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Digital Policy Agenda for the Environment

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Project management and editorial team
BMU, Division Z III 3, Digitalisation and Sustainability,
Dr Florian Kammerer, Nicolas Schäfstoß and Dr Martin Röw

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Digital Policy Agenda for the Environment

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“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 these measures are already underway and others 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.

Sincerely,

Svenja Schulze

Federal Minister for the Environment, Nature Conservation and Nuclear Safety

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 this path will lead to 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** are to 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.
→ *from p. 74*
With this agenda, the BMU is, for the first time, presenting a strategic framework for shaping the digital transformation in a sustainable manner.

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More than just technology: how digitalisation helps shape the world

Digitalisation has made its way into all spheres of everyday life, significantly changing society and the economy in the process. The Digital Policy Agenda for the Environment harnesses this formative power to benefit climate action, nature conservation and responsible resource management.

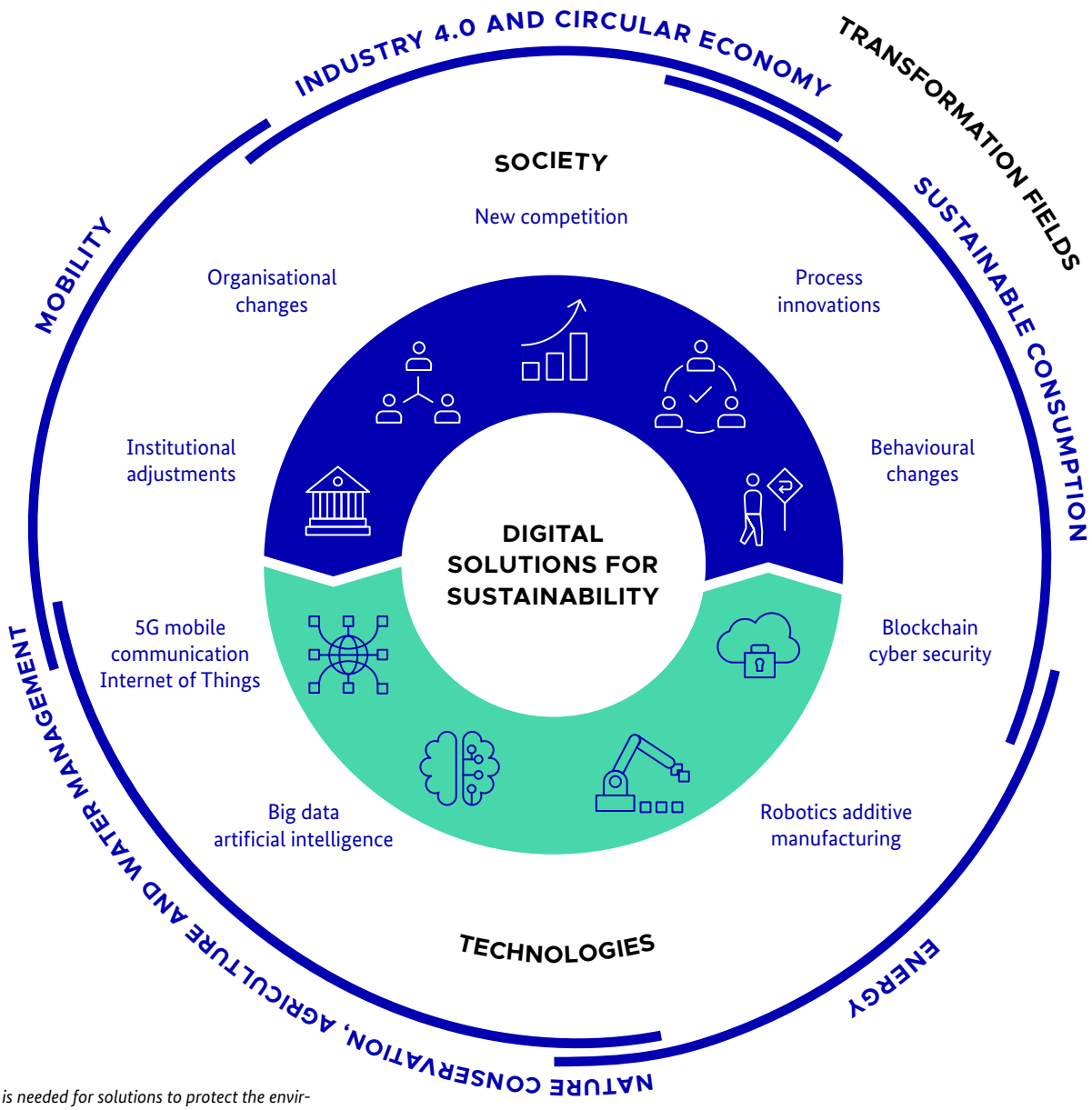
Digitalisation has changed dramatically in recent years - in all areas of life and the economy. And tomorrow, it might be completely different again. Digitalisation is influenced by extremely dynamic innovation. In other words, technological progress is rapidly changing how we collect, network, share and analyse data and, in turn, how this data ultimately affects our actions. Some key technologies like artificial intelligence → ***Graphic on the right*** – are becoming increasingly important. This is because they are drivers of innovation that are shaping, and even accelerating, change to a significant extent, making these technologies very important to the success of digital solutions.

