transformation towards Sustainability in the Digital Age, European sustainability policy must therefore, in accordance with the precautionary principle (Article 191 (2) TFEU), also consider new challenges associated with digitalization – irrespective of whether they are already taken into account by the current SDGs. In the context of the three Dynamics of the Digital Age (Box 1), these include: the protection of privacy; the fragility and autonomy of technical systems; economic and political power shifts and related consequences for inclusion; the preservation of human decision-making sovereignty where there is increased use of machine-supported decision-making; and ensuring that human-machine interactions are human-oriented (WBGU, 2019b: Sections 7.4, 8.3, 9.2). As these challenges have hardly been addressed by the SDGs up to now, a European strategy for sustainable development that is only defined as an ‘SDG implementation strategy’ might be unnecessarily narrow. For, important as it is to implement the SDGs while taking digital change into account in the short term, it is crucial for successful sustainability policy to have a long-term strategy that extends beyond 2030. The EU should play a pioneering role in deepening and further developing the global sustainability agenda in the Digital Age up to and beyond 2030. It is already doing so in the area of privacy protection with the General Data Protection Regulation (GDPR; EU, 2016b). In its draft Charter for a Sustainable Digital Age (Box 7), the WBGU outlines the premises under which the challenges of digital change can be addressed from the perspective of broader sustainability goals. Its basic principles and their further development at the global level should be supported by the EU.

Greater consideration of digital technologies in the 8th Environment Action Programme

The EU has been drawing up Environment Action Programmes (EAPs) since 1973. They are formally adopted by the European Parliament and the Council of the EU (Article 192 (3) TFEU) and lay down the priority objectives of EU environmental policy. The 7th EAP ends in 2020. The current work on the EAP opens up the possibility of dovetailing EU environmental policy better with digitalization.

- *Enshrine factors of digital change influencing environmental policy in the concept of the 8th EAP:* Digitalization is only implicitly taken into account in the 7th EAP, mainly regarding the exchange of and access to data, and in creating shared databases to improve the availability of data and statistics for the implementation of environmental policies (EU, 2013). Previous environmental action programmes have not contained a clearer linkage between digitalization and sustainability – e.g. in the form of using digitalization to strengthen and improve environmental policy beyond data availability. Furthermore, there is no mention of the transformative character of digitalization or of the ecological challenges connected with digitalization, such as the increasing use of resources and energy.
- *Analyse and assess the opportunities and risks of digitalization in individual sectors:* As in the SDG implementation strategy, the 8th EAP should take into account both the opportunities offered by digital solutions and the (environmental) risks of digitalization in sector-specific policies, e.g. on the circular economy, clean mobility or the protection of ecosystems. The WBGU has developed recommendations for various areas (21 ‘arenas’, WBGU, 2019b: Chapter 5), which can also provide guidelines for the 8th EAP. For example, digitalization plays a dual role in the circular economy: on the one hand as a cause of the increase in electronic waste, and on the other as part of a solution, e.g. by tracking material flows via the ‘Internet of Things’ (WBGU, 2019b: Section 5.2.5). In the field of mobility, intelligent transport systems (e.g. real-time tolls based on routes and environmental factors) or new digital and digitalized mobility services (e.g. sharing services and information and booking platforms covering several modes of transport) can improve sustainability if their use is based on a corresponding guiding principle (see example under Recommendation 2). In addition, the Transformation towards Sustainability requires new approaches of sustainable economic activity (WBGU, 2019b: Section 5.2.2). The 8th EAP should therefore provide targeted stimuli for environmentally and socially oriented digital enterprises.

➤ *Use digitalization for environmental governance:* Digitalization should be used to increase the effectiveness of European environmental policy. More effective implementation and enforcement of EU environmental law at the Member State level was already a challenge in the 7th EAP; its evaluation by the European Commission identified digitalization as a possible lever for further improvement (EU, 2013; European Commission, 2019a). In principle, the use of digital technologies can strengthen the enforcement of environmental law in the Member States, which are responsible in this field, through more efficient working procedures, better knowledge bases and simpler communication channels, as well as by promoting increased control of public authorities by civil society, inter alia through transparency. Important prerequisites for this are a sufficient volume and quality of data, as well user-friendly applications and judicial control options (WBGU, 2019b: Topic box 5.3-1). Digital technologies should be used to improve policy networking, coordination and the exchange of information between EU institutions and Member States on environmental policy, which has (also) been regarded as poor by the European Committee of the Regions (2019). The increasing volume of data should be made easily accessible and usable, and communication between users facilitated, as part of a comprehensive, near-real-time form of monitoring, as recommended by the WBGU within the framework of SDG monitoring. The establishment of an EU-wide, internationally compatible environmental data infrastructure is already an important step in this direction. Building on this, (further) services and applications should be developed that practically support

the use of data and the exchange of information and knowledge. The EU should follow this up by encouraging Member States to use these new, comprehensive monitoring systems as a basis for reforming their systems of tax and charges, in order to consistently gear them to the objectives of sustainable development and, in particular, the protection of the natural life-support systems. Environmental degradation and resource consumption should be priced according to their societal costs, unless they are adequately covered by market prices. This would also lay down important framework conditions and send out signals for the application and (further) development of digital technologies (WBGU 2019b: Section 9.2.3.2).

➤ *Resource intensity of the digital infrastructure as a challenge in the 8th EAP:* Another major challenge for the Transformation towards Sustainability is the rising demand for resources and energy of the digital technologies and infrastructures themselves, which has so far been difficult to quantify (Köhler et al., 2018). The EU should begin identifying, describing and assessing more systematically the negative environmental impacts of digitalization. This should be complemented by an assessment of whether the environmental impacts of digital programmes, plans and projects are subject to a sufficient strategic environmental or environmental impact assessment. Where appropriate, EU Directives 2001/42/EC on Strategic Environmental Assessment and 2011/92/EU on Environmental Impact Assessment should be adapted (EU, 2001; 2011) to ensure the necessary integration of environmental factors in the planning of large-scale digital projects.

Shape digital policy with sustainability in mind

A consistent alignment with sustainability is not limited to specific (e.g. environmental policy) measures, but, following the horizontal principle, must be fundamentally integrated into guiding principles and measures in all policy areas. When shaping digital change, this is particularly urgent because of its enormous consequences for society as a whole. Digitalization enables new modes of behaviour, production methods and business models that put pressure on established business models and can disrupt even strong path dependencies. Powerful drivers of such changes are not least new companies and start-ups. However, solutions and practices that are more sustainable will not prevail automatically in this context; rather, targeted, sustainability-oriented governance is required (WBGU, 2019b: Chapter 4).

The EU's current digital policy so far meets this requirement only rudimentarily. Although the Digital Agenda (European Commission, 2010) contains a section on using digital technologies to achieve ecological and social goals – e.g. to combat climate change or promote dignified ageing – what is far more formative for current European digital policy, particularly in terms of its practical implementation, is apart from the GDPR the creation of a digital single market to promote (economic) growth and competitiveness (European Commission, 2015). This focus is carried over to the Commission's strategic vision on AI (European Commission, 2018d), which is largely oriented towards international competitiveness and only occasionally addresses the SDGs or energy consumption. Although the recent statement on trustworthy and people-centred AI (European Commission, 2019d) addresses sustainability aspects somewhat more firmly, it still not resolute enough in the WBGU's view (see below). Economic policy and competitiveness also remain the focus of digital policy in the conclusions of the Council of the EU (2019) on European digital policy after 2020. Although it emphasizes the challenges of digitalization for social cohesion and suggests a people-centred approach to digital policy that is based on fundamental rights, references to environmental protection, climate-change mitigation and nature conservation are only made in a separate section and are not sufficiently linked to the further challenges of sustainable digital development in Europe. As part of

business-oriented measures, greater support should be given to socially and ecologically oriented digital companies, including start-ups. In addition, in the WBGU's view European digital policy has so far failed to also effectively implement the horizontal environmental and social-policy clauses (Articles 8-13 of the TFEU) in a balanced way, i.e. alongside and opposed to economic interests.

