More information available at:
https://www.bmu.de/en/topics/sustainability-international/digitalisation-and-the-environment/

Shaping digitalisation for humans and the environment

Digitalisation is a megatrend of our time. Together with climate change, globalisation and demographic change, it is one of the developments that is shaping our world of today and tomorrow. Digitalisation in itself is neither good nor bad. What matters is what we make of it - whether we allow ourselves to be overwhelmed by it or use it to our benefit.

As digitalisation rapidly grows, so too does the need for power and valuable resources. Our wonderful new world of smartphones, streaming services and social networks is still powered primarily by coal, oil and gas. Streaming our favourite series, online shopping and digitalised production are currently not improving our CO_2 balance, but merely increasing consumption. Some estimate that in just a few years, the digital sector might be responsible for more global CO_2 emissions than passenger cars. Is digitalisation therefore destined to become a threat to the climate?

Digitalisation for the benefit of social and environmental restructuring

This does not have to be the case. Digital solutions can support climate action, clean air, intact soils and biodiversity conservation. Artificial intelligence helps us process more plastic waste into plastic for production. Smart textiles turn disposable products into long-lived and recyclable fashion. These are just two of the countless examples of digital creativity and pioneering spirit.

The effects of global warming have been felt in Germany for some time now. Fundamental changes are needed. An equitable restructuring of cores areas of our lives: how we generate energy, our agricultural practices, construction practices and how we produce goods. Digitalisation can play an important role in this. So far, we have underexploited the potential of digitalisation for the environment and climate. I want to change that.

I am advocating that environmental and climate policy make use of the possibilities offered by digitalisation while ensuring that it does not harm the environment or climate. It is up to policy-makers to shape digital progress in a way that benefits humans and the environment.

Solve problems don't create them

My goal is for digital innovation to drive the energy transition forward, for buses, cars and trams to link urban and rural areas and thus provide an alternative to individual car ownership. Digitalisation will create new impetus in industry for good and recyclable design thus enabling Germany to remain at the forefront of environmental innovation. It can also help us fertilise our crops in a more targeted way and therefore protect insects. Digitalisation should create more transparency for

consumers. In short: I want to take advantage of the opportunities digitalisation presents for more prosperity and competitiveness, social equity and an intact environment, and minimise its risks.

In preparing this Digital Policy Agenda for the Environment, the Federal Environment Ministry has broken new ground and accomplished a pioneering feat. At the re:publica 2019 conference, I presented the key points for a Digital Policy Agenda for the Environment and initiated a broad participation process. During a three week environmental workshop (#umwelt.werkstatt), the Federal Environment Ministry drew up the agenda together with around 200 experts from politics and administration, industry and research, and from municipalities and civil society. The agenda is the product of a broad range of knowledge, different perspectives and the unified will to utilise the benefits of digitalisation. We discussed common values and strategies, addressed more environmentally sound IT and looked at fields where the digital transformation is already in full swing. These fields are, in particular, mobility, agriculture, industry and circular economy, and everyday consumption. The Agenda thus contains several measures for all of these areas, many of which are already underway and others that are still in the planning stages.

Some of our projects can only be implemented in a combined effort at European level.
The European Union can set the global bar for a sustainable digitalisation that combines economic, social and environmental progress. I hope to use the EU Council Presidency, which Germany will hold for the second half of 2020, as an opportunity to generate fresh momentum in line with this agenda. Environmental protection and climate action should be incorporated into every algorithm - in Germany, in Europe and throughout the world.

Svenja Schulze
Federal Minister for the Environment, Nature Conservation and Nuclear Safety

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Berlin, 02 March 2020

At a glance
The Digital Policy Agenda for the Environment: how a problem can become the solution.

Climate change is marching onward, habitats are disappearing and species are dying out: in the medium term, a good life in an intact environment is no longer guaranteed in either Germany or Europe. Core areas of our lives will have to change. The economy, work, every aspect of our day-to-day lives are facing social and environmental restructuring. The course for this will be set in the next ten years. How we shape digitalisation will determine whether we are on course towards a greenhouse gas neutral future in a liveable world.

Addressing megatrends together
Digital technologies and infrastructures leave behind a significant and ever-growing ecological footprint. Guiding principles are needed to ensure digitalisation does not exacerbate environmental degradation. If digitalisation is successfully designed in a sustainable way, it can decisively support social and environmental restructuring. Digitalisation opens up new options in environmental policy for shaping climate action and the conservation of nature and resources, for example through more transparency and technological innovation.
The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) launched the Digital Policy Agenda for the Environment to ensure digitalisation works in harmony with the environment, climate and nature. The Agenda defines strategic principles and targets and contains four packages of measures to anchor environmental protection in digital policy in the long term.

I. Package of measures: Future Programme for Environmentally Friendly Digitalisation
The Future Programme for Environmentally Friendly Digitalisation is intended to reduce the energy needs and resource consumption of digital technologies. The measures will close loopholes, in particular in European rules and provisions regarding hardware, software and cloud services. These measures will ensure that smartphones are also regulated in the EU Ecodesign Directive or that electronic products will become longer-lived through obligatory updates, replacement parts and repair services. A data centre register is to improve the monitoring and reduction of energy consumption of digital infrastructure. The programme will be accompanied by criteria for sustainable artificial intelligence.

II. Package of measures: Transparency initiative
Better information creates transparency. Transparency creates new possibilities for design, management and action. A Digital Product Passport containing the environmental data on the life cycle of products and services will enable consumers, industry and the waste management sector to act more sustainably. Digital platforms will support the transition towards sustainable consumption e.g. by prioritising environmentally friendly products in search engines and ensuring goods are no longer destroyed unnecessarily. Municipalities will be supported in the use of data and ICT for smart traffic management systems and the reduction of rebound effects through digital mobility services. Pattern recognition, improved monitoring and public data promote a better understanding of ecosystems.
This could help provide solutions for sustainable agriculture.

III. Package of measures: digitalisation for social and environmental restructuring
The Digital Policy Agenda for the Environment sets important impulses for utilising digital innovations as a tool for social and environmental restructuring. With its Artificial Intelligence (AI) lighthouse projects for the environment, climate, nature and resources, the BMU is promoting the targeted use of artificial intelligence to tackle environmental problems. New instruments to promote innovations, like the Digital Innovation Hub for Climate and the

Platform for Social and Environmental Innovations are to channel the innovative capacity of the digital sector and civil society towards environmental policy challenges.

IV. Package of measures: environmental policy 4.0
Digital technologies facilitate data based, transparent and robust environmental policy. The BMU wants to strengthen environmental administration with the environmental policy 4.0 package of measures. A Satellite Remote Sensing and Sensor Technology Competence Centre, an AI Application Lab and big data will support data use and analysis as service providers. Access to environmental data is to be made easier by means of a German environmental and nature conservation information system. A review will be carried out of the legal and technical requirements for automating the associated administrative processes and making them more effective.

The Digital Policy Agenda for the Environment comprises over 70 measures, many of which are already underway, some which are being initiated and others which are in the development stages. With this agenda, the BMU is, for the first time, presenting a strategic framework for shaping the digital transformation in a sustainable manner.

Principles of the Digital Policy Agenda for the Environment

Clear principles create synergies when two megatrends can no longer avoid each other

The agenda brings two megatrends of the 21st century together: environmental protection and climate action, and digitalisation.
In 2015 the international community made a binding commitment under the Paris Agreement to keep global warming to well below 2 degrees Celsius and if possible to 1.5 degrees Celsius compared to pre-industrial levels. Germany is thus pursuing the goal to become greenhouse gas neutral by 2050. This goal and the conservation of biodiversity and habitats are vital for humankind and our planet. They both require us to fundamentally change our society, way of life and economic practices over the next 30 years. Noone can afford to ignore the need for ambitious environmental protection and climate action. However, there are also megatrends that environmental protection and climate action cannot avoid.
Digitalisation is one of these megatrends. Firstly, because it is currently a major driver of energy consumption and CO_2 emissions. Secondly, because digital technologies if designed appropriately, can be a key tool for the necessary social and environmental restructuring of our economy, work and society. Across all environmental policy strategies, they can help meet the Sustainable Development Goals (SDGs) and the goals set out in the Paris Agreement.
Digital technologies are both a challenge and an opportunity for environmental policy. The BMU Digital Policy Agenda for the Environment sets out guiding principles to take advantage of these opportunities while also minimising the risks. The Agenda is based on the following six principles:

1_Social and environmental aspects of restructuring only possible with digitalisation
Binding environment and climate policy goals and the wide range of expectations within society as regards a good life can only be met if society makes better use than it has up to now of digital technologies for sustainable forms of economic activity, housing, working and co-existing. Without digital technologies, the energy transition and transformation of the transport sector are just as inconceivable as a resource-efficient industry - a fundamental requirement for maintaining prosperity, competitiveness as well as good and well-paid work. Digitalisation allows new business models and forms of cooperation between policy-makers, administration, economy, science and civil society. It provides data and management potential for transparency in supply chains, more environmentally sound production, informed consumer decisions and more responsible action on the part of all stakeholders in society. And lastly, it opens up new regulatory possibilities in environmental policy. This potential is by no means exhausted yet. The Digital Policy Agenda builds on a number of measures which stem from existing strategies and programmes of the German government and the BMU. These include the Climate Action Programme 2030, the National Artificial Intelligence Strategy, the German Resource Efficiency Programme (ProgRess) and the National Programme for Sustainable Consumption. The Agenda integrates these measures and describes solutions for establishing a framework for digitalisation.

2_Digitalisation itself has to become environmentally sound
Digital technologies and business models leave behind a significant ecological footprint - both directly and indirectly. Every new digital application leads to an increase in data volumes that are moved and managed. Energy consumption is rising steeply. Each new end-device and new digital infrastructure consumes valuable raw materials and energy along global production and supply chains. The interventions in nature are substantial.
If left uncontrolled, digitalisation will accelerate the adverse environmental impacts which it can actually counteract. What is needed to make digitalisation environmentally friendly? Software, data centres and end-devices have to become energy- and resource-efficient. In addition, material cycles for the manufacture of digital devices must be closed.

As a first step, greater transparency and better traceability are needed with regard to the ecological footprint of digital technologies. This is the only way to recognise risks and undesirable developments and make independent, responsible decisions which will enable counteractive measures.

3_Digital technologies facilitate "more with less" - utilising digital environmental dividends
The focus of digital technologies is now first and foremost on their economic potential: digital solutions offer greater efficiency in services and production. They conserve resources, reduce time requirements and lower costs. However, it is precisely this that can exacerbate environmentally harmful developments.
This is because many businesses and consumers often invest these freed up resources into additional production and more consumption. In some cases, digital business models are the very models that first create the conditions for such rebound effects - for example, high energy consumption due to streaming services.
That is why guiding principles are needed to ensure that digitalisation stays on track. It is not just about minimising undesired consequences or rebound effects. Rather, the time has come to make use of the efficiency potential of digital technologies and solutions to yield digital environmental dividends. Resources saved should be invested in future tasks. To this end, a regulatory framework is needed.