Interplay of technology and society

Digitalisation, however, is not just a collection of individual technologies. The ultimate effect is achieved through the ever-changing interplay of different technologies, for example, when various hardware components are networked with one another and controlled by intelligent software. In addition to this, digital solutions change information processes. New information processes in turn change the world. However, this transformation will only take full effect when it is commonplace for technologies to be integrated into society: into organisational workflows, work processes, human behaviour, business models and political action.

Digital solutions are essentially socio-technological innovations that closely link people and technology.

SCOPE OF DIGITAL SOLUTIONS



What is needed for solutions to protect the environment and mitigate climate change (examples of transformation fields here) to be implemented is technological transformation (from the bottom up) and social restructuring (from the top down).
Source: BMU

Digital solutions are essentially socio-technological innovations that closely link people and technology. It is precisely these communicative, procedural and organisational adjustments that are changing the economy, society and politics, thus making digitalisation a profound creative force.

Digitalisation can therefore realise its full environmental potential, in particular where it fundamentally changes life as we know it now: lifestyles and consumer habits, business practices or the organisation, for example, of energy systems, cities and transport. As a result, when shaping digitalisation to benefit sustainability, the focus should be on digital solutions that change society, the economy and politics through the interplay of different technologies. Solutions that give rise to individual, social, organisational, institutional-regulatory and commercial innovations. The Digital Agenda for Environmental Policy provides examples of how this can be achieved in different sectors in the various transformation fields. → ***from p. 40***

To this end, the Agenda sets new priorities to foster systemic and social innovations. → ***from p. 60***

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.
→ ***p. 26***

3_Digital technologies facilitate more with less – utilising the digital environmental dividend

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.

THE PUBLIC DISAGREE ABOUT HOW DIGITALISATION WILL IMPACT THE ENVIRONMENT.

Do you think digitalisation has a more positive or negative impact on the environment?

37,2 % positive

31,1 % undecided

31,7 % negative

Source: Civey representative survey; number of people surveyed: 5,008: December 2019

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. → ***p.40***

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 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.

THE DIGITAL DIVIDEND

In all spheres of life, digitalisation has created completely new possibilities for using digitally networked systems to make decisions and take action. For private users and users in business, industry and politics, this leads to many advantages and opportunities. The Digital Policy Agenda for the Environment has coined a term for this effect: the digital dividend.

Two aspects are particularly relevant:

- → The explosion in available information is taking knowledge about our world to an unprecedented level. This enables better decisions to be taken and new areas where action is needed to be precisely identified.
- → The increasing availability of data and the growing capacity for analysis make it possible to more effectively manage, optimise and accelerate processes in the economy and society and to reduce the associated costs considerably. In other words, it will be possible to do even more in an even shorter time with even less effort.

THE DIGITAL DIVIDEND UNLOCKS POTENTIAL AND FREES UP RESOURCES THAT CAN BE INVESTED IN THE CHALLENGES OF THE FUTURE

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 things are used by digital environmental policy to better protect the environment and nature and mitigate climate change. To have more 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 a digital dividend 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. → ***p. 68***

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.

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. To 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.

REPORT

Artificial intuition for plastics

IN GERMANY THERE ARE STILL TOO FEW HIGH-QUALITY RECYCLED MATERIALS FROM PLASTIC WASTE, WHICH ARE THEN REUSED IN PRODUCTION. THE RECIRCE PROJECT AIMS TO DO MORE THAN JUST IMPROVE THE WASTE SORTING PROCESS USING ARTIFICIAL INTELLIGENCE. A DIGITAL PRODUCT PASSPORT IS INTENDED TO CREATE TRANSPARENCY FOR THE ENTIRE CHAIN OF RECYCLABLE MATERIALS, THUS MAKING IT EASIER TO REUSE GRANULATE FROM COMPLEX PRODUCTS LIKE ELECTRIC KETTLES, CAR SEATS OR TOY DOLLS.

At 6 am, 80 kilometres north-west of the city of Kaiserslautern in Germany, the first shift is starting at Papier-Mettler, Europe's largest producer of paper and plastic packaging. The factory gate rattles up as a lorry comes to a stop in front of it. The plastic waste being transported in the back of the lorry is about to get a new lease on life. Plastic films, bags and plastic packaging are collected in the region's supermarkets and department stores and brought to the recycling facility. Here, the plastic waste is crushed, washed and melted down to produce a fine granulate, which is a valuable raw material for new packaging.

Not enough recycling of plastic waste

700 kilometres away, in Berlin, Andreas Ciroth is pouring himself a cup of tea in his office. The founder of the company GreenDelta bought the electric kettle a few years ago. If the appliance breaks at some point, it cannot be entirely recycled. "The kettle is made of lots of different materials, and separating these materials for plastic recycling of electrical appliances is a very complex process," says Ciroth. It's just not worth it financially.