Recommendation 2

Strategies and measures of European digital policy should not focus primarily on economic aspects, but in addition pursue the ecological and social dimension of the guiding principle of sustainability – also to meet the requirements of environmental and social protection as horizontal clauses of the EU treaties. The measures should be defined in such a way that they take account of interactions between the sustainability dimensions. For example, forward-looking policy-making must ensure that digitally optimized offers replace rather than complement existing products and services (as long as this does not jeopardize societal inclusion). Efficiency gains through digitalization should above all lead to a reduction in ecological impacts instead of triggering an increase in consumption that partially or completely offsets them ('rebound').

In principle, EU strategies and framework plans – such as the European Digital Agenda, the vision for AI or the Digital Europe Programme in the context of the multi-annual financial framework – should be further developed and implemented in a sustainability-oriented way. A good example is the policy area of mobility, which also illustrates the ambivalence of digital technologies from a sustainability perspective.

Consequences of a sustainability-oriented guiding principle for the digitalized mobility transition

Digital technologies are currently revolutionizing the mobility of people and the transport of goods (WBGU, 2016; 2019b: Section 5.2.8), although it is not always clear whether this will lead to an improvement in the direction of more sustainability and a better quality of life. For example, although digital information and booking systems (see also p.19) strengthen local and long-distance public transport, digital traffic-management systems not only improve the flow of traffic: they can also shift it and generate more traffic. The potentially greater comfort or safety of highly automated vehicles might make not only car sharing, but also individual transport more attractive. Although ride- and car sharing can reduce the total number of vehicles on the roads, it can also compete with public transport and cycling. In other words, the impact of new digital mobility services depends how the framework is designed and how they are integrated into the existing transport system.

- *Derive technologies to be promoted from a sustainable mobility concept:* In view of possible unintended side-effects and conflicts of objectives, it is also the case in the mobility sector that digital and digitalized solutions should only be promoted if they are in line with a sustainability-oriented guiding concept and resulting technology assessments. The example of highly automated vehicles illustrates the contrast between a European model and other visions for future mobility systems. The Chinese state's target, primarily motivated by industrial policy, is a 50% share of partially or fully automated new cars by 2020 and almost 100% by 2025 (NDRC, 2018; GIZ, 2018; cf. also WBGU, 2019b: Box 5.2.8-2 on the broader orientation of Chinese transport policy). In the USA, the development is largely left to the technology corporations. The direction of European development should be determined by democratically legitimized institutions. They should press ahead with a mobility transition that focuses on people's well-being within planetary boundaries (e.g. with complete decarbonization of mobility by 2050 at the latest). The demand for digital, digitalized as well as analogue solutions should be derived from this, even if, for example, it should turn out that there is a need for autonomous (and electrically driven) vehicles primarily for sharing systems, thus leading to much smaller production volumes of passenger cars than today.
- *Establish guard rails against unwanted side-effects when introducing new technologies:* Digital technologies make certain means of transport easier, faster or cheaper to use; in this way they can cause shifts between modes of transport and also increase the overall demand for mobility. For this reason, with the

arrival of new digitalized mobility services, accompanying measures (regulation, pricing, infrastructure, etc.) should be directly adopted which may affect not only the new services, but also existing services or the whole transport system. These measures should ensure that efficiency gains and changes in mobility behaviour really support a mobility transition towards more sustainability and a better quality of life in cities rather than having the opposite effect (e.g. because ride sharing is used *in addition to* private cars and replaces public transport, walking and cycling), or creating new, undesirable path dependencies (e.g. by gearing infrastructures towards highly automated, private motorized transport).

In the following, recommendations are formulated for the sustainability orientation of three main digital policy topics – data policy, AI and digital infrastructures.

Sustainable data policy: making use of private-sector data

Data are a key resource and an essential driver of the Digital Age. Unlike natural resources, they can be reproduced at next-to-no cost and using them, in principle, does not reduce their amount or value for other users or uses. The societal interest in making collected data as widely usable as possible is correspondingly high. Societal and economic value-added from the use of data is usually generated by the combination of data collection, exchange, aggregation and processing. This creates the basis e.g. for well-founded decisions, new knowledge or learning and automated systems. This results in a wide range of potential benefits and risks not only for the economy, but also for socially and ecologically sustainable development. In its latest flagship report, the WBGU therefore argues that data policy should be seen as a new field of sustainability policy (WBGU, 2019b: Chapter 8).

Data policy is essentially confronted with questions of adequate data accessibility, since those who collect data can effectively exclude third parties from using the data, for example via closed user groups. The definition of data ownership rights would not meet the real challenge of how to make the best use of these data for society (Drexler, 2017; Jones and Tonetti, 2018; Varian, 2018). Apart from problems with the appropriate allocation of these rights, it would essentially strengthen these possibilities of control legally, but not improve the accessibility of data. In shaping accessibility, however, data policy must strike a balance between the interests at the commercial, macroeconomic and societal level on the one hand, and individual (protective) rights on

the other that are affected by data collection, use and access, and in some cases are in conflict with each other.

In the WBGU's view, the guiding principle, especially with regard to non-personal data, should be the creation of digital commons in order to exploit the digital possibilities of the reproduction and dissemination of data and information – if, and to the extent that, the common and broad use of data and other digitalized (knowledge) goods promises significant societal benefits in terms of sustainable development in all its different dimensions (WBGU, 2019b: Section 5.3.10). In particular, the following benefits should be considered:

- The exchange, aggregation and processing of data promise great information gains with considerable potential for sustainable development. On this basis, for example, production processes, agriculture, transport or logistics systems can be designed to better conserve natural resources, or new (scientific) findings can be gained, for example on the interrelationships and consequences of climate change. They form important foundations for political action and can create an individual awareness of the causes and significance of human environmental destruction.
- The participation of hitherto excluded people or societal groups in (knowledge) goods that can be digitized can be specifically promoted by means of shared data or digitized (knowledge) goods. This data-related category of 'digital commons' includes, for example, educational material or digitized cultural assets from human history (WBGU, 2019b: Section 5.3.10).
- Being able to access and share data is an important prerequisite for functioning market-economic and societal competition between different ideas, arguments, services and goods. With the spread of data-driven business models and services, being able to access and further process data is becoming a power and competition factor. Once they are successful, providers of digital services can continue to collect data, control access to them and – reinforced by network effects – gain growing advantages in the innovation race (Prüfer and Schottmüller, 2017; Mayer-Schönberger and Ramge, 2017). The increasing information lead of individual competitors, market and power concentration involve the danger of growing inequality and (non-transparent) possibilities of influencing individual and societal decisions (WBGU, 2019b; Section 4.2). This threatens not only fair economic competition, but also free, responsible societies. Open data, supplemented by an extended public-sector responsibility for digital infrastructures and basic services (see below), create scope for alternatives that prevent economically and societally problematic processes of concentration on a few private or state actors. Especially in the long term, this can also help

reduce the risk of false conclusions being drawn from (raw) data or of self-reinforcing dynamics that endanger the stability of society and the economy (WBGU, 2019b: Chapter 4.2).