4_Digital solutions are not an end in themselves The environmental policy approach to digitalisation focuses on the bigger picture
The potential and impacts of digital technologies differ from sector to sector. We are talking here about "transformation fields" which include industry, circular economy, mobility, consumption, nature conservation, agriculture and water management.
Potential can only be tapped and impacts managed by first looking at the overall picture and correlations between the individual transformation fields. It is important to note here that new technology and techniques do not in themselves constitute progress. We can only speak about progress when these new technologies improve people's lives are improved and benefit the environment, climate and nature. Their purpose, quality and impact are decisive. This also requires cross-cutting sociopolitical issues like gender equality, diversity and demographic change to be taken into account. Digital solutions have to provide answers to the concrete challenges presented by social and environmental restructuring. Many require start-up finance. New and existing support instruments therefore have to be consistently geared towards positive effects on the environment and society.

5_Digital technologies help modernise environmental policy and environmental administration of the federal government, the federal states and municipalities
Data, automation, new forms of communication, artificial intelligence: all these are used by digital environmental policy to better protect the environment and nature, mitigate climate change, improve transparency and communicate on an equal footing with citizens. Digital technologies help to better monitor the status and development of the environment. They are, as it were, a promise of more effective and efficient protection measures. A prerequisite for digital dividends is investments in data infrastructure and in the competence of the administration. The Digital Policy Agenda for the Environment is intended to make environmental administration a pioneer in the use of digital technologies and solutions for fact based policies and for good administrative action with an ethical compass.

6_The window of opportunity for making digital technologies a driver of sustainability is now We need to use this opportunity
The use of digital technologies is bringing about a fundamental restructuring in the economy

and society. Businesses and consumers are changing their patterns and behaviour. Many sectors and industries are undergoing structural change. New market and power structures are emerging. New stakeholders are establishing themselves.

Consumers are changing their consumption patterns. The concept of statehood is evolving and social discourse is increasingly taking place in social networks. We are experiencing a new era. Over the coming years, fundamental investment decisions will be made on the establishment and expansion of new infrastructures, platforms and production processes. In this phase of upheaval lies an opportunity to break away from the negative path dependencies of digital technologies and anchor the guiding principle of sustainability into newly forming structures.

As new structures become more and more fixed and in light of the tasks to be tackled today, the window of opportunity for taking action will close.

This is already being made clear by the rise in dominant market platforms in online retail and social networks.

Conclusion: Shaping a policy for digitalisation determines whether it will exacerbate social and environmental crises or provide a set of tools for a sustainable future.

The Digital Policy Agenda for the Environment describes strategic goals from which concrete measures can be derived to make digitalisation itself more sustainable, promote innovations and to shape digitalisation in the individual transformation fields.

It is clear that the digital transformation is as much a part of our reality as climate change. The good news is that we can shape both. But we will only succeed by actively taking control of these changes. With its Digital Policy Agenda, the BMU is taking on the task of creating a digitalisation that is fit for the future, environmentally sound, social, fair, European and international. The Agenda aims to prepare society for the changes ahead and promote innovations in industry, work, the environment and administrative structures. We need pioneering spirit and digital creativity for social progress. The Digital Policy Agenda for the Environment makes digitalisation into a driver of opportunity for society's project of sustainability.

I. Environmentally friendly digitalisation

Responsibility for climate- and resource-friendly technologies

Digital business models, the production, operation and disposal of mobile devices, digital infrastructure components for data centres and communication networks, and rapidly growing data communication all lead to an ever-increasing consumption of energy and resources. In order to fully tap the potential of digitalisation for environmental protection, climate action and resource conservation, its own ecological footprint must be as low as possible.
This is far from the case in reality. The growth in the development and use of digital technologies also increases energy and resource consumption. It is no longer just about billions of devices networked on the Internet of Things.

Users cannot fathom or control the environmental impacts resulting from the interaction between memory, software and processing power in the Cloud. This increases the corporate responsibility of developers, manufacturers and operators of devices, software and data centres. Environmental policy must step in and set the right framework conditions and incentives for limiting the ecological footprint of digitalisation.

Making digital infrastructure and data centres more efficient
The Internet is not a virtual cloud. Behind the Cloud are data centres and servers of businesses and authorities that are doing the "thinking work" of digitalisation. Data centres have become a key sector in the economy and constitute critical infrastructure in some cases. There are currently no legal requirements regarding minimum energy efficiency for data centres and there are few incentives to encourage the careful use of energy and raw materials. As a result, the performance capacity of data centres is underexploited. Consequently, there is a greater need for environmental policy to deliver effective strategies and rules to reduce the energy and resource consumption of data centres.

Mandatory limit values for efficiency require a stocktake and effective monitoring, neither of which have been carried out up to now. The BMU is therefore advocating uniform statistical recording in data centres as a prerequisite for preparing a register and as a basis for effective sector coupling (e.g. municipal thermal planning). In its project KPI4DCE, the Federal Environment Agency (UBA) already presented indicators for evaluating the energy and resource efficiency of data centres.

With the Blue Angel ecolabel we are demonstrating how energy and resource efficiency can be improved in the operation of data centres and in data centres of service providers (co-location data centres). It is an opportunity for the sector to show its commitment to the environment. Through its National Climate Initiative (NKI), the BMU supports municipalities in investments and optimisation services for increasing efficiency in data centres.
Under the European GAIA X Cloud Service Initiative the BMU, together with industry, supports aligning this forward-looking infrastructure with environmental criteria from the very beginning. This will enable Europe to set global standards for environmentally friendly digitalisation.

Energy- and resource-efficient product design
The energy and resource efficiency of products and innovations on the European market is guided by a mix of minimum efficiency standards, mandatory energy consumption labelling and voluntary ecolabels.
The EU Ecodesign Directive is a key tool for defining product standards. It also applies to imports, for example from Asia or the US, which enter the internal market. To make this directive fit for the digital age, the BMU is committed to ensuring the swift application of the Ecodesign Directive to digital products such as smartphones, tablets and network components. To modify outdated criteria in line with technological progress, provisions for products already

covered by the directive such as PCs, notebooks, servers, storage systems must be updated much more quickly than has been the case up to now.

In addition to energy efficiency requirements primarily enshrined in the Ecodesign Directive, efficiency standards of materials and resources for digital electronic devices must also be laid down in regulatory law. As part of Germany's EU Council Presidency, the BMU will work to incorporate resource conservation into the EU Ecodesign Directive and adapt EU regulatory law to the accelerated technology and product cycles of the digital age (fast-track ecodesign/ top runner approach).

Long hardware life

A fundamental problem with hardware is its short life span. Obsolescence, that is the ageing of a product, can occur naturally or be brought about artificially. Both instances render the product unusable for the desired purpose. Digital electronic devices often lose their ability to function due to lack of spare parts, software changes or security gaps due to lack of support. Mandatory provision of updates, repair manuals, replacement parts and tools and cross-manufacturer solutions for exchanging batteries, screens and other short-lived hardware components are therefore central to the modular design, reparability and life span of devices. For this reason, the BMU is advocating binding requirements for manufacturers in the EU Ecodesign Directive that will guarantee the functionality of hardware software systems for many years. This applies to digital products and conventional household appliances that are increasingly becoming digitally networked.

In addition, the BMU is in favour of extending European manufacturer obligations to include statements on the guaranteed life span of their products (guarantee statement obligation). This is an important step towards a comprehensive European right to repair under the EU Ecodesign Directive or a new directive on the repair of electrical and electronic equipment that would guarantee independent and long-term repair services in the interest of consumers.

Closed cycles for digital technology materials

The environmental and social consequences of raw material extraction for digital devices are a fundamental problem of digitalisation. Take smartphones for example; metals like gold, cobalt and other rare Earths are extracted using high levels of energy and in some cases under inhumane and dangerous conditions. Toxic substances are often used to remove precious metals from the rock. In the process, heavy metals enter the air and water, render soils infertile and have harmful effects on humans, animals and plants. The product design and marketing strategies of digital electronic devices must therefore, and also with a view to the future availability of raw materials, be geared towards closed loop cycles and recyclability from the very beginning. In order to increase the use of secondary materials in production, the BMU is advocating EU-wide and environmentally appropriate minimum quotas for the use of recycled materials (plastics and metals) in the manufacturing of components for digital infrastructures and electronic devices. This would strengthen the European market for secondary raw materials and make the EU less dependant on imports.

Industry and policy-makers are also responsible for ensuring that end-of-life electrical and electronic equipment is not disposed of illegally. If exported, the importing country must guarantee environmentally sound disposal. The BMU will review European and national legislation on waste electrical and electronic equipment with regard to compliance and effectiveness and, if necessary, work to tighten such legislation.

Environmentally sound software programming

Software significantly influences energy consumption and the life span of hardware. It activates energy saving modes, transfers and saves large volumes of data and initiates computing operations. Despite its major significance, the regulation of sustainable software is still in the initial stages - legal requirements for energy efficiency do not exist.

The Federal Environment Agency's Blue Angel ecolabel for resource- and energy-efficient software products is an important step forward. The label certifies that the software uses hardware resources efficiently, conserves energy, is compatible with older hardware and that updates will be available in the long term. Furthermore, certified software is characterised by high transparency and autonomy. The BMU and the Federal Environment Agency (UBA) are developing and launching a syllabus and a network for "green coding" to create the tools for incorporating environmentally sound software programming into the training of programmers.

AI and blockchain: future technologies for the benefit of the environment and climate
With its AI Strategy, the German government wants to tap the potential of artificial intelligence for sustainable development. The BMU AI lighthouse projects for the environment, climate, nature and resources promote the use of AI solutions in these fields. As AI requires enormous processing power and energy, the BMU is developing criteria to assess the environmental impacts of AI and will introduce the goal of environmentally friendly AI into the forthcoming update of the AI Strategy and European white paper process on AI.

In its Blockchain Strategy, the German government also made clear that blockchain solutions must be used in a manner that is in line with the Sustainable Development Goals (SDGs) and the climate targets. This means using the opportunities for the environment and climate while at the same time critically reviewing the appropriateness of the envisaged fields of use and limiting the energy and resource consumption of blockchain solutions. Together with experts from the blockchain sector, the BMU will develop sustainability standards for the relatively new technology to steer investments along environmentally sound paths and ensure sustainability aspects are considered in the awarding of contracts and implementation of public projects.

Environmentally sound expansion of mobile communication infrastructure
5G technology and the associated expansion of mobile communication infrastructure is vital for many fields of application of the future, for example for networking different modes of transport. New digital infrastructure involves higher demand for energy and, above all, raw materials. This is in part due to the parallel operation of mobile communication networks and infrastructures. Mobile broadband coverage could be improved and environmental impacts reduced through national roaming or new terms for awarding frequencies in future. The BMU and UBA are conducting an environmental technological impact assessment with a view to developing recommendations for action.