Most plastic waste in Germany is recovered for use as energy, for example, in waste incineration plants, but it is also sometimes shipped abroad. This is something environmental engineer Andreas Ciroth would like to change with artificial intelligence. And this is where the recycling experts from Rhineland-Palatine come into play.

Papier-Mettler, Andreas Ciroth's company GreenDelta and other well-known partners from the private sector and scientific community joined forces under the ReCircE project to reorganise the entire sorting process in preparation for high-quality recycling. The consortium also includes the German Research Center for Artificial Intelligence, the Technical University of Darmstadt and the Fraunhofer-Gesellschaft for the Advancement of Applied Research. Together they applied to the BMU support programme as the Artificial Intelligence (AI) lighthouse project for the environment, climate, nature and resources.

Goal to use the same plastic compound up to 20 times

ReCircE aims to use artificial intelligence to remedy weaknesses in the sorting process. Near infrared spectroscopy has already been established as a sorting technology for packaging such as plastic films and bags. It detects the most common polymers and can sort them automatically. However, it is not yet possible to sort plastics made of complex products with highly diverse materials and possibly even harmful substances.

As a result, manufacturers of products like car parts, food packaging or textiles tend to use new plastic. Using granulates from recycled materials is generally not an option for them for quality and cost reasons. In theory, molecular chains of plastic could be used as many as 20 times, says Ciroth. However, for this to happen, the recycling process would have to be significantly improved. One breakthrough could be combining the established sensor-supported processes with the new possibilities offered by machine learning. Which is exactly where ReCircE is focussing its efforts.

Artificial intelligence will produce pure granulate in the future

It starts when waste is sorted on the conveyor belt. With an intelligent combination of infrared technology and 3D object design, sensor-supported machines could analyse the composition of the waste it is trained to detect and distinguish between, for example, commercial and household waste. The Fraunhofer Institute developed the prototype of a machine for ReCircE, which can even be trained using artificial intelligence. "Over time, the machine will be able to recognise the origin of the waste and predict the likely composition more accurately," says Ciroth.

> "It will be a major undertaking to convince a wide range of manufacturers and distributors to participate."
>
> ***Andreas Ciroth,*** *Papier-Mettler KG*

The waste is then better sorted by material class when it enters the melting process, where it can be further refined using AI. This occurs after the plastic has been melted into hard pellets. In the future, the aim is for AI to be able to detect the individual molecular chains in this state and treat the melted plastic in such a way that it breaks down into the individual fractions. The goal is not to have a mixed granulate, but to create four or five pure grades of a quality comparable to primary plastics. This will enable more plastics to be turned into a valuable raw material for industry.

Papier-Mettler will be the first company to test this new AI-supported process. Initially, the share of recycled materials in plastic bags and simple plastic films is to be increased from the current level of 80 percent to nearly 100 percent. The company will then start to use recycled granulate, also for industrial films, which Papier-Mettler currently makes with new granulate.

A Digital Product Passport aims to ensure transparency and repeated recycling

But the planned project intends to use AI even more extensively: the idea behind the Digital Product Passport, a kind of record of the product's life cycle, is to make it easier for manufacturers and recyclers to deal with plastic properly. Until now, companies like Papier-Mettler have not known enough about the substances contained in certain products. And, when in doubt, they don't recycle them at all. Manufacturers, on the other hand, unintentionally use methods that exclude products from recycling, including adhesive that the recycler can no longer remove.

A Digital Product Pass would provide this important information to everyone involved at the different stages of the material cycle: how materials were used, how they are combined and how the product needs to be disposed of. GreenDelta has already developed an open source tool for this purpose that enables everyone from the manufacturer to the retailer and recycler to read and add information. Ciroth: "This transparency will let us create a material cycle that can be repeated numerous times."

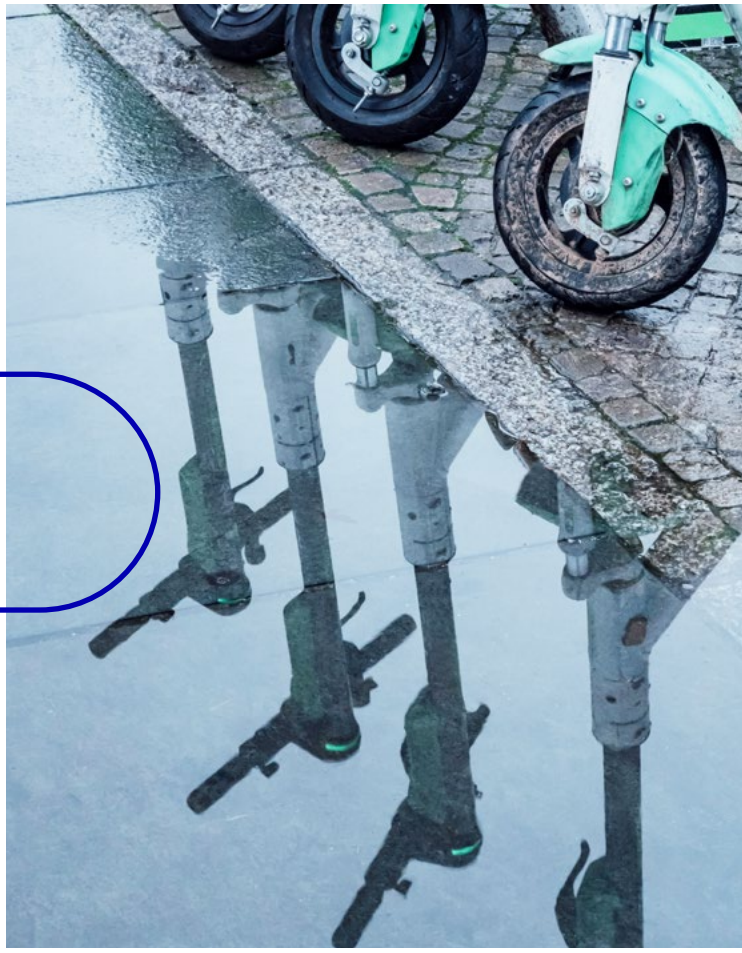
However, in order for this tool to be of benefit, input from all stakeholders involved in a wide range of products is required, from e. g. electric kettles to dolls or smartphones. "It will be a major undertaking to convince a wide range of manufacturers and distributors to participate," says Ciroth. "We want to initiate this process and hope that it can become established throughout Europe over the next few years."