However, it is apparent that balancing commercial and macroeconomic as well as individual and societal interests does not always imply that there should be unlimited, open access to data. Data collection and access must be regulated and restricted where there is a special interest in protection, such as guaranteeing privacy, business interests or safety.

- On the one hand, this applies to personal data, and the EU took an important step towards its protection with the GDPR (EU, 2016b), which entered into force in 2018. The EU thus shows that it is possible to set rules for the handling of data, even when powerful private-sector interests and numerous business and private areas of life are affected. However, the GDPR must be resolutely enforced, implemented and further developed in view of its possibilities and effects. There is a need for research and action, for example with regard to the distinction between personal and non-personal data and the effective and permanent deletion of personal references by means of anonymization procedures (Pohle, 2017; Veale et al., 2018), as well as with regard to the handling of behavioural data of internet users, which is to be regulated by the new ePrivacy Directive.
- On the other hand, the protection of commercial and technical trade secrets and other private-sector interests must in principle also be taken into account when defining access and reporting obligations relating to non-personal data, e.g. of private companies – if, and to the extent that, these can be justified in the sense of protecting intellectual property or maintaining economic incentives to collect data. However, not least because data is in many cases generated and collected as a by-product of an (economic) activity, the risk of a lack – or the removal – of private-sector incentives for data collection is often considered to be quite low, even when data access has to be granted. Similarly, in the case of (raw) data as opposed to data-generating services, in many cases no creative personal contribution is seen that would justify the preservation of factual, private control possibilities in the sense of intellectual property protection (Duch-Brown et al., 2017).

A European data policy on improving access to data is emerging: the right of everyone to access information from the EU institutions (Article 15 (3) TFEU), is – like freedom of expression – a (fundamental) right protected by the EU (Article 11 CFR); it includes the right to pass on information and ideas across borders without state interference. Open access to data ('open

Box 3**EU initiatives and regulation to promote the exchange and use of data collected by the private sector**

The European Commission is aware of the importance of private-sector data. In its 'Communication towards a common European data space' (European Commission, 2018b), the Commission discusses in detail the benefits of the shared use of private-sector data by companies and public authorities. Firstly, the Commission draws attention to the importance of data-sharing between companies for innovation and a functioning market economy. Secondly, with regard to mobility management, environmental protection and urban planning, it highlights the benefits that shared data use by private companies and public authorities can create (European Commission, 2018b:14). Generally, when it comes to the motivation behind and objectives of the common data space, the European Commission refers not only to its importance for economic growth and innovation, but also to the benefits of data-driven innovations for coping with societal and ecological challenges, e.g. in the form of real-time environmental monitoring using high-resolution satellite data. Alongside its Communication, the European Commission has also issued a guideline (European Commission, 2018a) to promote the shared use of data both between companies and between companies and public authorities, which, however, only contains recommendations on data preparation and is not legally binding.

Neither the INSPIRE Directive (EU, 2007) nor the revised 'Directive (EU) 2019/1024 on open data and the re-use of public sector information' (EU, 2019), which goes beyond

geodata, provides a concrete regulation to address the openness of private-sector data. However, the recitals on the latter explicitly point to the possibility for EU Member States to impose legal obligations on private companies in line with the directive (EU, 2019: recital 19). An exception with regard to concrete access obligations is the PSD2 Directive on payment services in the internal market (EU, 2015). Here, the EU regulates both access to payment systems and necessary third-party access to account data in order to enable competition among (digital) payment services.

In addition, the exchange of personal data collected by the private sector is promoted by so-called portability requirements under the GDPR, without leading to further obligations on the part of private actors to open up any general access to data: providers of digital services must provide the personal data they collect in such a way that it can be transferred to competing services in order to facilitate switching between different providers (Article 20 GDPR). Complementing these requirements for personal data, 'Regulation (EU) 2018/1807 on a framework for the free movement of non-personal data in the EU' (EU, 2018) harmonizes the legislation on other data-processing services in the Member States. In particular, barriers caused by different national regulations on the location of data storage and processing (data-localization requirements) are to be removed. In order to implement the portability requirements, the EU requires both personal and non-personal data to be made available in an interoperable format (Article 6 Regulation (EU) 2018/1807; recital 68 GDPR). Comparable requirements for compliance with the principle of interoperability also apply to the publication of data from public bodies and public enterprises (recitals 34 and 35 Directive (EU) 2019/1024).

data') is the guiding principle of European data policy, but it is essentially limited to data held by public institutions in the Member States and by public enterprises. The 'Directive (EU) 2019/1024 on open data and on the re-use of public sector information' (EU, 2019) defines open data as 'data in an open format that can be freely used, re-used and shared by anyone for any purpose' (recital 16). The directive does not regulate which data access must be granted to – reference is made here to existing access rights – but the modalities of *sharing* the data. The data are to be made usable for private, public or (non-)commercial purposes, with minimal or no legal, technical or financial restrictions, e.g. essentially free of charge, possibly at marginal costs (Articles 3 (1), 6 (1) Directive (EU) 2019/1024). The aim is to promote the establishment of the single market through data-based innovation for services and products and to support social engagement.

By way of contrast to data from public companies, privately collected, non-personal data are not yet covered by these disclosure obligations. Here, access and possible uses continue to be determined largely by those who collect data and may be detailed by private-sector contracts. However, the exchange and use of privately collected data is encouraged by the EU through recently

adopted measures (Box 3). The WBGU sees this as an important cornerstone of sustainable data policy: private companies in particular are increasingly performing tasks in the public interest with their digital services and offerings. Search engines or map and navigation services are increasingly shaping the everyday private and business lives of people in the EU Member States and allow the providers behind them to collect data on a correspondingly large scale. The same applies to vehicles and agricultural machinery equipped with and interconnected by sensors, which in particular collect extensive environmental data of great public interest. Already today, there are significant information disparities in some cases between public authorities and private providers, which make the design of public spaces and mobility systems, as well as effective environmental protection and resource conservation, considerably more difficult for the state and the administration (WBGU, 2019b: Sections 5.2.7, 5.2.8, 5.2.9). Finally, the structural problems of increasing market and power concentration will only be fully addressed if the obligation to make available and share (non-personal) data is extended to private companies. Competition law as a downstream intervention related to individual cases of abuse of market power cannot achieve this to the same extent.

To some extent, the regulation of access to data from private companies may also be in the interests of the companies themselves: vehicle manufacturers, for example, would mutually benefit when developing assistance systems and autonomous vehicles if they could access the (training) data used by their competitors to develop their systems. Strategic interests, however, make the necessary coordination more difficult and can stand in the way of a more economically favourable joint collection and use of the required data pools (Jones and Tonetti, 2018). In order to expand the regulation of data provision and access, and to engage private companies more strongly for a functioning EU single market and sustainable development, it is necessary to work on a more precise delimitation between data that is worth protecting and data that is of high societal interest.