Protecting health
Environmentally sound digitalisation also includes protecting the health of citizens. The expansion of mobile communication infrastructure raises concerns about the health risks of electromagnetic fields. These concerns are to be taken seriously as such an expansion can only be carried out together with the local community. For this reason, the existing high level of protection laid down in the German government's Mobile Communications Strategy will also be applied to the 5G sector and, if necessary, enforced by ordinance. The BMU set up an Electromagnetic Fields Competence Centre in the Federal Office for Radiation Protection (BfS) to provide the public with comprehensive information on mobile communication, its technology and possible health effects. The BMU is also paying attention to nature-friendly grid expansion: the standards laid down in nature conservation law shall not be affected by the 5G expansion.

Setting a good example: Green IT project
The German government is making progress on green IT: since 2009, in the framework of the green IT energy saving programme, the energy consumption of the government's IT systems has decreased by nearly 60 percent, in spite of a significant rise in performance. By 2024, this energy consumption is to be further reduced by an additional two percent each year. Under the Climate Action Programme 2030 and Climate Change Act, in future German government data centres under development and data centre services for the government will have to comply with Blue Angel criteria. Greater consideration will also be given to climate action in public

procurement. Before strategic decisions on the use of IT are taken, in addition to the use phase, the environmental impacts of the manufacturing, recycling and disposal stages will also be taken into account. Consideration of the Blue Angel criteria in the awarding of contracts for IT services and the purchasing of IT products will be thoroughly checked as part of the IT procurement strategy.

One final question:
Does everything always have to be networked and digital? Do we really need toasters and coffee machines that can be controlled while we're on the go, or smart water bottles that remind us to drink water? Is digital monitoring of our pets really necessary? These are all legitimate questions. The decision as to who needs what lies with consumers themselves. And sufficiency, in other words the voluntary decision to forego unnecessary digital consumption, makes an important contribution to reducing the ecological footprint of digitalisation.

Environmentally friendly digitalisation measures

Measures already underway
- *Blue Angel as orientation for green IT*
  The Blue Angel ecolabel has been established for the following four product groups: energy-efficient data centre operation, climate-compatible co-location data centres, resource- and energy-efficient software products, and server and data storage products
- *Safeguard health and nature conservation in the expansion of 5G mobile communication infrastructure*
  Transfer of existing high level of protection against electromagnetic fields to the 5G sector under the Mobile Communications Strategy of the German government; for expanding the grid, maintaining protection standards set out in nature conservation legislation
- *Further development of government Green IT Initiative*
  Consolidation of energy consumed in the federal administration by IT operation to a maximum of 350 gigawatt hours in 2022; implementation of sustainable IT procurement and application of Blue Angel criteria for government data centres being established
- *Environmental impact assessment of 5G technology*
  Research into trends in energy and raw material consumption of new mobile networks including selected end-devices with a particular focus on 5G mobile communication infrastructure under the UTAMO project
- *Promotion of climate action in data centres (NKI)*
  Support for municipalities with investments and optimisation services that significantly increase energy and resource efficiency in data centres
- *Studies on climate action potential in IT and building engineering in data centres (NKI)*
  Promotion of municipal studies to analyse potential of existing IT and building engineering in data centres as well as short-, medium- and long-term potential for energy and greenhouse gas emissions savings
- *Climate-friendly procurement in the German government*
  Consideration of environmental impacts in manufacturing, use, recycling and disposal stages before strategic decisions are taken on the use of IT in the German government
- *Electromagnetic Fields Competence Centre*
  Pooling of BfS expertise and intensification of research and communication on static, low-frequency electric and magnetic, and high-frequency electromagnetic fields

Measures to be initiated
- *Initiative to extend EU Ecodesign Directive*
  - Extend application to cover new product groups (e.g. smartphones)
  - Update criteria for products already covered (e.g. PCs)
  - Establish minimum standards for resource efficiency
  - Lay down requirements for manufacturers to ensure long operation life spans of their hardware software systems.
  - Make existing legislation more dynamic in light of accelerated technology and product cycles
- *Push for guarantee statement obligation and right to repair (obsolescence)*
  Extension of European manufacturer obligation on statements about the guaranteed life span of digital electronic products; creation of legally binding rules on provision of updates, repair instructions, replacement parts and tools, and cross-manufacturer solutions for exchanging batteries, screens and other short-lived hardware components as a basis for a European right to repair under the EU Ecodesign Directive or a directive on the repair of electrical and electronic equipment
- *Green coding syllabus*
  Development of a syllabus for computer science students on methods to develop energy- and resource-efficient software including a support network
- *Sustainability criteria for blockchain*
  Establishment of sustainability standards for distributed ledger technologies as a task under the Blockchain Strategy of the German government; consideration of ongoing project *Nachhaltigkeit für Distributed-Ledger-Technologien & Smart Contracts* (sustainability for distributed ledger technologies and smart contracts) which is part of BMU support for associations
- *Sustainable artificial intelligence*
  Update of AI Support Programme of the BMU and development of criteria to evaluate the environmental impacts of AI (particularly energy and resource consumption)

Measures to be developed next
- *Register for data centres*
  Creation of a register for data centres (through extended classification of branches of the economy (WZ 2008) to include a sectoral category for data centres)
- *Use of recycled materials*
  Development of EU-wide minimum quotas for the use of recycled materials (plastics and metals) in the manufacturing of components for digital infrastructures and electronic devices
- *Research on energy and resource consumption indicators*
  Creation of a database and establishment of systematic monitoring of the energy and resource consumption of digital electronic devices and infrastructures as a prerequisite for data based policy

II. Transparency initiative for transformation fields
How and where digitalisation is driving social and environmental restructuring

How the digital transformation progresses also depends on the respective economic sector and area of life. The Digital Agenda must therefore take account of the various requirements without losing sight of the overarching goals.

Understanding how digitalisation is altering the economy, social interactions and our day-to-day lives is not easy. There is no one single digitalisation. Rather, there are digital development paths which differ according to economic sector, area of life and field of action. That is precisely why individual policy approaches are needed to shape digitalisation in a sustainable manner. For digitalisation to benefit social and environmental restructuring, the best possible use must be made of the digital dividend.

An environmental policy strategy to shape digitalisation therefore has to be broken down into the different fields in which digitalisation is unfolding. Four particularly relevant fields covered by the Digital Policy Agenda for the Environment are:
_Industry 4.0 and circular economy
_Mobility
_Sustainable consumption
_Nature conservation, agriculture and water management

For all four transformation fields, the Agenda outlines measures which take account of the different requirements and problems in each. The four fields also have something in common, namely the four overarching goals that are crucial to the successful implementation of the Agenda.

Create more transparency through data
Digitalisation can improve transparency on the sustainability of products and services, thereby helping consumers and businesses make informed decisions and take more sustainable action. The state also benefits as more transparency means that compliance with environmental and social standards can be monitored and enforced more effectively.

Use digital platforms as drivers of sustainability
Digital platforms are increasingly being used as market places and for social interaction. Ultimately, they can influence consumer and production decisions. The regulatory goals and framework conditions regarding these platforms therefore undoubtedly affect key questions on how to shape environmental policy.

Strengthen sustainable innovations through digital solutions
Digital technologies and innovations are often not designed to provide solutions to sustainability issues. An innovation strategy of the Digital Agenda must therefore identify challenges and opportunities of digitalisation in the transformation fields. This would enable innovations for sustainability to make better and more targeted use of digital solutions.

Establish guiding principles for environmental policy
Digitalisation needs environmental regulation. Without the appropriate guiding principles, the digital transformation cannot bring sustainability forward. Interestingly though, it can help improve regulatory approaches by making them more tailored, more dynamic and more flexible.

Networking people and machines in an intelligent system managed in real time increases efficiency and productivity, but also allows for greater customisation in production. Industry 4.0 makes businesses more flexible and better able to respond. It also taps new optimisation potential, for example through automated and self-learning manufacturing and logistics systems. Data is being increasingly used in this context - within businesses, but also generally via platforms. This in turn facilitates the emergence of new data based business models and services. Competitive usage requires standards for data and interfaces.

The BMU Digital Policy Agenda for the Environment focusses on the transparency of products, value and supply chains. It also provides important impetus for a greenhouse gas-neutral and resource-efficient economy. This is both a prerequisite for the competitiveness of German industry and a core element of a forward-looking environmental industrial policy.

Digital Product Passport
The key measure of the Digital Policy Agenda is the introduction of a standardised Digital Product Passport as proposed in the European Green Deal of the EU Commission. It is intended to cover all significant environmental and material data of a product that will be updated, supplemented and consolidated throughout the manufacturing stages. This data makes it possible to create a "digital twin" that accompanies the product throughout its lifetime. The Product Passport is intended to make mandatory reporting easier for businesses and create transparency for buyers and consumers: transparency on the environmental impacts of manufacturing, materials contained in the product and on repair and proper disposal. In this way, consumer decisions can become more sustainable.
The BMU is making the Digital Product Passport a focus of the German EU Council Presidency and will work on concepts for its design and implementation.

Binding and reliable data
A prerequisite for a Digital Product Passport is reliable and comparable information on the social and environmental impacts of manufacturing and on the environmental features of products and services. Digital technologies like blockchain can document this data in a reliable and forgery-proof way. To make environmental and social standards visible along the supply and value chains of businesses in CSR reports, the BMU is calling for the CSR Directive to include mandatory reporting on environmental damage arising from the extraction and processing of raw materials.

Data for better recycling
Standardised data on products and waste material flows can help upgrade facilities in the waste management sector and recycling industry and make them more efficient. Tasking the European Chemicals Agency (ECHA) with setting up a database on substances of very high

concern for operators of waste treatment facilities is an important step. Such a database will help ensure that undesired substances are filtered out of recyclable material cycles.

Potential of digitalisation for production: ProgRess III
In the latest update of the German Resource Efficiency Programme, the BMU shines the spotlight on digitalisation in production (ProgRess III, due to be published in spring 2020). ProgRess III integrates environmental aspects into industry 4.0 and identifies standardisation requirements. Furthermore, it envisages setting up an open data platform for resource conservation. The platform is intended to help recognise advances, undesirable trends and action required in resource policy, and to extend the public data base for individual material flows and their environmental significance.

Facilitate corporate environmental and energy management with digital tools
The voluntary European environmental management system EMAS (Eco-Management and Audit Scheme) is an important instrument for systematic corporate environmental protection. In addition to improving environmental performance, EMAS offers economic opportunities: potential for saving resources is recognised and legal certainty is increased through verifiable compliance with provisions. The use of digital tools can make reporting significantly easier and more attractive. The BMU wants to effectively support this digitalisation potential (see also UBA brochure *Umweltmanagement und Digitalisierung* (environmental management and digitalisation)).
Corporate energy management makes it possible to integrate aspects of digitalisation into the switchover to renewable energy sources and thus to reduce greenhouse gas emissions. The UBA guidelines *Energy Management Systems in Practice*, updated in 2020, help businesses simplify the introduction of a corporate energy management system.