A recycled electric kettle contains hardly any petroleum and generates 65 percent fewer CO_2 emissions.

At some point, these efforts will lead to a plastic from the recycling process that can be used to make the electric kettle later used in GreenDelta's staff kitchen. Its production will not only minimise the use of fossil fuels, it will also result in 65 percent fewer CO_2 emissions. Ciroth sees no alternative to plastics in the long run. No other material can be shaped and used as flexibly. "The only thing we need to get to grips with is achieving circular economy, otherwise plastic is an enormous environmental problem." But this is exactly what he and his colleagues at ReCircE are working on.

REPORT

Efficiency strikes back



More and more people are using eco-friendly modes of transport or technologies. Yet energy consumption and CO_2 emissions have not decreased. This is due to rebound effects triggered by changes in behaviour. These setbacks are particularly evident in mobility. The city of Bremen has shown how rebound effects can be curbed using digital technologies.

It is raining on this November morning in 2019. The thought of cycling through the city is not particularly inviting on a day like today, as Bremen begins a new chapter in its transport history. The first e-scooter rental company began operations overnight. Around 700 electric scooters can now be rented via app: to commute to work, to buy groceries or to get from point A to point B.

While the rental companies are celebrating the scooters as a technical revolution, they caused some debates in the city: about crowded footpaths in the city centre, for example, about possible electronic waste dumped into the Weser River or the advantages of scooters in a city that already has more bicycles than inhabitants. Stories people had heard from other cities like Berlin or Hamburg. The controversial issue wound up on desk of Michael Glotz-Richter, policy officer for sustainable mobility in Bremen. “I think that e-scooters can be a viable part of environmentally friendly mobility in cities,” he says today. “We just have to be careful not to end up with too many unwanted effects.”

Why fuel-efficient cars can lead to more air travel

Researchers have found these unwanted effects in practically all areas where more efficient technologies converge with old behaviours and lifestyles. Rebound effects are said to occur when a new technology fails to meet its original goals - or even completely reverses a positive outcome. Although the share of renewable energy in Germany has doubled in the last ten years, the heating requirements in private households have decreased by one third since 1999 and more than 100,000 electric cars are now registered: energy demand and CO_2 emissions in Germany are falling more slowly than the potential technological savings would lead us to expect. How is this possible?

"New technologies trigger all sorts of changes in behaviour," says Reinhard Madlener, professor for energy economics at RWTH Aachen University. Increased energy efficiency makes energy services cheaper. And, new technology can often make people's everyday lives easier, ultimately leaving them with more time and money. "This creates an enormous incentive to consume more." If you spend less money on car maintenance, you might just spend the money you saved on a flight for a weekend away. If you switch to energy-saving LED lights, you may be tempted to buy an entire lighting system and leave it on longer. The Federal Environment Agency (UBA) estimates that rebound effects cancel out around 10 to 30 percent of potential savings from energy-efficient technologies.

"New technologies trigger all sorts of changes in behaviour."

Reinhard Madlener, *professor for energy economics at RWTH Aachen University*

How e-scooters create more traffic

The Bremen mobility planner Michael Glotz-Richter also deals on a daily basis with the effects that lead to increased demand for transport. These effects are particularly pronounced in the mobility sector, all the more so as systems based on digital innovations and artificial intelligence are becoming increasingly common in this sector. Glotz-Richter is familiar with studies showing that car sharing primarily appeals to people who used to get around by public transport or bicycle. He knows that self-driving and electric cars tempt people to get behind the wheel instead of taking the tram. He took note of the first surveys on e-scooters in San Francisco and Paris. Three-quarters of users would have walked, cycled, taken the bus or stayed at home had it not been for the new scooters. The scooters also lead to more traffic on the road because they have to be collected, charged and serviced every night. Researchers also suspect that carelessly parked scooters displace bicycle and pedestrian traffic.