Recommendation 3

The WBGU recommends that not only data collected by public authorities but also data collected by the private sector should be placed at the service of societal objectives. In order to defuse possible conflicts on the appropriate protection of commercial and technical trade secrets or privacy, procedures and criteria should be developed for the appropriate delimitation of data. Directive (EU) 2019/1024 should be extended accordingly and an obligation to provide and share private-sector data and information established. Already in the short term, Member States should make use of the option provided by the directive for making greater use of private companies' data. Germany should play a pioneering role here.

Sustainability-oriented use of AI – the European way

AI is key to evaluating large amounts of data and to unlocking the associated potential for a sustainable society; but it also poses new ethical and sustainability challenges. The European Commission has already positioned itself in a communication on 'Building trust in human-centric artificial intelligence' (European Commission, 2019d). However, in the WBGU's view, the wording on societal welfare and ecological aspects

is considerably lacking in incisiveness. The effects on the environment discussed there should not only be taken into account "for AI to be trustworthy", and the natural life-support systems should by no means be sustained only "ideally", but as a necessary condition for sustainable "human-centric AI" (European Commission, 2019d:6). In this sense, responsible AI that is ecologically and common-good oriented should be not only promoted, but also bindingly laid down as the standard of a European way. This implies, for example, a cautious use of AI for tasks for which there are currently no – or only ineffective or inefficient – solutions because, among other things, methods of machine learning are frequently applied that require extensive training data and computing power and are accordingly characterized by high energy and resource requirements.

As a general rule, the WBGU believes that AI should be used to enhance human well-being, while protecting human dignity and sustaining the natural life-support systems (Floridi et al., 2018; Villani, 2018; Cath et al., 2017). However, research on the use of AI systems for sustainability is only just beginning (Rolnick et al., 2019; Microsoft, 2019; Hilty and Aebischer, 2015), as is research on 'explainable AI', which aims to ensure methodological quality by making machine learning – which has hitherto often been seen as a black box – more traceable or transparent. In this context, it is necessary to question "the current broad and sometimes rather unreflected use of machine learning in all application domains in industry and in the sciences" (Lapuschkin et al., 2019:7). From a technical perspective, explainable AI, quality-assurance measures for AI systems and their (training) data, as well as certification are essential steps towards the implementation of trustworthy, fair and accountable AI systems which also take into account normative requirements such as the protection of decision-making sovereignty, individual privacy and protection against discrimination.

In view of the still existing methodological deficits, "developing AI responsibly, grounded on ethical principles and human rights" (Dignum, 2019) is necessary, and this should not be dominated or prevented by the international race for new algorithms and solutions. The EU is not yet pursuing a stringent strategy in this respect. Ethical approaches for the use of AI in the interests of the common good and sustainability in particular, such as 'AI4People' (Floridi et al., 2018) or 'meaningful AI' (Villani, 2018), have already been developed and discussed. In addition, the European Commission's High-Level Expert Group on Artificial Intelligence (2019b) has published a first controversial draft of ethical guidelines. In the WBGU's view, it is necessary to disclose and clearly point out the underlying conflicting interests and

to work towards a clear prioritization and specification of Europe's value-based AI approach.

Recommendation 4

In the development and application of digital technologies, including AI, the WBGU recommends consistently pursuing the EU's values-based approach in terms of EU fundamental rights, the precautionary principle and international sustainability goals. In the WBGU's view, fundamental rights and environmental and sustainability principles are the EU normative foundations in international competition and are non-negotiable. By means of explainable and secure, i.e. reliably verified and validated, AI it should be ensured that only trustworthy, fair and accountable methods are used. Legal regulation of AI is urgently needed, as ethical guidelines and debates alone are not enough to achieve its consistent, people-centred and sustainable application. To this end, ethical reflections, particularly for AI use in support of the sustainability goals, and corresponding societal discourses should also be promoted.

Guarantee a public-service digital infrastructure

Digital data, knowledge and information goods depend on corresponding digital infrastructures – especially when they are made available in the interests of the common good to companies and the public by public and private bodies (digital commons). The EU and the Member States should develop infrastructures for information and communication services according to corresponding standards. The Member States typically have a constitutional responsibility to guarantee the basic provision of water, electricity and telecommunications services to the population (Dörr, 2014:335; Wissmann, 2014:376). This understanding of infrastructure, which is based on physical basic services that are generally tied to networks, should be expanded in the context of digitalization.

In an increasingly digitalized world, access to certain digital data, information and services is a fundamental prerequisite for societal, political and economic inclu-

sion, free personal development, effective environmental protection, a fair economic order and a digital public sphere that supports social cohesion and democratic processes, and thus, taken together, for a transformation towards sustainability. The exclusive, oligopolistic provision of certain digital information and services by private companies and their central importance for economic and societal processes and the forming of political will mean that citizens and (especially small and medium-sized) companies cannot avoid using their services. Although they can choose between different private providers, they cannot, for example, influence the conditions of participation (scope, type and location of data collection and use) or recognize criteria for filtering, prioritizing and displaying information. As things stand today, this restricts the sovereignty of citizens and consumers as well as fair competition and leads to a societal concentration of power among a few private providers, which also endangers the potential of a pluralistic digital discourse space for politics and society (WBGU, 2019b: Section 5.3.2).

In a digitalized world, the EU and its Member States should recognize that their obligation to provide services of general interest needs to be extended accordingly. They should meet this obligation by using public-service digital infrastructures firstly to make digital commons accessible and usable, and secondly to offer basic digital services. 'Public sector' does not always mean provision by the public authorities themselves. Rather, for example, legal requirements in the public interest can be laid down, state or other supervisory bodies under public law can be created, or public investments can be used to provide an appropriate framework. Institutional forms such as corporations (or other entities) under public law are also conceivable (as is the case with public-service broadcasting). Because of the high costs, economies of scale and network effects, in many cases EU-wide projects can be considered.

In the following, the WBGU presents examples from three different areas in which public-service ICT should be developed according to high quality standards (Box 5) in order to safeguard the common good: cloud services, platforms for mobility data and services, and a European search index for internet search engines. Further examples include the creation of urban data spaces and European platforms for media and communication (explained e.g. in WBGU, 2019b: Sections 5.2.7, 5.3.2 and 5.3.5).

Application example: cloud services

The European Cloud Initiative (European Commission, 2016) aims to set up a digital basic service for storing, sharing and processing large amounts of data using a 'European Data Infrastructure' consisting of data

Recommendation 5

Ensuring adequate access to digital commons and basic digital services is part of the obligation of the state to guarantee public services of general interest. The EU and its Member States should recognize their responsibility to guarantee the provision of services in this area and, where appropriate, enshrine it as a public obligation in their treaties, in the Charter of Fundamental Rights, and in national constitutions (Box 4). They should provide and develop public-service ICT infrastructures in areas of high societal relevance. From the concept stage onwards, public-service ICT should be geared to ecological, social and economic standards such as transparency, security, interoperability, inclusivity and usability, participation, competition and plurality, and environmental protection (Box 5). The appropriate implementation and organizational form can vary depending on the context.

storage devices, high-speed broadband networks and high-performance computing facilities. This will initially be available to research as the European Open Science Cloud (EOSC) and later be opened to further users from the public sector and industry (EOSC Executive Board, 2019). It will not be implemented as a completely new, central infrastructure, but will network partly existing infrastructures distributed across the Member States (as the Infrastructure for Spatial Information in the European Community (INSPIRE) did; EU, 2007). This will create a “pan-European federation of data infrastructures built around a federating core and providing access to a wide range of publicly funded services supplied at national, regional and institutional levels, and to complementary commercial services” (DG Research and Innovation, 2018a), with start-up funding from Horizon 2020. The present proposals on participation criteria, suitable governance models and financing structures (EOSC, 2017; European Commission, 2018e; EOSC Executive Board, 2019; Science Business Network, 2018) for making the scheme permanent after 2020 indicate various institutional options. In the WBGU’s view, the following points must also be taken into account:

- *No profit orientation:* The data and computing resources, which are primarily publicly financed and

networked for the common good by the EOSC’s ICT infrastructure, should be made available to a user group that is as broad as possible, without any intention of making a profit. Business models with market-based data access run counter to this. It seems more attractive to have continuous public basic financing at least of the federating core, possibly supplemented by cost-oriented fees, e.g. for private-sector use and computing power.