Environmental innovations in industry
The promotion of digital industrial innovations for climate action and resource conservation strengthen the capacity for action in industry and the circular economy. In industrial companies many environment related approaches to digital innovations already exist within industry 4.0, in environmental management 4.0 and in corporate environmental protection. Air quality control or wastewater treatment facilities can, for example, be directly linked and made more efficient through digitally controlled production processes. This potential is demonstrated by current examples taken from the Environmental Innovation Programme of the BMU which supports large-scale facilities with a model character in the areas of resource efficiency, climate action and waste avoidance: the construction of a facility for the digital manufacture of packaging reduces CO_2 emissions and saves waste at the same time.

Good examples of integrated solutions
Digital solutions are offering new possibilities in waste management for direct interaction with consumers. Apps can provide impetus for waste prevention and raise awareness for the separation of waste. Corporate waste management, which faces the challenge of efficient collection logistics in densely populated cities and scattered rural areas, can also profit from apps. The BMU plans to respond to these challenges through the support and development of model projects in a living laboratory for digitally networked model municipalities. These projects will also help create data standards for a uniform data base.

Industry 4.0 and circular economy measures

Measures already underway
- *Vocational training in industry*
  The VDI Centre for Resource Efficiency (VDI ZRE) offers training courses on behalf of the BMU on how digital technologies can help reduce material and energy consumption in production processes
- *German Resource Efficiency Programme: ProgRess III*
  Update of German Resource Efficiency Programme (ProgRess) with special emphasis on the interactions between digitalisation and resource efficiency

Measures to be initiated
- *Open Source Data Platform*
  To identify advances, undesirable developments and need for action in resource policies, usable central data and information on resource conservation is to be made available to the general public via the Open Data Platform of the German government
- *Integration of resource efficiency and environmental aspects into industry 4.0*
  Research, financial research support and practical testing on resource and environmental aspects of industry 4.0 to further develop the link between resource efficiency and digitalisation in the industry 4.0 field and address risks
- *Corporate environmental management*
  Promotion of digitalisation potential through the European environmental management system EMAS
- *Introduction of Digital Product Passport*
  Support of the EU Commission initiative to develop a Digital Product Passport, as part of Germany's EU Council Presidency
- *Standardisation and standards*
  Acceleration of standards on and standardisation of the integration of resource and environmental aspects in industry 4.0, automation and IT
- *Industry 4.0 Platform*
  BMU dialogue with Industry 4.0 Platform on sustainability and production issues from the perspective of industry

Measures to be developed next
- *Corporate Social Responsibility (CSR)*
  Initiative supporting consideration of environmental impacts along supply and value chains
- *Living laboratory for networked model municipalities in circular economy*
  Establishment of test area to explore digital solutions for optimised waste logistics and management, waste prevention and interaction with consumers
- *Environmental aspects of critical raw materials*
  Initiative supporting consideration of environmental aspects in EU list of critical raw materials (adaptation of classification methodology and approach)

_Mobility

Target vision
Digital solutions will be used to reduce air pollutants and the climate impacts of transport and to provide affordable, reliable mobility in urban and rural areas. In this way, they not only contribute to a higher quality of life, but also to the competitiveness of the mobility and transport sector in the structural change. Digitalisation is to create room for more recreation areas and free spaces as opposed to transport areas. It will help make loud and congested roads a thing of the past and ensure that the most environmentally friendly option is always the best option.

Digital technologies offer a great opportunity to reorganise mobility in a new and environmentally sound manner. They could be the key for a sustainable transformation of the transport sector. In cities, bike and car sharing as well as ride-sharing and carpooling are already alternatives to people driving their own cars. Digital transport schedule information and booking options via apps make it more comfortable to use public transport and combine different modes of transport. Sensor technology and artificial intelligence create the conditions for automated and, in future, driverless electric driving.

More transparency, high-quality traffic data and interlinking offers on digital platforms facilitate new mobility services and dynamic traffic management systems in real time. At the same time, it appears that digitalisation today is not yet leading to more sustainability in transport and its potential can only be tapped under certain conditions.

Solid facts for targeted policy
The BMU has commissioned extensive research into the environmental and climate impacts of digital solutions in mobility. An important question in this context is how will networked infrastructure and vehicles change capacities in road transport? Building on this, proposals for regulations will be developed aimed at strengthening the potential of digitalisation in transport for the environment and minimising the risks. For the envisaged update of the Carriage of Passengers Act (PBefG), the BMU is pushing for ride-sharing and carpooling to become a practical addition to public transport. These offers should be integrated into public transport services outside of the test areas and be offered alongside traditional transport services.

More transparency and better use of data
Transparency is essential for achieving the Sustainable Development Goals in the transport sector. Firstly, because all users receive digital information via different platforms and direct access to mobility services. Access barriers to public transport and to other environmentally sound offers are decreasing. Secondly, municipal traffic planning benefits from data on the use of the service. This data is available in real time and provides the possibility to manage transport and offers in a needs based way.

However, individual digital solutions and platforms of different operators will not inevitably lead to greater sustainability. Digital traffic management at local level presents both a challenge and great strategic potential. Municipalities have the important task of taking over traffic management locally, to ensure it benefits transport and digital public services and yields positive environmental effects. One possibility is to combine different offers on one platform, coordinate them and have them actively managed in the municipalities (e.g. private transport, public transport and sharing services). However, this goes hand in hand with the establishment of new infrastructures and requires corresponding experience and digital expertise at municipal level.

Municipal know-how and experimental spaces for transport sector transformation
The BMU advocates building up digitalisation expertise in the municipalities that are necessary for a sustainable transformation of the transport sector. In addition, it should be assessed what financial assistance can be made available to municipalities as a lever for sustainable digital mobility. The BMU is also planning, on the basis of projects supported through the competition on the future of sustainable mobility (see box), to promote living laboratories that will help create guiding principles, concepts and platforms for a future transport sector that is environmentally sound. Alongside options for implementation at local level, requirements and framework conditions for an intelligent environmental and transport policy will be be developed. In addition, legal, economic or fiscal instruments are to be developed that will enable municipalities to support and manage digital transport services.
Through the National Climate Initiative (NKI), the BMU is already assisting municipalities in carrying out studies on the potential of digitalisation in traffic management. The NKI also supports the procurement and use of data for intelligent traffic management and greenhouse gas mitigation.

<u>Mobility measures</u>

Measures already underway
- *Research on digitalisation in transport sector*
  Research projects on the potential and risks of digitalisation in the transport sector for the environment and climate, including networked and driverless driving; development of regulatory concepts and framework conditions for sustainable mobility; sharing research findings with municipalities, the automotive industry and mobility providers
- *Climate action through intelligent traffic management (NKI)*
  Promotion of municipal procurement and use of data sources (big data) relevant to transport as a measure for intelligent traffic management to enable municipalities to upgrade and favour environmentally friendly transport networks
- *Studies on potential for climate action arising from digitalisation in traffic management (NKI)*
  Promotion of municipal studies on potential with focus on intelligent traffic management that demonstrate options for reducing greenhouse gas emissions through the use of big data in traffic management
- *Support for associations*
  Support for project *Autonom unterwegs in der Stadt – Chancen und Risiken der Digitalisierung für die Verkehrswende* (Autonomous travel in the city - opportunities and risks of digitalisation for the transport sector transformation) of the Verkehrsclub Deutschland e.V. association. The project uses a participatory approach to identify development paths, for instance private cars in combination with mobility services, that can contribute to sustainable urban transport

Measures to be initiated
- *Competition on the future of sustainable mobility for environmental protection and climate action in the transport sector*
  Support municipalities in development of forward-looking traffic planning that considers digitalisation aspects, including new forms of participation - with a focus on the following areas: commuter traffic, commercial traffic and rural areas
- *Municipal network for sustainable digital transformation of the transport sector*
  Exchange of best practices and experiences in the context of the envisaged competition on the future of sustainable mobility for environmental protection and climate action in the transport sector with regard to the sustainability of digital concepts in the transport sector; reducing environmental pressures and managing rebound effects

- *International cooperation*
  Set an example for environmentally sound mobility in developing countries and emerging economies: project support through International Climate Initiative (IKI) call for project ideas on digitalisation in transport in urban areas of Asia and Latin America to reduce greenhouse gas emissions
- *Regulatory instruments*
  Formulation of recommendations for action for regulatory, economic and fiscal instruments to strengthen the environmental potential of digitalisation for the transport sector

Measures to be developed next

- *Living laboratory for environmentally sound digitalisation in the transport sector*
  Test out municipal organisation of environmentally sound transport using digital instruments e.g. dynamic real time management or digital mobility network - impact of digital mobility at neighbourhood level in the context of the competition on the future of sustainable mobility for environmental protection and climate action in the transport sector
- *Legislation on carriage of passengers*
  Support for creation of legal foundation for ride-sharing and car pooling as a useful supplement to public transport and introduction of management methods for municipalities (e.g. specifications on areas served, drive types or feeder function of local rail transport and options for implementing digital offers)

Sustainable consumption

Target vision
Sustainable consumption in the digital world goes hand in hand with greater consumer autonomy and savvy. Reliable information about products, services and their environmental impacts is readily available and smart assistance systems help consumers make sustainable choices in their everyday lives. Clear rules apply for platforms and online services. Greater transparency creates new incentives to expand the range of sustainable products and services.

Consumers are faced with a wide variety of decisions about what to buy or use on a daily basis. As a result, they can have a significant influence on how consumption affects the environment and on how products are made. In day-to-day life, many different requirements collide: work and home, family and friends. When it comes to environmental policy, the aim is to design consumption options to allow consumers to make sustainable choices.

The challenge of consumption 4.0
The influence of digitalisation on consumption and consumer habits is steadily growing. Online retail is booming while sales of brick-and-mortar retailers are stagnating. Consumption 4.0 is a buzzword used to describe a sweeping development that goes far beyond simply moving services online and expanding them. New types of consumption processes are gaining momentum. Digitalisation not only plays an important role in how services, search processes and consumer choices evolve, but on how they make their way into markets and everyday life. Through tracking user behaviour online, social media accounts and "customised" profiles, big data analytics enable customers to be targeted with personalised advertising tailored precisely to their individual lives. They predict consumer preferences and evoke (supposed) needs. The non-stop availability of online shopping in particular runs the risk of harming the environment and counteracting the potential benefits of digitalisation.

Using digital technologies for sustainable consumption
The challenge for environmental policy is to encourage sustainable consumption with digital solutions and design digital markets to be more environmentally friendly. The retail sector needs to develop and broadly implement environmentally compatible communication, information and marketing strategies. Meaningful and reliable information is essential if consumers are to buy and use sustainable products. Regulation is also needed in some cases as this information is either insufficiently available to consumers in their daily lives or only with considerable effort. The key to enabling independent consumer choices is thus transparency and the introduction of a Digital Passport for products and services. Sustainable consumption must be possible without obstacles.