Where clear rules support the transport concept

These studies are not a "plea to ban new technologies in urban transport," says Glotz-Richter. "Instead, they encourage us to consider all aspects of traffic flows and management." For the e-scooters, this means: clear rules for e-scooter rental companies, more cycle paths and the use of artificial intelligence. For example, parks are off limits to e-scooters in Bremen. The providers' app automatically prevents users from parking e-scooters in these no-go zones, saving the local authorities from daily checks. Glotz-Richter: "I would love to see something like this for cars parked carelessly on footpaths and cycle paths. They are by far the biggest obstacle to traffic in the city."

ENVIRONMENTAL IMPACT COMPARISON OF VEHICLES GREENHOUSE GAS EMISSIONS* OF MODES OF TRANSPORT IN GERMANY

147 g	80 g	58 g	58 g	0 g
Passenger cars	Public buses	Tram, urban railway, underground	Railway (regional trains)	Bicycle, walking

**2018, average: CO_2 equivalents (gram per passenger kilometre) including emissions from the provision and conversion of energy sources into electricity and fuels.*
Source: https://www.umweltbundesamt.de/themen/verkehr-laerm/emissionsdaten#verkehrsmittelvergleich_personenverkehr

Initial evaluations suggest that Bremen's plan is working. Many people in this city on the banks of the Weser River use the e-scooters as they should be used: to supplement local public transport and their own bicycles. The Swedish e-scooter sharing service Voi recorded more than 50,000 trips in the first two months alone. One hotspot is the area around the train station. The city's outer districts will be connected in the coming months. Claus Unterkircher, General Manager of Voi for the German market, regards the scooters as serious competition for cars. "What's important is that they are integrated into existing transport infrastructures as seamlessly as possible, for instance, in local mobility apps." And it is essential that more cycle paths be built. "Bicycles and e-scooters sharing the roads with cars is not an attractive option for anyone."

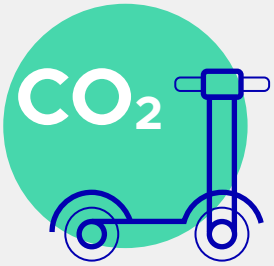
When e-scooters will start to compete with cars

This is also how Glotz-Richter sees it. Bremen benefited from being one of the most bike-friendly cities in Europe when the e-scooters were launched. "There is no way that anyone here would get rid of their bicycle in favour of an e-scooter. They're also much too expensive for this." However, the inhabitants of Bremen would certainly reconsider owning a private car given the right alternative. For more than ten years, the city has been developing a car sharing system with large and small vehicles ranging from two-seaters to vans. Of the 20,000 people who use the service, 6,000 have given up their own cars.

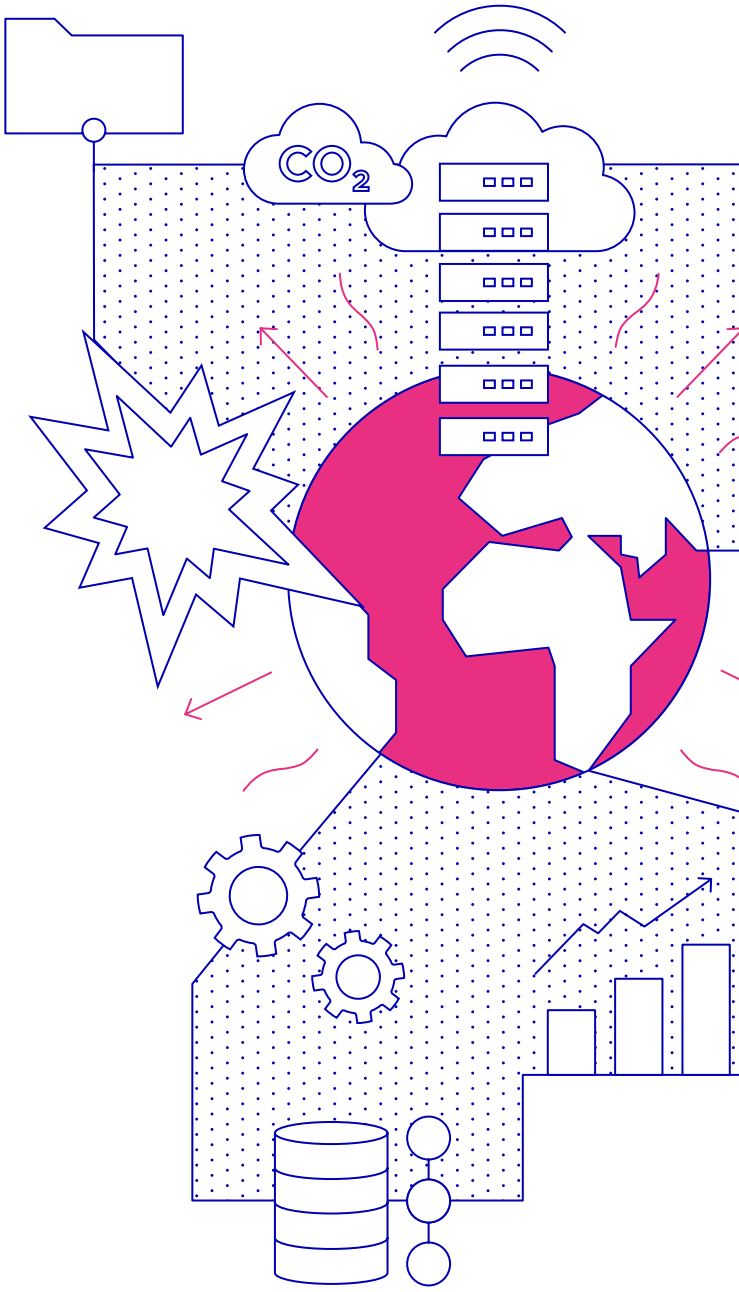
"The ultimate goal in an urban area like Bremen is for it to no longer be worthwhile to own a car," says Glotz-Richter. He adds that the better coordinated and more widely available car sharing, local transport, bicycles and e-scooters are, the easier it will be to prevent rebound effects and achieve the ultimate goal. One factor that should not be underestimated is how much fun e-scooters are to ride. "One reason people drive so much is because they enjoy it. It can only be a good thing if there are emotional alternatives."