- *Limited involvement of private providers:* In the interests of European data and technology sovereignty, the publicly financed storage and processing of data in the EOSC should be controlled end-to-end by the EU and its Member States and meet certain requirements particularly with regard to participation, competition and plurality (Box 5). Any comprehensive outsourcing of data processing to the currently dominant private companies in the USA and China, e.g. in the form of the participation of private providers in an EOSC-internal market (credit system) for cloud services, is hardly compatible with this.
- *Resource protection:* The current concept and planning documents for the EOSC make no reference whatsoever to resource conservation in the construction and operation of the necessary physical infrastructure. There is a need for improvement here.

Application example: EU-wide mobility platform

Both private and public providers are currently developing integrated solutions – in some cases jointly – for planning, booking and realizing complex journeys involving different modes of transport on a single platform (including e.g. ticketing, vehicle access, rescheduling). The aim is to reduce the fragmentation of mobility services, both regionally and between providers, and to offer mobility as a service from a single source – where possible, without using a private vehicle (Mobility as a Service – MaaS, e.g. maas-alliance.eu). A user might, for example, take a shared taxi (in the future perhaps an autonomous one) to the inter-regional train and reach their destination in another city with an electric shared bike; everything would be conveniently planned, paid for and assisted in real time by a single smartphone app. Such a service is realized by three main components: the separate mobility services; the technical systems that compile and link them; and the platforms, specifically websites or apps, through which users can plan and book complex trips. In many cities, such services are also offered with monthly flat rates or credits, or are integrated into public transport fares. Existing MaaS offers often represent only parts of the mobility options and are mostly limited to individual cities or city centres (MaaS Alliance, 2019). Finland has so far been the most consistent in pushing ahead with

Box 4

Responsibilities for the provision of digital infrastructure in the EU: Member States have an obligation here

Partly because of its legislative competences, the EU itself can only provide digital infrastructures, or oblige Member States to do so, to a limited extent.

Sectoral legal acts can be based on sector-specific competences of the EU, such as Directive 2007/27/EC on the European Spatial Information Infrastructure INSPIRE (EU, 2007), for which the EU has used its competence for environmental policy (Article 192 TFEU). However, the EU has no specific competence on passing a legal act that includes a general obligation to provide digital services and infrastructure. As a general rule, responsibility for network-based infrastructure lies with the Member States. Pursuant to Article 170, 171 of the TFEU, the EU only contributes to the establishment and development of trans-European networks in the fields of transport, telecommunications and energy, for example by way of guidelines setting out objectives, priorities and the main features of projects in the field of trans-European net-

works. It can also promote interconnection, interoperability and access to national networks. It is questionable whether the EU's existing scope for supporting and promoting infrastructure, as just described, can be used for the regulation of not only physical, but also virtual infrastructures such as the digital services mentioned. In addition, there are special provisions for 'services of general economic interest' (e.g. Articles 14, 106 TFEU), which give the Member States a lot of room for manoeuvre (Koenig and Paul, 2018). At the Member State level, there is usually no obligation to provide digital infrastructures either. In Germany, the Hessian constitution is an exception at Länder level: Article 26d states in its first sentence: "The State, municipalities and associations of local authorities shall promote the establishment and maintenance of technical, digital and social infrastructure [...]". Neither the Germany's Basic Law nor the EU Treaties contain a comparable obligation, and they should be amended accordingly.

Individual projects, such as the development of the European Spatial Data Infrastructure INSPIRE, show how European ICT projects can be unifying for the EU. The Member States and the European institutions should continue to work together in this spirit in the future.

implementation: in 2017, all mobility providers were required by law to open their sales systems to external providers; up to now this has been used primarily by the 'Whim' app from provider MaaS Global. MaaS systems can be expected to spread further, but in what form and in whose responsibility is still open.

- *Promote pan-European MaaS platforms:* MaaS offerings have the potential to make public transport, sharing and micromobility (e.g. e-scooters) more attractive by combining them to ensure fast, convenient door-to-door mobility. Here, too, an integrated view is necessary, e.g. to capture rising demand for mobility generated by greater convenience. However, it can be assumed that convenient MaaS systems can reduce the competitive advantages of motorized private transport and thus boost more eco-friendly alternatives. In order to move towards a Single European Transport Area, European policy must ensure that such services function across borders. Accordingly, in its White Paper on the European Transport Area the European Commission envisions that "[o]nline information and electronic booking and payment systems integrating all means of transport should facilitate multimodal travel" (European Commission, 2011:6). It sets itself the goal of establishing a framework for a European multimodal information, management and payment system by 2020 (European Commission, 2011). This should oblige mobility providers to make their systems more interoperable, e.g. through standardized or in some cases even open interfaces.
- *MaaS platforms under public responsibility:* There are different models for operating MaaS platforms, from the technical integration of different systems to distri-

bution and ticketing (Smith et al., 2018). In line with a public responsibility for central infrastructures, it is also necessary in the WBGU's view to ensure a strong public influence on the design of MaaS systems. In addition to the regulatory framework at EU level, this can also include the provision of basic infrastructure in the sense of a decentralized network architecture, as described above for the Open Science Cloud, for example. Furthermore, the EU should strengthen the role of public mobility providers, in particular municipal transport operators and long-distance rail operators, in the implementation of MaaS offers. They should form nodes in a networked, decentralized model and provide multimodal booking platforms, either under their own name or as partners for new services (e.g. jelbi in Berlin or offers organized via transport associations). Control over the digital interface with the users of mobility services (e.g. the smartphone app) is key to the pursuit of sustainability goals, as it enables the prominent and barrier-free placement of sustainable mobility services. In economic terms too, control over booking platforms is important for public transport providers. At the same time, MaaS offerings cannot reach their full potential if they do not integrate public transport. The role of public providers can be strengthened by the EU both in shaping the European (regulatory) framework and by promoting local and regional pilot projects, especially in structurally weak areas.

Application example: creating a European search index

Particularly for digital infrastructures such as search

Box 5

General requirements for public-service ICT infrastructures

The provision of public-service ICT infrastructures alone does not lead to comprehensive quality assurance, which is why the WBGU has drafted quality-assurance standards (WBGU, 2019b). The EU should further specify them where necessary, formulate them as requirements for public-service ICTs, and potentially consolidate them by a legal act (Fromm et al., 2013:9f.; Fromm et al., 2014; Schieferdecker et al., 2018:209ff.):

1. *Transparency*: Public-service ICT systems should be characterized by clear decision-making processes and traceable functions.
2. *Security*: A holistic approach to security is key. Data protection, data security, as well as IT and functional security should already be taken into account at the planning stage.
3. *Interoperability*: Because public-service ICT systems are becoming increasingly connected and their organization is often decentralized, it is important that they can cooperate across levels and domains.
4. *Inclusivity and usability*: Involving users in the planning of

the ICT and user-friendly operability are key to creating inclusivity and promoting the use of public-service ICT. In addition, non-discriminatory and barrier-free access must be guaranteed in order to open up new possibilities of societal, economic and political participation for everyone.