Enabling informed consumer choices
Digital solutions such as apps or digital assistance systems for the mass market should be designed to facilitate access to information about production, environmental impacts, composition, use, reparability and recoverability. Alternative products and services should also be accessible. The BMU is making use of artificial intelligence to promote completely new possibilities.

Shopping around the clock, around the world - the growth rates in online retail are enormous. Thanks to constantly improving analytics, many consumers are being encouraged to buy more and more rather than to buy more sustainably. This trend must be reversed. For online shopping in particular, it is essential to make user-friendly information available to help consumers make sustainable choices. One focus of the BMU is therefore the design and

regulation of platforms, marketplaces and online retail. The aim is to incorporate sustainability aspects as early as the search and decision-making process.

Increasing market surveillance
The growth in online shopping has both direct and indirect environmental impacts: due to increasing transport volumes, logistics, packaging and returns. The BMU is exploring how these processes can be managed online without harming the environment and what other risks and opportunities online retail entails. A Blue Angel ecolabel is currently being developed for delivery and shipping services.
Action is also needed because products from non-EU countries, which are not manufactured in line with EU specifications ("third-country free riders"), are entering the European market through global online retail. This allows prohibited substances such as banned pesticides or chemicals to also reach Germany, giving rise to competitive disadvantages for companies based in Germany and the EU. Important progress has been made thanks to the EU's new Market Surveillance Regulation, which explicitly regulates online sales (fulfilment service provider). But this alone is not enough. The BMU also advocates the introduction of an obligation to review, which would require the electronic marketplaces themselves to verify whether the electrical and electronic products, batteries and packaging being sold are properly registered. Efforts also need to be stepped up to combat illegal online trade in endangered and protected species.

Returns are not waste
It is estimated that several billion euros worth of functional goods are destroyed every year. It is a problem that affects both online and stationary retail outlets. An end must be put to the practice of destroying merchandise that is in mint condition because the season is over or destroying luxury items to keep prices high. For this reason, the BMU wants to introduce a duty to exercise proper care in the Circular Economy Act, which would only allow excess inventory or returns to be destroyed when necessary, for example, for safety or health reasons.

Videos and music - no-guilt streaming
Growing numbers of users and networked devices, the trend towards media-on-demand: all of this is causing data traffic and the energy requirements of the cloud infrastructure to grow rapidly. Between 2017 and 2022 alone, global data traffic is expected to triple to around 400 billion gigabytes per month, which roughly equates to the storage capacity required for 100 billion DVDs. Much of the traffic is generated by streaming videos in ever-higher quality. For this reason the BMU is not only pushing for more efficient data centres, but also for binding provisions designed to prevent unnecessarily high data rates without impairing use. Whether this takes the form of provisions on standard resolution, autoplay or the display of advertising videos, we plan to talk to large service providers about these issues during Germany's Council Presidency.

Sustainable consumption measures

Measures already underway
- *AI for sustainable consumer choices*
  Support for research and development of AI-based innovations and methods for sustainable consumption under the AI lighthouse projects for environment, climate, nature and resources
- *Destruction of usable products*
  Introduction of a duty to exercise proper care for retailers as part of the amendment to the Circular Economy Act, which stipulates that returns and excess inventory must be kept in a usable state
- *Lighthouse project on sustainable consumption*
  The lighthouse project Pathways and Components of a Digital Agenda for Sustainable Consumption systematically analyses cross-cutting digitalisation issues in the

implementation of the National Programme on Sustainable Consumption and develops solutions for sustainable consumption patterns and lifestyles for the new digital age

- *Blue Angel delivery and shipping services*
Definition of award criteria for the Blue Angel ecolabel for delivery and shipping services

Measures to be initiated

- *Energy consumption and media streaming*
Review of binding provisions to limit high data rates when streaming media (in particular videos); discussion with platform operators with regard to possible approaches to voluntary commitment or regulation during Germany's EU Council Presidency
- *Obligation to review for electronic marketplaces*
Introduction of an obligation for operators of electronic marketplaces as well as fulfilment service providers to review and verify that the manufacturers of electrical and electronic products and packaging being sold are properly registered through amendments to the Electrical and Electronic Equipment Act and the Packaging Act

Measures to be developed next

- *Making the ecological footprint visible*
Support for research and development on the potential, opportunities and limits of communication and visualisation of information related to the supply chain and environmental impacts of production (virtual reality/augmented reality)
- *Regulation for sustainable online retail*
Development of regulatory approaches, e.g. a requirement to provide environmentally relevant product information and sustainability labels; incorporation of sustainability criteria in search and selection algorithms; filtering options and appropriate presentation of sustainable products in search results and recommendations
- *Living laboratory for sustainable consumption in the platform economy*
Establishment of an experimental space to conduct practical tests of the effectiveness and technical feasibility of practical regulatory and incentive systems for sustainable consumption; innovation partnership with online retailers and relevant stakeholders
- *Label for sustainable online retailers*
Development of criteria to identify sustainable online shops, for example, with regard to the presentation of environmentally relevant information and services, and the energy- and resource-efficient operation of platforms
- *Trend analysis for sustainable consumption and digitalisation*
Continuous collection and update of data on sustainable consumption through systematic market monitoring (analysis of consumer trends and lifestyles taking gender aspects into consideration)

_Nature conservation, agriculture and water management

Target vision
Digitalisation serves to protect nature and the environment. It helps to create a better understanding of ecosystems and to conserve biodiversity. It supports viable and sustainable agriculture that not only protects species, soil, water and air, but also mitigates climate change. In terms of water management, it contributes to improving general public services.

Plant and animal diversity and healthy ecosystems are the basis of our existence. But biological diversity is declining worldwide. This is an alarming development with regard to the environment, nature, economy, food security and our quality of life. Knowledge about the state of biodiversity is an important prerequisite for political action. Digital methods such as pattern recognition and artificial intelligence (AI) can help to identify species or to record and evaluate the status of populations and habitats.

Digital technologies not only improve monitoring, they also create new possibilities for environmental enforcement. The National Centre for Biodiversity Monitoring, which is scheduled to open in 2020, aims to help gain better knowledge of the state of biodiversity in Germany and how it has changed. Under Germany's EU Council Presidency, the BMU plans to work together with the European Environment Agency (EEA) to also launch a European centre for monitoring biodiversity. At national and European level, the overlay with other data, particularly from remote sensing, will be another key component.

Harnessing the potential of digitally supported precision agriculture for nature conservation and environmental protection
One of the main reasons for the decline in diversity is the increasing intensity of agriculture, which not only has a significant impact on biodiversity, but also on the quality of water, air and soil. Digitally supported precision agriculture has the potential to better reconcile the interests of nature conservation and environmental protection with agricultural interests. Farmers, producers and consumers benefit from greater transparency in production as well as easier implementation and compliance with environmental requirements. Fertiliser and pesticide use can be optimised for weather conditions, quantities and needs. Smaller equipment can replace heavy machinery that compacts the soil. High-resolution satellite images can help to organise agricultural areas to be more in harmony with nature.

Access to data, networking and platform
To ensure that agriculture 4.0 promotes environmental protection and nature conservation, it needs to actively serve the cause of sustainability. A major role is played in this context by access to data and networking in platforms, where company data, environmental data and the data of private stakeholders converge. These platforms acts as hubs for digital cooperation and land management. But they can also result in new dependencies and an intensification of agriculture if they are primarily designed to increase revenues.

A good example of sustainable and location-specific digital support for land management is the Open Source GeoBox initiative of the state of Rhineland-Palatinate. The platform links company data with public data on climate, weather, soil, water and environmental conditions that are subject to dynamic change. The initiative helps farmers take decisions to ensure that production is environmentally sound and resource efficient. It is based on an integrated landscape assessment that aims to coordinate entire regions instead of optimising individual areas. In addition to fulfilling the Sustainable Development Goals, the platform also reduces the administrative workload. The BMU will support the further development and scaling of the GeoBox.

As a contribution to sustainable land management with an integrated landscape assessment, the BMU is also planning to set up regional living labs to test new ecosystem services based

on the use of digital platforms and applications for nature conservation and environmental protection.

As part of the EU's future Common Agricultural Policy from 2020, the BMU is assessing whether and how the potential of digitalisation can be integrated into support for environmental measures (e.g. "eco-schemes") as well as monitoring of agri-environment measures.

Digital water management for better general public services

Water management in Germany is also facing new challenges: the changes caused by climate change and demography as well as by land use cannot be tackled through local measures alone. Digitalisation has the potential to shape these changes positively. Through more efficient water management operations. Through saving and recovery of energy and resources. And through digitalised planning processes for the construction and maintenance of the water management infrastructure. Digital technologies can improve cost efficiency and service quality, enforcement, safety and reliability in water supply and wastewater disposal as well as in protection from flooding and low water levels. And thus general public services. To achieve this, it is essential to improve the data infrastructure and establish digital services for water management. The BMU will work together with other federal authorities and the federal states to set up a web-based information system for low water levels.

Nature conservation, land and water management measures

Measures already underway
- *National Centre for Biodiversity Monitoring*
  Establishment of a National Centre for Biodiversity Monitoring to expand and ensure biodiversity monitoring at national level

Measures to be initiated
- *EU Common Agricultural Policy*
  Proposals for digitally supported environmental protection and nature conservation measures (e.g. eco-schemes, agri-environment measures and investment measures under Pillar 2)

Measures to be developed next
- *European centre for biodiversity monitoring*
  Initiative to establish EU-wide biodiversity monitoring during Germany's EU Council Presidency in cooperation with the European Environment Agency (EEA)
- *GeoBox: further development and scaling*
  Concept to further develop the GeoBox infrastructure with regard to the potential use and automated exchange of the environmental and nature conservation administration's data and machine learning
- *Information system for low water levels*
  Support for the federal states in the establishment of a web-based information system for low water levels to help improve data infrastructure; establishment of digital services for water management
- *Living laboratory for sustainable digital agriculture*
  Testing of platform-based approaches for nature conservation and environmental protection as well as new ecosystem services as a contribution to sustainable land management with an integrated landscape assessment (to supplement the activities of the Federal Ministry of Food and Agriculture)
- *Imaging technologies in agricultural monitoring*
  Easier use and deployment of new imaging technologies (including Sentinel satellites of the Copernicus Earth Observation Programme of the EU) for agricultural monitoring,

particularly with regard to environmental and climate requirements set out in the Common Agricultural Policy

III.   Digitalisation for social and environmental restructuring

Digital breakthroughs make people's lives easier. But what will it take
for innovations to mitigate climate change and protect the environment?