CO_2 EMISSIONS OF E-SCOOTERS

There is no meaningful data available yet on the CO_2 balance of the production and operation of e-scooters, especially in rental fleets. However, e-scooters are generally only an environmentally friendly alternative if they replace trips by car or motorcycle and if they do not lead to more fuel-powered vehicles on the road. The CO_2 and air pollutants otherwise emitted by these vehicles are then prevented.



Political mandate: the pivotal role of the BMU



Sustainability, environmental protection, nature conservation, climate action, resource conservation and radiation protection are not merely peripheral to the digitalisation process. They must be incorporated as overarching goals into all digitalisation strategies of the German government and the federal states. The BMU is actively shaping the German government's digital policy with the digitalisation implementation strategy, the strategies for artificial intelligence and blockchain and with the mobile communications and data strategy.

Without a change of course, digitalisation is threatening to exacerbate the destruction of nature and social inequalities. Environmental policy at federal, state and local level must therefore set guiding principles to ensure the risks of digital technologies are minimised while their potential for social and environmental restructuring is exploited. The strategic principles and measures outlined in the Digital Policy Agenda for the Environment are the first decisive approaches to paving the way forward.

In order to successfully master the economic and social transformation through digitalisation, the approach to shaping policy is directed outward. But efforts are also needed internally to deploy digital technologies for a modern, transparent and effective environmental administration. → ***from p. 24***

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

Our strategy

Environmentally friendly digitalisation

Reduce the ecological footprint of digitalisation and protect human health

Digitalisation as a driver for social and environmental restructuring

Develop targeted policy approaches and instruments to restructure markets and processes in individual transformation fields

Harness digital technologies for environmental policy governance, participation and engagement and more effective administration, decision-making and enforcement

Environmental policy 4.0

Innovations for social and environmental progress

Further develop support for innovation in line with environmental policy needs, close research gaps and tap into systemic potential for innovation

Implementation of the Digital Policy Agenda for the Environment requires new alliances and better cooperation within the environmental administration at all federal levels and in Europe as well as between the federal government, federal states, cities and municipalities, citizens, civil society, start-ups and established companies.

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. → ***p. 34***

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.

Businesses have to gear their product design and marketing strategies towards recyclability from the very beginning.

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).

Binding requirements for manufacturers in the EU Ecodesign Directive should guarantee the functionality of hardware software systems for many years.

3 questions for Professor Dr Lorenz Hilty

Head of Informatics and Sustainability Research (ISR) Group at the University of Zurich

Professor Hilty, you have conducted research into why it is so difficult to establish sustainable IT structures. What are the biggest problems?

Our power requirements are still growing at a faster rate than energy efficiency. Power is doubling at least every two years, which means that every two years we get twice the amount of computing operations per kilowatt-hour from the respective current microprocessors. The picture is similar for storage capacity. Both represent enormous technological progress. At the same time, however, demand for IT services is growing even faster. At present, this increase in demand stems from mobile internet access in mobile phone networks and from the trend to make videos of everything. It is not just energy, but raw materials and IT are also affected by this increase. Materials efficiency is rising, everything is getting smaller and lighter, but the pipeline from raw material to waste is becoming increasingly full because of rapidly rising consumption. Recycling is of course useful, but of the over 50 metals processed in the electronic components of digital electronic products, at most only 17 can be recovered. Globally, a significant share of the annual 50 tonnes of electronic waste ends up in rubbish dumps in poorer regions of the world. In these regions, for example, gold and copper are often recovered in an informal recycling sector at significant cost to human health and the environment.

What needs to be done to use these resources as sparingly as possible?

We need to once again understand that hardware can function for a very long time. Having said this, newer software versions systematically and regularly demand more from hardware and, as such, we have become accustomed to replacing functioning devices. In addition, we need to look at the entire life cycle of the hardware and find ways to make repairs and the continued use of functioning components easier.

What role do public stakeholders like the BMU play here?