5. *Participation*: In order for public-service ICT to adequately fulfil its societal functions, an equitable balance of interests among all actors (civil society, business, science, public administration) should also be established (Fromm et al., 2014). The involvement (cooperation, coordination, information) of as many actor groups as possible is needed to ensure the functioning of public-service ICT infrastructures and services.
6. *Competition and plurality*: Technical components should be designed to be standards-based, modular and exchangeable, in order to avoid dependencies on individual manufacturers and infrastructure providers. Furthermore, open-source components should be used or created (with support from public funds) wherever possible. The principle of net neutrality must also be guaranteed and strengthened by regulatory measures.
7. *Environmental protection*: Protecting and sustaining the natural life-support systems should be ensured when establishing, expanding and operating ICT infrastructures and services.

engines, media platforms, social networks and news services, which enable everyday communication and information retrieval via the internet and therefore play a key role in the digital public domain, a concentration of power can be observed among a few corporations (mainly from the USA; WBGU, 2019b). A public-service alternative should therefore be considered in these cases.

- *Build a public-service European search index*: As an alternative to the search indices from Google, Bing (USA), Yandex (Russia) and Baidu (China), this would lay the foundation for European search engines and strengthen the informational sovereignty of the EU. Implemented via public-service ICT and in collaboration with a public-service platform infrastructure (WBGU, 2019b: Box 5.3.5-1), it should represent a core element for a cross-border, open information and communication area based on democratic values, instead of being driven primarily by private business models – a European alternative in contrast to US platforms. As a “public library of the internet” (Huss et al., 2019) and a “basis for diversity” (Lewandowski, 2016: 15) such a search index could make all traceable websites and their contents accessible in a database based on transparent criteria.

Corresponding projects such as the Open Web Index (Huss et al., 2019:7) aim to secure this infrastructural basis for internet search engines as a critical information infrastructure and to restore Europe’s informational sovereignty in the digital domain. A European search index could have a stimulating impact on digital innovations, in the field of search engines and for the European start-up and internet economy. It would be available globally to all companies, public institutions, civil society and individuals as a central part of a future European public-service ICT infrastructure. On that basis, a new pluralism regarding access to and the dissemination of digitalized information would be possible, as well as data-protection-friendly business models. This search index is a project for the European level, as it is a large-scale project for which the Member States should pool their financial, human and data resources. The concrete scale of the costs of development and operation should be scientifically determined in a timely manner within the framework of a research project involving the expertise of all current initiatives and similar earlier approaches in this field (e.g. Exalead, Quaero, Theseus between 2004 and 2013).

Research and innovation policy for sustainable digital development

In view of the changes and uncertainties that are partly triggered or intensified by digitalization, research plays a central role in shaping transformations and dealing with (digital) systemic risks. At the same time, (sustainability) science will also undergo major changes in its methods, theories and self-organization in the face of digitalization.

Knowledge-oriented research and innovation, i.e. the implementation of new ideas, products or methods in markets where they have hitherto not been used (Eurostat, 2012), are well promoted by the state, which also determines the overall direction. The EU also provides substantial support not only for research, but also for projects that directly link the creation of new knowledge and technical inventions with implementation, e.g. through joint market launches with companies. A *sustainability-oriented* research and innovation policy for digital technologies should promote innovations that support or facilitate a Transformation towards Sustainability. However, in turn these must themselves

satisfy the corresponding sustainability criteria and be or include socio-technical or ecological innovations. New corporate forms such as social enterprises or green start-ups can play an important role in their introduction to markets. The creation of 'Horizon Europe' – the EU's next Research Framework Programme for 2021–2027 with a budget of probably more than €100 billion – is currently opening up a window of opportunity for implementing these principles. In this context, the WBGU argues for a broad understanding of innovation and against its one-sided restriction to innovation as an economic factor, as can be observed, for example, in the context of the currently discussed 'innovation principle' (Box 6).

Many of the objectives of the EU's innovation and research policy are already subject to the basic concept of sustainability orientation as described above. This applies, among other things, to the horizontal clauses, the precautionary principle, a citizen-centred data-protection system and, specifically for research policy, the

Box 6

No weakening of the high levels of environmental and consumer protection or occupational health and safety as a result of an innovation principle

The importance of innovation for economic development in the EU is emphasized by the so-called innovation principle, which is being discussed in European innovation politics on the initiative of various industrial lobby organizations (Garrett et al., 2018). It has now been mentioned by the Commission in the explanatory memorandum on the draft of the future Research Framework Programme Horizon Europe (European Commission, 2018). This innovation principle does not yet exist as a legal principle either at the EU level or in the Member States. In its original form, it states that, in all political and legislative decisions, "their impact on innovation as a factor for jobs and economic growth" should be taken more into consideration (Dekkers et al., 2013). This restricts the understanding of innovation to innovation as an economic factor, even though innovations are also particularly necessary to achieve social and ecological goals. The WBGU is opposed to such a narrow understanding of innovation. Rather, an innovation

principle must include innovations that promote environmental and social objectives, as enshrined in the EU treaties.

Moreover, the introduction of an innovation principle cannot ignore the EU's existing and binding fundamental decisions for a high level of environmental protection, consumer protection and occupational health and safety, as well as the associated legal principles (e.g. the precautionary principle) – or dominate them when balancing conflicting legally protected interests. Thus, if an innovation principle were to be introduced, these values and objectives would be inherent in it, so that only those innovations would be promoted that serve the pursuit of these goals and legal principles and do not fundamentally contradict them. Where there is uncertainty over the consequences of an innovation, the precautionary principle under environmental law continues to apply, i.e. adverse effects on the environment must be prevented or at least reduced as far as possible. Furthermore, the focus must not be narrowed to technical innovations: social innovations, such as the dissemination of new behavioural and use patterns, or institutional innovations that can be the basis and result of digital solutions, are just as decisive for the Great Transformation towards Sustainability.

Responsible Research and Innovation (RRI) approach. It aims to better take into account the positive and negative effects of research and innovation on the environment and society through stakeholder participation. In the WBGU's view, this approach should be implemented throughout the entire future Research Framework Programme and not only – as in the case of Horizon 2020 – in sub-programmes with a comparatively small budget (e.g. in the sub-programme 'Science with and for Society' with 0.6% of the Horizon 2020 budget (WBGU, 2019: Chapter 10; European Commission, 2013).

Alongside a fundamental sustainability orientation, research and innovation should be strengthened by digital means:

The development of open European data infrastructures under public responsibility (as described above in relation to the European Open Science Cloud) offers great potential for advancing open science. In the process, the use of private data should be expanded in the sense of digital commons; this would benefit science in particular. Research needs the best possible insights into key areas of society (e.g. social media, mobility behaviour, consumer behaviour), of course taking private rights into account (personal data, commercial and technical trade secrets).