For digitalisation to have a long-term impact on society as a whole, more is needed than just technical progress. It requires new technologies designed to provide positive impetus for socio-cultural change. Only the interplay of digital innovations and new solutions for industry, policy-makers and society will make change possible.
Social and environmental restructuring needs innovations. New technologies and solutions are essential for meeting the global Sustainable Development Goals (SDGs) and the Paris Agreement: innovations make it possible to reach social goals and help strike a balance between social cohesion on the one hand, and prosperity and economic competitiveness on the other. The introduction and widespread use of sustainable innovations is often coupled with the elimination of unsustainable technologies, practices or usage systems (exnovation). The Digital Policy Agenda for the Environment puts the innovative power of digitalisation at the service of this task. A broad range of digital solutions is available here: from software that makes devices and applications more energy-efficient to the development of image recognition methods for environmental monitoring through to process innovations in industry and the circular economy. They include digital traffic management systems in cities and networking in neighbourhoods to organise regional consumer groups, shared use of vehicles and tools, and social interaction. The measures set out in the Digital Policy Agenda for the Environment specifically leverage the character of digital solutions as an innovation to bring about social and technological change.

It is not just a question of developing new hardware or software. Above all, it is about the formative power of digitalisation to change behaviour, processes and social systems. Innovations in the context of the Digital Policy Agenda therefore span both technical solutions and the development of new business models as well as regulatory and social innovations that allow new forms of social cooperation and social action. The specific innovative activities in the different fields make key contributions in this area, but are not enough on their own.

From the perspective of social and environmental restructuring, Germany's innovation system must progress along the following development axes:
- *Digital solutions for environmental challenges*
  Innovations and support for innovations must be more strongly focused on and measured in terms of specific problems along the path to sustainability and climate neutrality. This primarily involves springboard innovations that need to be rolled out quickly for widespread use. Environmental policy must identify strategic innovation requirements, provide support for digital solutions through a regulatory framework and align support measures accordingly. Competitions, innovation-driven public procurement and networks for innovators provide key stimuli.
- *Driving system innovations*
  The transformation of the economy and society requires a coordinated approach by many stakeholders. The necessary changes can only be brought about through the convergence of technical solutions, new business models in industry, government and society and the establishment of new digital infrastructure. An important role is played by the targeted networking of innovators and support for local innovation networks, for example, in living laboratories where new markets and innovative forms of regulation can be tested.
- *Scaling social innovations*
  The focus of support for innovations, which is often dominated by technical aspects and economic policy, not only needs to be more strongly aligned with environmental and climate goals, it must be broadened to include support for social innovations. Many

digital innovations in the public interest need help to get off the ground - whether to scale them up or to mobilise demand from society and the public sector.

In the context of its innovation-driven environmental policy, the BMU will further develop its own support instruments along the development axes and interdependencies outlined above. In addition, the Digital Innovation Hub for Climate and a Platform for Social and Environmental Innovation will create new institutions that advance digital solutions as innovations for a sustainable future.

Digital Innovation Hub for Climate: thinking outside the box for climate action

Sustainable digital solutions and business models need innovation, creativity and the will to bring about positive change to the status quo. Many start-up networks, support and cluster initiatives, innovation hubs, technology centres and universities are driving digital innovations in Germany and Europe. We want to capitalise on this potential for innovation in a Digital Innovation Hub for Climate to tackle to challenge of the century: climate change mitigation.

Germany is an industrialised country. This industry with its products and services must continue to be a foundation for good and well-paid work, for competitiveness and prosperity. At the same time, meeting the climate targets requires a high degree of innovation, but can also become a new engine for economic development.

As a trendsetter and driving force, the Digital Innovation Hub for Climate aims to link concrete innovation requirements in climate policy with existing innovation structures. The goal is to support the development and dissemination of digital solutions that contribute to the prevention and reduction of greenhouse gas emissions. The need for action in climate policy must be translated into concrete innovation requirements and addressed with stakeholders networked across different innovation ecosystems.

To this end, an open "hub of hubs" network of innovators is to be established under the umbrella of the Digital Innovation Hub for Climate, which does not focus on a single sector, technological approach or innovation process. Instead, work will revolve around digital innovations and system innovations that are particularly relevant to the climate. The hub will act as a network that links innovators and start-ups working to develop solutions for climate action with investors, small- and medium-sized enterprises and established companies. It will also serve as a centre for contact and provide advisory services on possibilities for support and networking.

The Digital Innovation Hub for Climate will identify concrete innovation requirements, including both individual technologies as well as system innovations, which will be addressed in the "hub of hubs" network. It will also develop hackathons, start-up pitches and competitions as well as tailored support instruments.

Traditional innovation hubs are often organised for a specific region or a specific sector. They therefore only address one part of the value chain or ecosystem. The Digital Innovation Hub for Climate aims to close this gap by bringing together relevant stakeholders to find common solutions to problems.

The Digital Innovation Hub for Climate will encourage demand and market opportunities for climate action by advising public contracting authorities on how to implement innovative procurement measures. Traditional public procurement approaches have not been a vehicle for innovative solutions to date, but have considerable potential for dissemination and scaling.

The Digital Innovation Hub for Climate was enshrined by the BMU in the Climate Action Programme 2030 and is to be launched in 2020. An organisational structure and a networking concept for cooperation with stakeholders and organisers of innovation hubs and start-up associations is currently being developed as part of a concept study.

**Platform for Social and Environmental Innovation:
digitalisation for the common good and sustainability**

Digitalisation makes new forms of coexistence possible. And it can support how sustainability is organised in society. To this end, civil society must of course be able to use digital technologies to meet social and environmental challenges. The interaction between technology and work for the common good can give rise to new synergies for individual involvement.

Work carried out in the general interest of the public in Germany is facing growing challenges: initiatives for community-oriented neighbourhood management, for nature conservation or sustainable mobility services are often organised on a small scale. In many cases, they are limited by insufficient funding or staff. In addition, financing and support, for example, from the government, are usually also only available for a limited period.
Digitalisation can simplify and stabilise the work of social and environmental initiatives or breathe new life into them, for example, by creating opportunities for cross-regional exchange for often locally based initiatives. Whether or not digital tools are used to bring about social and environmental change is decided in the neighbourhoods, urban districts and rural communities. In other words, wherever citizens are committed to environmental protection, climate change mitigation, nature conservation and thriving communities. Networks that combine digitalisation with social and environmental initiatives will play an important role here as both aspire to shape the future responsibly and are potential allies.

With the establishment of the Platform for Social and Environmental Innovation: digitalisation for the common good and sustainability, the BMU wants to encourage dialogue and create networks between social initiatives and innovators and develop concepts to enhance digitally based innovation for a sustainable society. The most important components are:
- Best practices: enable targeted best-practice screening at regional, national and international level to support local stakeholders in analysing problems and finding solutions in different settings, for example, as an intermediary between stakeholders in the fields of social work and IT
- Knowledge management: establishment of a marketplace where knowledge about effective instruments and quality standards is shared to leverage synergies in the joint procurement and use of digital tools
- Support: development of opportunities for support that go beyond traditional innovation support
- Living laboratories: experimental spaces for digitally based, social and environmental innovations where digital tools, applications and new cooperation structures are developed and tested as models

The process with environmental, social and digital initiatives launched and organised by the BMU is intended to tie in with and supplement existing initiatives. It is scheduled to run for around three years until the end of 2022. A viable concept (milestones, location, financing) will be presented by the middle of 2020.

Social and environmental innovation measures

Measures already underway
- *Artificial Intelligence (AI) Support Programme for environment, climate, nature and resources*
  With its AI lighthouse projects, the BMU is promoting, through its AI Strategy, the development and testing of artificial intelligence-based solutions to tackle environmental problems. The projects set an example for green, environmentally sound and climate-friendly digitalisation.

- *Code4Green Hackathon*
  Continuation of the BMU's Code4Green Hackathon series launched in 2018 for the years 2020 (for Germany's EU Council Presidency) and 2021 to develop data-driven solutions and business models for environmental protection

Measures to be initiated
- *Digital Innovation Hub for Climate*
  Support for the development of digital solutions for climate action under the Climate Action Programme 2030 by creating a "hub of hubs" network in addition to a centre for contact, consultation and networking for start-ups, small and medium-sized businesses and established businesses
- *Support agenda for digital innovation for the environment*
  Analysis of BMU's existing support programmes to determine the adaptation potential and requirements driven by digitalisation, taking into account good examples from other European countries and from abroad with clear distinction from existing programmes of the German government
- *Dialogue series of the German Federal Environmental Foundation (DBU)*
  To incorporate issues of digitalisation for environmental policy into the public discourse, the German Federal Environmental Foundation is to organise regional discussions together with the BMU
- *Transformation roadmap for digitalisation and sustainability*
  Establishment of a research network to explore and analyse future research needs in order to develop strategic solutions related to digitalisation and sustainability

Measures to be developed next
- *Platform for Social and Environmental Innovation*
  Network of social initiatives and innovators to enhance digitally based innovation for a sustainable society

IV. Environmental policy 4.0

Environmental policy shapes the digital world and digitalisation enhances data-driven, transparent and robust environmental policy.

Digitalisation is changing the way the government carries out its duties. And environmental policy-makers must fully capitalise on the possibilities offered by digital technologies to fulfil their responsibility to protect, guarantee and shape policy. In fact, there are countless solutions that can drive environmental policy 4.0 forward. These include powerful information and communications technologies as well as sensors, smart devices, automated processes and self-learning systems. In addition, big data analytics as well as data mining and data evaluation are expected to spur modernisation. Environmental policy 4.0 has enormous potential:

- Policy-makers and environmental administrations at federal, state and local level can be networked for their collaboration. They can take decisions based on highly detailed data and organise administrative procedures to be more efficient.
- Citizens and companies can conveniently handle approval procedures and administrative services online. It would be easier for them to communicate with public authorities and they would have better access to public information.
- Satellites, drones, sensors and smart devices supply new data about the state and use of the environment.
- Data-driven management of networked systems enables more effective and efficient operation of environmental infrastructure, for example, in water management.
- Digitalisation improves transparency and openness and creates new possibilities for interaction and participation: in environmental research, public dialogue, public participation and public awareness.

But some work is still needed to tap the potential of the new technical solutions. Most importantly, the environmental administration needs to develop further in organisational terms. It needs to boost technological skills and capabilities, but also provide the right IT infrastructure. It is not enough to make data available and adapt legal bases. Administrations must also practice new forms of cooperation. They need to acquire expertise on how, for example, to evaluate, analyse and use large data volumes with big data analytics and machine learning.

Modernise and simplify data access: UNIS-D environmental data cloud
Data is an important factor in a modern environmental policy. Germany's Environmental Information Act and the relevant statutory provisions of the federal states create a far-reaching right to access information related to environmental issues. However, access is highly fragmented across institutions and federal levels. In addition, big data analytics and high-performance AI systems impose new requirements on the technical availability of data on environmental protection, climate action and nature conservation. This data is intended to inform the public, but also to develop data-driven business models in agriculture or traffic management systems.
In light of these requirements, the BMU is developing multidisciplinary and multilevel access to public data, services, research findings and educational materials as well to legislation and regulations by means of a German environmental and nature conservation information system (UNIS-D). UNIS-D is an environmental data cloud designed to simplify the use of AI systems and enable the participation of third parties (citizen science) with a view to improving the underlying data.