Policy-makers set the framework conditions. And these should strengthen the rights of consumers in the digital world and ensure they are not forced into accelerated consumption. A consumption pattern in which the premature depreciation of devices is initiated by software updates. If the rules are fair, this would allow for more creative business models that are not based on the continuously increasing flow of resources. The digital economy can do things differently. And the IT sector can set an example for other sectors, which thanks to IT could also focus more on longevity and services instead of the throwaway mentality. But this will only work if consumers become more autonomous. Policy-makers can also support this, for example with labels such as the Blue Angel for software or through independent recommendations for sustainable IT consumption.

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 dependent on imports.

The Blue Angel eco-label for resource- and energy-efficient software products is an important step forward.

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 this 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 eco-label 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.

The environmental impacts of manufacturing, recycling and disposal will in future also determine strategic decisions on the use of IT.

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

now 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

new 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)

next 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

The ecological footprint of digitalisation

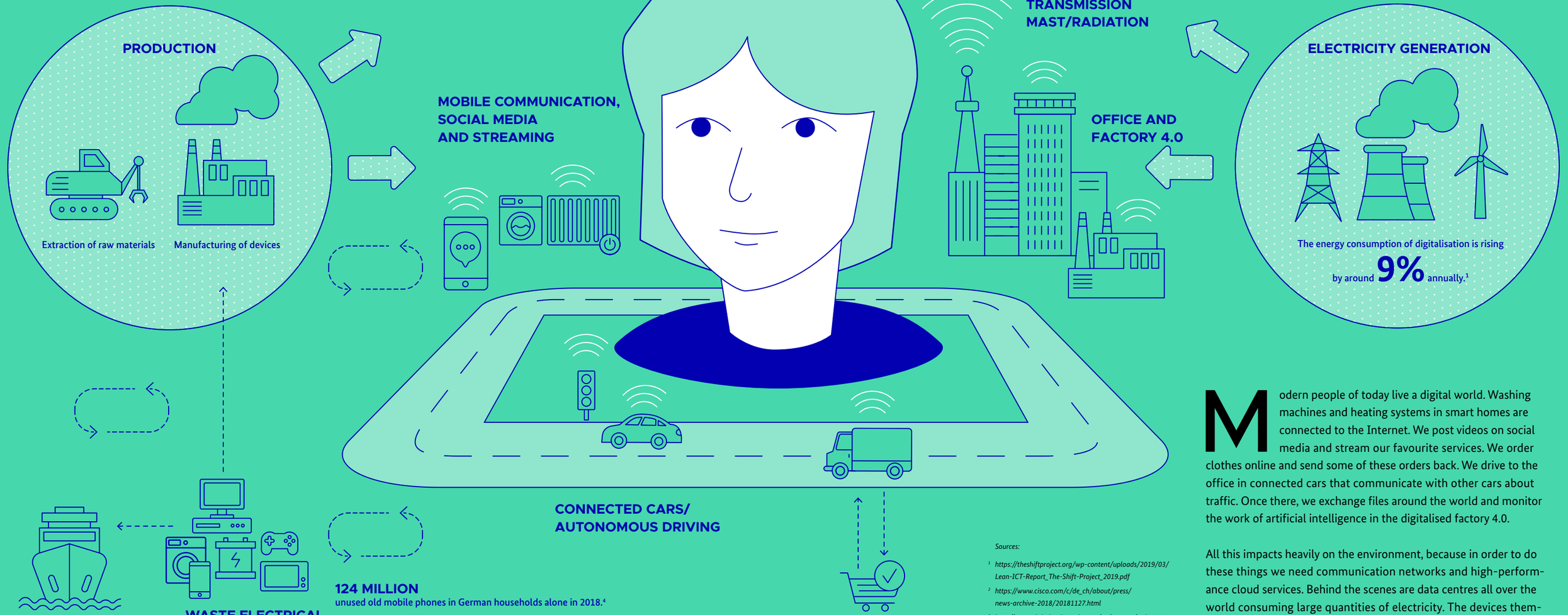
DATA CENTRES

≈ 20 %
of global energy consumption of digitalisation[1]

COMMUNICATION NETWORKS
(mobile/5G and fibre optic)

400 BILLION GIGABYTES
Predicted global data traffic in 2022:
396 billion gigabytes per month (2017: 122 billion gigabytes)[2]

≈ 4 %
of global greenhouse gas emissions is attributed to digitalisation. This roughly equates to the same share of emissions of Germany and Canada combined.[1,3]



Modern people of today live a digital world. Washing machines and heating systems in smart homes are connected to the Internet. We post videos on social media and stream our favourite services. We order clothes online and send some of these orders back. We drive to the office in connected cars that communicate with other cars about traffic. Once there, we exchange files around the world and monitor the work of artificial intelligence in the digitalised factory 4.0.

All this impacts heavily on the environment, because in order to do these things we need communication networks and high-performance cloud services. Behind the scenes are data centres all over the world consuming large quantities of electricity. The devices themselves are also problematic for the environment: from the extraction of raw materials through to production and insufficient recycling of waste electrical and electronic equipment.