Systematic EU-wide innovation management (extending existing approaches) should be used to strengthen the contribution of digital approaches to sustainability goals – at all phases of innovation from research and the generation of ideas to testing, introduction and, in particular, the scaling-up phase. At its core would be a comprehensive, open database with, ideally, all projects with public-sector participation (e.g. through funding, infrastructure or data) at the EU, Member State or municipal level (existing overviews are often fragmented, e.g. even for EU research and innovation projects; European Commission, 2019c). In conjunction with sustainability goals, this database should form the basis for a transparent selection of projects to be funded for further innovation phases respectively. The expected contribution to the various target dimensions should be consistently reviewed in order to be able to promote more innovative ideas in critical areas in good time where necessary. The database could also improve the Europe-wide transfer of knowledge and serve as a 'project exchange' for identifying further areas of application, particularly at the sub-national level (for example, a digital mobility service successfully piloted in one municipality could be more easily identified and tested by other European municipalities). On this basis, the municipal, national and EU levels could furthermore prepare better for the testing, introduction and scaling phases of selected sustainability innovations, e.g. by creating regulatory frameworks in good time, and thus accelerate the Transformation towards Sustainability.

Recommendation 6

EU research and innovation policy should consistently gear the promotion of research and innovation towards EU's sustainability goals in a balanced manner. Responsible Research and Innovation (RRI) should become the European standard of scientific practice as an overarching principle to avoid unintended impacts on sustainability goals. Strengthening the innovation principle only makes sense if it is based on a broad understanding of innovation that equally includes technical and social innovations for ecological, social and economic goals and respects the precautionary principle. Open science should be strengthened to increase scientific agility, effectiveness and transparency. A Europe-wide innovation-management system, particularly for projects with public-sector participation, should be introduced to achieve a broader selection and more targeted promotion of sustainability-oriented projects – from the initial idea to large-scale implementation.

Integrated design of missions for Horizon Europe

The missions for Horizon Europe are to be defined in the coming years with reference to global challenges and will bundle several research projects around a common, clearly defined goal. Using missions to concretize Horizon Europe offers an excellent opportunity to structure overarching research along fundamental global challenges (referred to as 'grand challenges').

- *Digital technologies in sustainability missions:* Projects on the sustainable use of digital technologies, including the consideration of social cohesion, should be a fixed element within the necessary environmental and sustainability missions (clusters on 'Climate, energy and mobility', 'Food and natural resources', and 'Inclusive and secure society'; cf. also the Finnish Academy's 2018 proposal on a 'Climate Neutral Europe 2045').
- *Sustainability in digitalization missions:* At the same time, in the sense of RRI and a sustainability orientation of digital policy, it is essential that sustainability criteria are strongly and visibly embedded in the 'Digital economy and industry' cluster. This should

apply both to entire projects and to project components in the individual missions, e.g. in expected missions relating to AI and big data.

- *Missions on digital grand challenges:* Missions that deal specifically with digital grand challenges are also necessary. Some of these digital grand challenges are described by the WBGU (2019) also under the term 'systemic risks in the Digital Age'. Digital systemic risks include conceivable, large-scale changes in our societies, each of which could trigger a destabilization in our societies – either separately or, in particular, in combination with each other. Among other things, they describe the breaching of planetary guard rails by digitally driven, resource- and emissions-intensive growth patterns or a possible disempowerment of the individual, threats to privacy and the undermining of digitalized publics by digitally empowered authoritarianism or totalitarianism. Other examples of digital grand challenges might be an emerging dominance of corporations that (driven by a further data-based concentration of power) elude state control, or a deepened division of world society as a result of the differential use of digital potential.

The design of such missions that bring digitalization and sustainability together should also be used as an instrument to strengthen networking between the respective communities, which are made up of both scientists and practitioners.

Embed research on sustainability and digitalization into institutions

In institutional terms too, the interface between sustainability and digitalization should be embedded into the European science system in order to facilitate a better exchange within science, especially between actors from the sustainability and tech communities, but also with companies.

- *Create a Knowledge and Innovation Community (KIC) on Digital Sustainability:* The WBGU proposes that a Digital Sustainability KIC should be created at the planned European Institute of Innovation and Technology (EIT) in cooperation with industry and other societal actors as a cooperative community of science, industry and society to promote structural change, e.g. in the field of environmental services (together with the RawMaterials KIC).
- *A sustainability-oriented understanding of innovation for the Enhanced European Innovation Council:* The WBGU welcomes the establishment of an Enhanced European Innovation Council (EIC), which provides the basis for a better translation of research findings into actual innovations. A broad understand-

ing of innovation – extended to include social and ecological aspects – should be used here. In addition, better innovation management is necessary, also via better platforms (see above) on which sustainability options and innovations become visible and thus reproducible.

Strengthen transformation research and transformative research

The WBGU's recommendations on science in the Transformation towards Sustainability (WBGU, 2011) still apply – more than ever – in the context of sustainability and digitalization. Digitalization is driving comprehensive change and providing tools for its design. In all pillars and missions of Horizon Europe (WBGU, 2019b:411) there is a considerable need for transformation research and transformative research. Such research should look into how to handle all three dynamics of the Digital Age (Box 1; WBGU, 2019b: Chapter 7), as there are still many uncertainties and gaps in knowledge.

- *Strengthen transformation research digitally:* Transformation research aims at a better understanding of fundamental societal change processes, which are currently strongly driven by digitalization. At the same time, digitalization offers instruments for raising empirical and long-term research to a new level of quality. These instruments make even extensive tasks of observation and analysis feasible such as the further development of the SDG indicators at the national and global level. Data analyses, time-series analyses, pattern recognition, modelling, simulations and predictions can be improved by orders of magnitude in terms of coverage, precision, repeatability and traceability – thanks to the accuracy of possible observations, as well as their topicality, scope and duration.
- *Shape digitalization through transformative research:* Transformative research aims to initiate and catalyse transformation processes towards sustainable development with its research results (WBGU, 2011:23ff.). In the context of digitalization, transformative research firstly develops direct, digitally based methods and solutions for sustainability-related challenges (e.g. innovations for decentralized energy supply systems, automated driving in the context of sustainable mobility, precision agriculture, the circular economy). Secondly, it initiates societal debates on the sustainability potential and risks of digitalization by creating a suitable framework and sensitizing people to the interrelatedness of different problems. A typical mode of transformative research is working in real-world laboratories, places and contexts where the

Transformation towards Sustainability is promoted and investigated. The WBGU supports the proposal of the High-Level Panel of the European Decarbonization Pathways Initiative of 'Transition Super-Labs',

regional real-world laboratories lasting 5 to 10 years in which the decarbonization of the economy and society is promoted and tested in particularly challenging locations (European Commission, 2018b).

A European way to digitalization as a priority of foreign policy

The general value base of the EU, as set out above and enshrined in its treaties, is also the foundation for its foreign policy. In the WBGU's view, digital change is not only a new field of EU sustainability policy; it must also be the subject of international cooperation, precisely because of the cross-border nature of digital change.

Through technological innovation, the provision

Recommendation 7

As a globally important economic area, the EU and its Member States should seize the opportunity to establish a sustainability-oriented approach to digitalization in the territory of the EU and thus become a role model on a global scale for sustainable digital development. Sustainability-oriented digital policy should be integrated into the guiding concept of its foreign policy. The EU should initiate a UN World Summit on Sustainability in the Digital Age and work towards a global data infrastructure for sustainable development in the hands of an International Information Union.

of and access to digital commons and the provision of public-service ICT infrastructures for sustainable development, the EU could set an example in the current global technology race. Firstly, this serves to preserve European values and *Eigenart* in future digital development (WBGU 2019b: Section 2.2.3). Secondly, in this way the EU can fill a void that is currently left by the dominant American and Chinese digitalization models.