Developing an environmental policy data strategy
In order to be in step with the times in data policy, the BMU and its subordinate authorities will develop an environmental policy data strategy for the Federal Ministry and its subordinate authorities. This includes all processes relevant for data, starting with collection through to management, provision and processing all the way to its application. The strategy also

identifies areas where action is needed. In order to implement the data strategy, the joint working structures with the federal states and municipalities will be strengthened. Digitalisation, however, may not be allowed to turn environmental administration into a "green big brother". The BMU will therefore impose appropriate guidelines within the scope of its data strategy. These guidelines will include the findings of the German government's Data Ethics Commission and the Bundestag's Study Commission "Artificial Intelligence".

As part of the German government's data strategy, the BMU is committed to making data accessible to private stakeholders, beyond the applicable standard laid down in the Environmental Information Act in line with constitutional provisions through new legal regulations if this is in the public interest. To ensure that the potential of digital technologies serves the purpose of handling data, monitoring and enforcement, the BMU will conduct an ex-post digital check for applicable environmental law as part of its ministry-funded research.

Tracking violations of environmental law in the digital environment
The growth in online shopping platforms and social networks in some cases shifts environmentally harmful activities to the internet. Illegal trade in protected species and cross-border trade of uncertified, illegally obtained or toxic substances and products online creates new challenges for environmental authorities.

The BMU will provide support to establish relevant monitoring capacities in the competent authorities. If required, the BMU will work together with the federal states to draw up provisions to prevent violations of environmental law. These provisions will make it possible to detect violations, also in the digital environment, and prevent illegal activities

Using digital instruments for enforcement
Information and communications technology (ICT) can not only simplify enforcement of environmental law, it can also improve it. It is much more effective to analyse satellite images through automated image recognition than to perform an arduous assessment on site. Inter-agency communication, text mining and AI's analysis capabilities as well as big data applications will make it possible to analyse information relevant to permits, for example, when enforcing international species protection, on a scale not possible up to now. UBA is currently drafting handouts and investigating the need to adapt laws for automatic monitoring of the enforcement of environmental law. The BMU also envisages expanding the existing Satellite Remote Sensing Competence Centre and establishing a new Application Lab for Artificial Intelligence and Big Data. As a service provider, it supports the federal, state and local environmental administrations in the analysis of large data volumes. It also develops applications and solutions to meet the needs of the environmental administrations.

Digitalising environmental administration
In the future, citizens and companies will be able to access digitalisable approval procedures and services of the environmental authorities online. Under the act to improve online access to administrative services (Onlinezugangsgesetz), 16 services under the remit of the BMU will be digitalised: ranging from the application process for the import and export of protected plant and animal species to authorisation to use radioactive substances for medical research.

Digital tools for education and participation
Interactive forms of visualisation and social networks can make the state of the environment and the environmental impact of individual actions more transparent. This is why the BMU and UBA are tapping into the potential of data visualisation with digital atlases as well as the lighthouse project on environmental values to provide information to the media, the general public and experts. To promote data skills, the BMU is stepping up support for the environmental data school of the Open Knowledge Foundation.

But digitalisation also allows for greater participation and involvement of civil society in collecting information, reporting grievances and identifying solutions. The BMU is systematically expanding its instruments to test digital forms of participation. With its project association participation 4.0 (*Verbändebeteiligung 4.0*) the ministry is supporting the voluntary

work of environmental and nature conservation associations by networking them with civil society.

Environmental policy 4.0 measures

Measures already underway
- *UNIS-D environmental data cloud*
  Development of multidisciplinary and multilevel access to environmental data by means of a German environmental and nature conservation information system (UNIS-D)
- *Compliance assurance*
  Development of handouts to facilitate the collection and use of data to enforce environmental law; identification of possibilities to monitor the enforcement of environmental law
- *Implementation of the act to improve online access to administrative services (Onlinezugangsgesetz)*
  The BMU, in cooperation with the federal states, is implementing digitalisation measures and measures to provide digital access to services and approval procedures in environmental administration
- *Education and participation in civil society*
  Support for associations involved in educational activities related to digitalisation and sustainability and handling environmental data or citizen science projects

Measures to be initiated
- *Climate policy support for the digitalisation implementation strategy*
  Provision of tools and knowledge for the ex-ante and ex-post assessment of the greenhouse gas impact of the German government's digital policy projects
- *Development of the Federal Environmental Ministry's data strategy*
  Development of a data strategy for the Federal Environmental Ministry as a component of the German government's data strategy, including a concept that addresses how the federal working structures are organised
- *Modernisation of the administrative agreement on data exchange*
  Modernisation of the administrative agreement on data exchange between the German government and the federal states to enable comprehensive and mandatory data exchange between the federal levels

Measures to be developed next
- *Expansion of the Satellite Remote Sensing Competence Centre to include AI and Big Data Application Lab*
  Expansion of the Satellite Remote Sensing Competence Centre in UBA to support the enforcement, analysis of satellite and sensor data and the development of automated analysis processes; creation of capacities for artificial intelligence and big data to support the environmental administrations at federal, state and local levels in the evaluation of large data volumes
- *Monitoring of illegal online trade*
  Taskforce to assist the environmental authorities and customs officials in monitoring new environmental offences in online trade in protected species or harmful substances
- *Digital fitness check of environmental law*
  Review of provisions in environmental law relevant to enforcement for applicability of digital enforcement options/digital technologies

Overview of measures

Measures already underway

Area	Measures
Industry 4.0 and circular economy	• Vocational training in industry The VDI Centre for Resource Efficiency (VDI ZRE) offers training courses on behalf of the BMU on how digital technologies can help reduce material and energy consumption in production processes
Industry 4.0 and circular economy	• German Resource Efficiency Programme: ProgRess III Update of German Resource Efficiency Programme (ProgRess) with special emphasis on the interactions between digitalisation and resource efficiency
Innovation strategy	• Code4Green Hackathon Continuation of the BMU's Code4Green Hackathon series launched in 2018 for the years 2020 (for Germany's EU Council Presidency) and 2021 to develop data-driven solutions and business models for environmental protection
Innovation strategy	• Artificial Intelligence (AI) Support Programme for environment, climate, nature and resources With its AI lighthouse projects for environment, climate, nature and resources the BMU is promoting the development and testing of artificial intelligence-based solutions to tackle environmental problems. The projects set an example for green, environmentally sound and climate-friendly digitalisation.
Mobility	• Climate action through intelligent traffic management (NKI) Promotion of municipal procurement and use of data sources (big data) relevant to transport as a measure for intelligent traffic management to enable municipalities to upgrade and favour environmentally friendly transport networks
Mobility	• Studies on potential for climate action arising from digitalisation in traffic management (NKI) Promotion of municipal studies on potential with focus on intelligent traffic management that demonstrate options for reducing greenhouse gas emissions through the use of big data in traffic management
Mobility	• Support for associations Support for project *Autonom unterwegs in der Stadt – Chancen und Risiken der Digitalisierung für die Verkehrswende* (Autonomous travel in the city - opportunities and risks of digitalisation for the transport sector transformation) of the Verkehrsclub Deutschland e.V. association. The project uses a

Area	Measures
	participatory approach to identify development paths, like private cars in combination with mobility services, that can contribute to sustainable urban transport
Mobility	• Research on digitalisation in transport sector Research projects on the potential and risks of digitalisation in the transport sector for the environment and climate, including networked and driverless driving; development of regulatory concepts and framework conditions for sustainable mobility; sharing research findings with municipalities, the automotive industry and mobility providers
Sustainable consumption	• Destruction of usable products Introduction of a duty to exercise proper care for retailers as part of the amendment to the Circular Economy Act, which stipulates that returns and excess inventory must be kept in a usable state
Sustainable consumption	• AI for sustainable consumer choices Support for research and development of AI-based innovations and methods for sustainable development in the context of the AI lighthouse projects for environment, climate, nature and resources
Sustainable consumption	• Lighthouse project on sustainable consumption The lighthouse project Pathways and Components of a Digital Agenda for Sustainable Consumption systematically analyses cross-cutting digitalisation issues in the implementation of the National Programme on Sustainable Consumption and develops solutions for sustainable consumption patterns and lifestyles for the new digital age
Sustainable consumption	• Blue Angel delivery and shipping services Definition of award criteria for the Blue Angel ecolabel for delivery and shipping services
Nature conservation, agriculture and water management	• National Centre for Biodiversity Monitoring Establishment of a National Centre for Biodiversity Monitoring to expand and ensure biodiversity monitoring at national level
Environmentally friendly digitalisation	• Studies on climate action potential in IT and building engineering in data centres (NKI) Promotion of municipal studies to analyse potential of existing IT and building engineering in data centres as well as short-, medium- and long-term potential for energy and greenhouse gas emissions savings
Environmentally friendly digitalisation	• Blue Angel as orientation for green IT

Area	Measures
	The Blue Angel ecolabel has been established for the following four product groups: energy-efficient data centre operation, climate-compatible co-location data centres, resource- and energy-efficient software products, and server and data storage products
Environmentally friendly digitalisation	• Environmental impact assessment of 5G technology Research into trends in energy and raw material consumption of new mobile networks including selected end-devices with a particular focus on 5G mobile communication infrastructure under the UTAMO project
Environmentally friendly digitalisation	• Further development of government Green IT Initiative Consolidation of energy consumed in the federal administration by IT operation to a maximum of 350 gigawatt hours in 2022; implementation of sustainable IT procurement and application of Blue Angel criteria for government data centres being established
Environmentally friendly digitalisation	• Promotion of climate action in data centres (NKI) Support for municipalities with investments and optimisation services that significantly increase energy and resource efficiency in data centres
Environmentally friendly digitalisation	• Safeguard health and nature conservation in the expansion of 5G mobile communication infrastructure Transfer of existing high level of protection against electromagnetic fields to the 5G sector under the Mobile Communications Strategy of the German government; for expanding the grid, maintaining protection standards set out in nature conservation legislation
Environmentally friendly digitalisation	• Climate-friendly procurement in the German government Consideration of environmental impacts in manufacturing, use, recycling and disposal stages before strategic decisions are taken on the use of IT in the German government
Environmentally friendly digitalisation	• Electromagnetic Fields Competence Centre Pooling of BfS expertise and intensification of research and communication on static, low-frequency electric and magnetic, and high-frequency electromagnetic fields
Environmental policy 4.0	• Education and participation in civil society Support for associations involved in educational activities related to digitalisation and sustainability and handling environmental data or citizen science projects
Environmental policy 4.0	• Implementation of the act to improve online access to administrative services (Onlinezugangsgesetz)

Area	Measures
	The BMU, in cooperation with the federal states, is implementing digitalisation measures and measures to provide digital access to services and approval procedures in environmental administration
Environmental policy 4.0	• UNIS-D environmental data cloud Development of multidisciplinary and multilevel access to environmental data by means of a German environmental and nature conservation information system (UNIS-D)
Environmental policy 4.0	• Compliance assurance Development of handouts to facilitate the collection and use of data to enforce environmental law; identification of possibilities to monitor the enforcement of environmental law