In foreign policy, the EU can strengthen and deepen the links between digital change and the Transformation towards Sustainability in the context of trade policy or economic, financial and technical cooperation with

third countries, in international agreements, e.g. on environmental policy, and cooperation within international organizations, particularly the UN. In these areas and forums, the EU should act as a strong advocate of multilateralism (EU, 2016a) with the aim of raising awareness of the necessary links between digitalization and sustainability, and placing digitalization at the service of sustainability goals worldwide. This concerns, for example, the promotion of a development policy that also creates an analogue basis for digital change and improves development policy with digital technologies (WBGU, 2019b: Section 9.1.2), or the promotion of global research cooperation and knowledge networks to link digital change with the Transformation towards Sustainability.

The WBGU considers a world summit on these issues to be urgently needed and has accordingly proposed that a UN summit on sustainability in the Digital Age (e.g. under the title UN Conference for a Sustainable Digital Age) be held thirty years after the Rio Conference in 1992 (WBGU, 2019a, b). A key outcome of the UN summit could be the adoption of a charter by the international community. The WBGU has submitted a first draft for discussion at wbgu.de/charta (WBGU, 2019b: Box 7). In preparation for such a UN summit, a World Commission on Sustainability in the Digital Age should be appointed, modelled on the Brundtland Commission of the 1980s, to analyse and evaluate the problems and opportunities for shaping digital change and the Transformation towards Sustainability, especially those that extend in time beyond the 2030 Agenda.

As a concrete measure to promote the achievement of the SDGs, the EU should work globally to make the environmental and sustainability data collected for Earth observation and SDG indicators accessible as digital commons (UN IEAG, 2014). In this context, the EU could promote the establishment of an 'International Information Union' at UN level. The aim of this International Information Union would be to bundle previous data-related EU and UN initiatives and, in particular, to collect and process SDG-relevant data relating to

Box 7**‘Our Common Digital Future’ – a draft charter for a sustainable Digital Age****Preamble**

Conscious of the responsibility of all societies for our common digital future,

conscious of the urgent need for decisive action to limit anthropogenic climate change and sustain the natural life-support systems, and conscious of the responsibility of humankind in the new geological epoch of the Anthropocene,

endeavouring to work towards a humanistic vision for a networked global society of the Digital Age in which civilizational and human potential can fully unfold,

recognizing the Universal Declaration of Human Rights, the report of the World Commission on Environment and Development, the United Nations Conference on Environment and Development, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the United Nations-sponsored World Summit on the Information Society, the United Nations 2030 Agenda with its Sustainable Development Goals, the Paris Agreement and similar processes launched by informal initiatives,

the undersigned acknowledge and commit to the implementation of the following goals, principles, freedoms, rights and obligations.

Goals and principles

1. Human *dignity* shall also be inviolable in digital space. Everyone shall have the right to digital identity, sovereignty, data protection and privacy. This shall also include the right to evade digitalization in the private sphere and the right to be informed if an interaction partner is not a human being but a technical system.
2. The development of digital technologies and digitalized infrastructures shall always be geared towards sustaining the *natural life-support systems*. The planetary guard rails must be observed, global and local environmental problems must be avoided. The polluter-pays, cooperation, integration and precautionary principles must be observed as guiding principles.
3. The development of digitalized infrastructures shall always be oriented in such a way that it is *accessible to all* and offers equal opportunities for societal participation and realization. For the underlying technologies such as microelectronics, tele- and data-communication networks, data processing and artificial intelligence, information on the basic functions should be accessible to all worldwide.
4. The rights of the individual to the *protection of individual freedom of development* in the digital space shall be guaranteed. These rights shall include informational self-determination, the protection of freedom of expression and digital identity, the protection of minorities and protection against discrimination. All people shall have the fundamental right to inspect and correct data stored about them, to determine their use and to have them deleted. These rights shall be legally enforceable.

Digitalization at the service of sustainability goals

5. The potential of digitalization should be used worldwide to achieve the *goals of sustainable development* (2030 Agenda and beyond). Solutions based on digital technology should be considered in societal decisions involving the goals of sustainable development.
6. The development of digital technologies and digitalized infrastructures shall always take the environmental and social impacts into account. The *planetary guard rails* must be observed.

7. Digitalization shall be used specifically to monitor the *UN's sustainability goals* and thus to safeguard social and ecological standards.
8. All countries shall contribute to the development of *digital commons*, to the cultural and natural heritage and to the global state of knowledge, and shall ensure their protection and universal accessibility across generations.

Avoid systemic risks

9. All states and companies shall actively work to minimize *risks to critical infrastructures*. They shall be obliged to inform each other about errors and vulnerabilities and to ensure that these are remedied. Responsibility for damage shall always be clearly defined.
10. The use of digital technology involves obligations. Its use should at the same time serve the *common good*. Digital solutions may not be used to oppress people, to monitor them without cause, or to exercise social control.
11. All states shall have a duty to provide appropriate support for people affected to adapt to the *changes in the world of work* caused by digitalization according to the principles defined above.
12. Human *decision-making sovereignty* in the use of artificial intelligence and algorithm-based automatic systems in societal decision-making processes shall be guaranteed. Human beings shall retain the right to make the final decision. Automated decision-making and decision-making support must always be traceable, and shall take place only within a clearly defined framework and with the option of making corrections. The responsibility for automated decision-making and decision-making support shall always be clearly defined.
13. All states shall have a duty to preserve the *right of the individual to Eigenart and imperfection*. Societal pressure to optimize the human body through technology shall be countered. All states shall agree on binding rules and ethical guidelines at the multilateral level.
14. *Cyberattacks* shall be subject to the Geneva Conventions on Armed Conflict and their additional protocols, which must be supplemented to include attacks on critical infrastructures. The use of fully automated *autonomous weapon systems* shall be prohibited. The protection of the civilian population shall have the highest priority.

Prepare for procedural challenges

15. All states and companies shall develop *ethical guidelines* on the conception, development and application of digital technologies and solutions with regard to human dignity and sustainability goals and shall create the necessary legal and organizational frameworks for their implementation.
16. All states shall create *institutions* that give advice on the use of digital technologies when they impinge directly on human dignity, the natural life-support systems, the inclusion of all human beings, or the individual's *Eigenart*. All states shall create the conditions for *civil society* to participate in these processes at an early stage.
17. Through *technology-oriented future-proof education*, all states shall enable their citizens to participate in the use of digital technology, to develop an awareness of global responsibility and a holistic understanding of their options for action in the Digital Age, and to actively participate in shaping future developments of digital technologies and digital infrastructures. This shall include in particular education for sustainable development.
18. All states shall *cooperate* at a multilateral level in accordance with the objectives and obligations agreed in this Charter.

different regions, at different aggregation levels and over several years, and to make it available as open data using public-service information and communication infrastructures (WBGU, 2019a:4, 15).

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- › issue early warnings to draw attention to new problem areas,
- › identify gaps in research and initiate new research,
- › monitor and assess national and international policies for achieving sustainable development,
- › elaborate recommendations for action and research, and
- › raise public awareness and heighten the media profile of global change issues.

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