Measures to be initiated

Area	Measures
Industry 4.0 and circular economy	• Open Source Data Platform To identify advances, undesirable developments and need for action in resource policies, usable central data and information on resource conservation is to be made available to the general public via the Open Data Platform of the German government
Industry 4.0 and circular economy	• Standardisation and standards Acceleration of standards on and standardisation of the integration of resource and environmental aspects in industry 4.0, automation and IT
Industry 4.0 and circular economy	• Integration of resource efficiency and environmental aspects into industry 4.0 Research, financial research support and practical testing on resource and environmental aspects of industry 4.0 to further develop the link between resource efficiency and digitalisation in the industry 4.0 field and address risks
Industry 4.0 and circular economy	• Introduction of Digital Product Passport Support of the EU Commission initiative to develop a Digital Product Passport, as part of Germany's EU Council Presidency
Industry 4.0 and circular economy	• Corporate environmental management Promotion of digitalisation potential through the European environmental management system EMAS
Industry 4.0 and circular economy	• Industry 4.0 Platform BMU dialogue with Industry 4.0 Platform on sustainability and production issues from the perspective of industry
Innovation strategy	• Dialogue series of the German Federal Environmental Foundation (DBU) To incorporate issues of digitalisation for environmental policy into the public discourse, the German Federal Environmental Foundation is to organise regional discussions together with the BMU
Innovation strategy	• Digital Innovation Hub for Climate Support for the development of digital solutions for climate action under the Climate Action Programme 2030 by creating a "hub of hubs" network in addition to a centre for contact, consultation and networking for start-ups, small and medium-sized businesses and established businesses
Innovation strategy	• Transformation roadmap for digitalisation and sustainability

Area	Measures
	Establishment of a research network to explore and analyse future research needs in order to develop strategic solutions related to digitalisation and sustainability
Innovation strategy	• Support agenda for digital innovation for the environment Analysis of BMU's existing support programmes to determine the adaptation potential and requirements driven by digitalisation, taking into account good examples from other European countries and from abroad with clear distinction from existing programmes of the German government
Mobility	• Competition on the future of sustainable mobility for environmental protection and climate action in the transport sector Support municipalities in development of forward-looking traffic planning that considers digitalisation aspects, including new forms of participation - with a focus on the following areas: commuter traffic, commercial traffic and rural areas
Mobility	• Municipal network for sustainable digital transformation of the transport sector Exchange of best practices and experiences in the context of the envisaged competition on the future of sustainable mobility for environmental protection and climate action in the transport sector with regard to the sustainability of digital concepts in the transport sector; reducing environmental pressures and managing rebound effects
Mobility	• Regulatory instruments Derivation of recommendations for action for regulatory, economic and fiscal instruments to strengthen the environmental potential of digitalisation for the transport sector
Mobility	• International cooperation Set an example for environmentally sound mobility in developing countries and emerging economies: project support through International Climate Initiative (IKI) call for project ideas on digitalisation in transport in urban areas of Asia and Latin America to reduce greenhouse gas emissions
Sustainable consumption	• Energy consumption and media streaming Review of binding provisions to limit high data rates when streaming media (in particular videos); discussion with platform operators with regard to possible approaches to voluntary commitment or regulation during Germany's EU Council Presidency
Sustainable consumption	• Obligation to review for electronic marketplaces Introduction of an obligation for operators of electronic marketplaces as well as fulfilment service providers to review and verify that the manufacturers of electrical and electronic products

Area	Measures
	and packaging being sold are properly registered through amendments to the Electrical and Electronic Equipment Act and the Packaging Act
Nature conservation, agriculture and water management	• EU Common Agricultural Policy Proposals for digitally supported environmental protection and nature conservation measures (e.g. eco-schemes, agri-environment measures and investment measures under Pillar 2)

Environmentally friendly digitalisation	• Initiative to extend EU Ecodesign Directive
	   ○ Extend application to cover new product groups (e.g. smartphones)
	   ○ Update criteria for products already covered (e.g. PCs)
	   ○ Establish minimum standards for resource efficiency
	   ○ Lay down requirements for manufacturers to ensure long operation life spans of their hardware software systems
	   ○ Make existing legislation more dynamic in light of accelerated technology and product cycles

Environmentally friendly digitalisation	• Sustainable artificial intelligence Update of AI Support Programme of the BMU and development of criteria to evaluate the environmental impacts of AI (particularly energy and resource consumption)
Environmentally friendly digitalisation	• Push for guarantee statement obligation and right to repair (obsolescence) Extension of European manufacturer obligation on statements about the guaranteed life span of digital electronic products; creation of legally binding rules on provision of updates, repair instructions, replacement parts and tools, and cross-manufacturer solutions for exchanging batteries, screens and other short-lived hardware components as a basis for a European right to repair under the EU Ecodesign Directive or a directive on the repair of electrical and electronic equipment
Environmentally friendly digitalisation	• Green coding syllabus Development of a syllabus for computer science students on methods to develop energy- and resource-efficient software including a support network
Environmentally friendly digitalisation	• Sustainability criteria for blockchain Establishment of sustainability standards for distributed ledger technologies as a task under the Blockchain Strategy of the German government; consideration of ongoing project *Nachhaltigkeit für Distributed-Ledger-Technologien & Smart Contracts* (sustainability for distributed ledger technologies and smart contracts) which is part of BMU support for associations
Environmental policy 4.0	• Modernisation of the administrative agreement on data exchange

Area	Measures
	Modernisation of the administrative agreement on data exchange between the German government and the federal states to enable comprehensive and mandatory data exchange between the federal levels
Environmental policy 4.0	• Climate policy support for the digitalisation implementation strategy Provision of tools and knowledge for the ex-ante and ex-post assessment of the greenhouse gas impact of the German government's digital policy projects
Environmental policy 4.0	• Development of the Federal Environment Ministry's data strategy Development of a data strategy for the Federal Environment Ministry as a component of the German government's data strategy, including a concept that addresses how the federal working structures are organised

Measures to be developed next

Area	Measures
Industry 4.0 and circular economy	• Corporate Social Responsibility (CSR) Initiative supporting consideration of environmental impacts along supply and value chains
Industry 4.0 and circular economy	• Living laboratory for networked model municipalities in circular economy Establishment of test area to explore digital solutions for optimised waste logistics and management, waste prevention and interaction with consumers
Industry 4.0 and circular economy	• Environmental aspects of critical raw materials Initiative supporting consideration of environmental aspects in EU list of critical raw materials (adaptation of classification methodology and approach)
Innovation strategy	• Platform for Social and Environmental Innovation: Networked social initiatives and innovators to enhance digitally based innovation for a sustainable society
Mobility	• Legislation on carriage of passengers Support for creation of legal foundation for ride-sharing and car pooling as a useful supplement to public transport and introduction of management methods for municipalities (e.g. specifications on areas served, drive types or feeder function of local rail transport and options for implementing digital offers)
Mobility	• Living laboratory for environmentally sound digitalisation in the transport sector Test out municipal organisation of environmentally sound transport using digital instruments e.g. dynamic real time management or digital mobility network - impact of digital mobility at neighbourhood level in the context of the competition on the future of sustainable mobility for environmental protection and climate action in the transport sector
Sustainable consumption	• Trend analysis for sustainable consumption and digitalisation Continuous collection and update of data on sustainable consumption through systematic market monitoring (analysis of consumer trends and lifestyles taking gender aspects into consideration)
Sustainable consumption	• Making the ecological footprint visible Support for research and development on the potential, opportunities and limits of communication and visualisation of information related to the supply chain and environmental impacts of production (virtual reality/augmented reality)

Area	Measures
Sustainable consumption	• Regulation for sustainable online retail Development of regulatory approaches, for example, a requirement to provide environmentally relevant product information and sustainability labels; incorporation of sustainability criteria in search and selection algorithms; filtering options and appropriate presentation of sustainable products in search results and recommendations
Sustainable consumption	• Living laboratory for sustainable consumption in the platform economy Establishment of an experimental lab to conduct practical tests of the effectiveness and technical feasibility of practical regulatory and incentive systems for sustainable consumption; innovation partnership with online retailers and relevant stakeholders
Sustainable consumption	• Label for sustainable online retailers Development of criteria to identify sustainable online shops, for example, with regard to the presentation of environmentally relevant information and services and the energy- and resource-efficient operation of platforms
Nature conservation, agriculture and water management	• Living laboratory for sustainable digital agriculture Testing of platform-based approaches for nature conservation and environmental protection as well as new ecosystem services as a contribution to sustainable land management with an integrated landscape assessment (to supplement the activities of the Federal Ministry of Food and Agriculture)
Nature conservation, agriculture and water management	• European Centre for Biodiversity Monitoring Initiative to establish EU-wide biodiversity monitoring during Germany's EU Council Presidency in cooperation with the European Environment Agency (EEA)
Nature conservation, agriculture and water management	• Imaging technologies in agricultural monitoring Easier use and deployment of new imaging technologies (including Sentinel satellites of the Copernicus European Earth observation programme) for agricultural monitoring, particularly with regard to environmental and climate requirements set out in the Common Agricultural Policy
Nature conservation, agriculture and water management	• GeoBox: further development and scaling Concept to further develop the GeoBox infrastructure with a view to the potential use and automated exchange of data from environmental and nature conservation administration and machine learning

Area	Measures
Nature conservation, agriculture and water management	• Information system for low water levels Support for the federal states in the establishment of a web-based information system for low water levels as a contribution to improving data infrastructure; establishment of digital services for water management
Environmentally friendly digitalisation	• Register for data centres Creation of a register for data centres (through extended classification of branches of the economy (WZ 2008) to include a sectoral category for data centres)
Environmentally friendly digitalisation	• Research on energy and resource consumption indicators Creation of a database and establishment of systematic monitoring of the energy and resource consumption of digital electronic devices and infrastructures as a prerequisite for data based policy.
Environmentally friendly digitalisation	• Use of recycled materials Development of EU-wide minimum quotas for the use of recycled materials (plastics and metals) in the manufacturing of components for digital infrastructures and electronic devices
Environmental policy 4.0	• Monitoring of illegal online trade Task force to assist the environmental authorities and customs officials in monitoring new environmental offences in online trade in protected species or harmful substances
Environmental policy 4.0	• Digital fitness check of environmental legislation Review of relevant environmental provisions to determine applicability to digital enforcement options/digital technologies
Environmental policy 4.0	• Addition of the application lab for artificial intelligence and big data to the Satellite Remote Sensing Competence Centre Expansion of the Satellite Remote Sensing Competence Centre in UBA to support enforcement, analysis of satellite and sensor data and the development of automated analysis processes; creation of capacities for artificial intelligence and big data to support environmental administrations at federal, state and local level in the analysis of large quantities of data