Sources:

1 *https://theshiftproject.org/wp-content/uploads/2019/03/Lean-ICT-Report_The-Shift-Project_2019.pdf*
2 *https://www.cisco.com/c/de_ch/about/press/news-archive-2018/20181127.html*
3 *http://www.globalcarbonatlas.org/en/content/welcome-carbon-atlas*
4 *https://www.bitkom.org/Presse/Presseinformation/124-Millionen-Alt-Handys-liegen-ungenutzt-herum.html*

Aya Jaff, *24, is convinced that digitalisation can benefit the environment in the future if policy-makers, industry and consumers act together.*

“We need figures on the ecological footprint of digitalisation”

Aya Jaff is young, successful and digital. As a programmer, she regularly draws public attention to the environmental challenges of digitalisation. In an interview, she explains why new technologies have to be more resource-efficient and why DNA molecules are a suitable data storage medium.

Ms Jaff, digitalisation is currently an extremely important issue in all spheres of business and everyday life. However, you highlight its negative impacts for the environment. What’s your motivation?

No one can turn a blind eye to climate change, especially since the Fridays for Future movement appeared on the scene. My generation is fully aware that a lot needs to change. In my private life, everyone around me is already taking steps by not eating meat or avoiding plastic waste, for example. In the tech sector, however, there is still a lot to do, for instance, when it comes to data storage. Server farms consume vast resources. And demand will continue to grow dynamically. Artificial intelligence is extremely data-hungry and we are just barely getting started in this area.

It is said today that “streaming is the new flying”. Do you think that giving up technology is the right response to the environmental problems of digitalisation?

I think it is hard to tell people to write fewer emails and text messages or to stop travelling the world. For one thing, it would be a step backward and a lot of opportunities would be lost. We would miss out on gaining new input, sharing ideas and having access to information. Instead, we need to cultivate creativity and more ambition to tackle the challenges and develop new technologies that find solutions to the climate and environmental problems! It’s important that we start with development right now because smart solutions take time.

So we don’t need new rules and regulations?

In some cases, there’s no alternative. Manufacturers, for example, should be required to design mobile phones and tablets with individual parts like the battery that can be replaced. We need the right to repair. But generally speaking, I prefer incentives to bans. Incentives should be created to encourage start-ups and companies to develop technologies with as few resources as possible The Digital Policy Agenda for the Environment is an important step in the right direction because it attracts the necessary attention for the issue.

→ *You can read about how digitalisation is unfolding sustainable creative power in different sectors starting on* ***p. 40.***

How do we create digital literacy and raise awareness of the implications of the new technologies?
If we want to see real change, we need to actively involve the younger generation in the discussion. And by this I mean start-ups as well as the young people currently participating in demonstrations. The only way to effectively raise awareness of the issue is when the established players in the energy sector successfully collaborate with young players. If everyone just does their own thing, we won't get very far. Which is why I think policy-makers need to set the course. The goal is for digitalisation to drive the energy transition forward, not stop it.

What do you see as the biggest challenge in making digitalisation environmentally friendly?
Reaching the masses with environmentally sound alternatives. For this to happen, these alternatives have to be at least as good as the technologies currently in use. So, for example, more resource-efficient search engines like Ecosia have to deliver results at least on par with Google. This means that we need to become more innovative in the tech sector. Simply appealing to people's conscience is not enough.

Do you have an example of this kind of innovation?
The Boston-based start-up CATALOG has come up with a way to store data on DNA molecules. Just a single gram of DNA can store 215 petabytes of data, i.e. 215 million gigabytes. DNA can store roughly a million times more information than a conventional flash drive. It is also more durable, more secure and only uses minimal energy. I am working to get start-ups and companies excited about exploring these kinds of new ideas.

How can we set a course for the megatrend of digitalisation that also benefits the environment?
To achieve this, policy-makers, industry and consumers have to take responsible action together. This will then become a key factor for success: companies that are able to capitalise on digitalisation to make their products and processes more environmentally sound will benefit in the long run. People are aware. And as consumers, they have market power. This is already clearly evident in the fashion industry and in the choice of energy suppliers.

What will it take to successfully win them over?
Policy-makers and researchers need to provide reliable data on the ecological footprint of digitalisation as soon as possible. We don't yet know enough about the exact breakdown of resource consumption. But we need numbers so that people get an idea of the repercussions and trends, and policy-makers can formulate appropriate regulations based on this data.

Have companies already realised this?
It is slowly trickling down, although big players have a harder time linking digitalisation and sustainability. They should seek inspiration from smaller companies and from other countries. In April, for example, I am travelling to Botswana, which has a very vibrant start-up scene. And the people there are already feeling the effects of climate change today. I can imagine that they think about sustainability and digitalisation differently than we do in Europe. To meet the challenges of the future, we can't lose sight of the big picture. nicht verlieren.

Aya Jaff *is a programmer, trader, entrepreneur and author. Her first book, "Moneymakers" will be published in April 2020. Since February, she has been writing a column called "Tech for the Future" for the digital magazine t3n that focuses on resource-efficient approaches to the future of technology.*

Energy transition – the basis for environmentally friendly digitalisation

Restructuring the energy system is one of the key challenges of the 21st century as sustainable development of the economy and society is only possible with an environmentally and climate-friendly energy supply. The same applies to digitalisation.

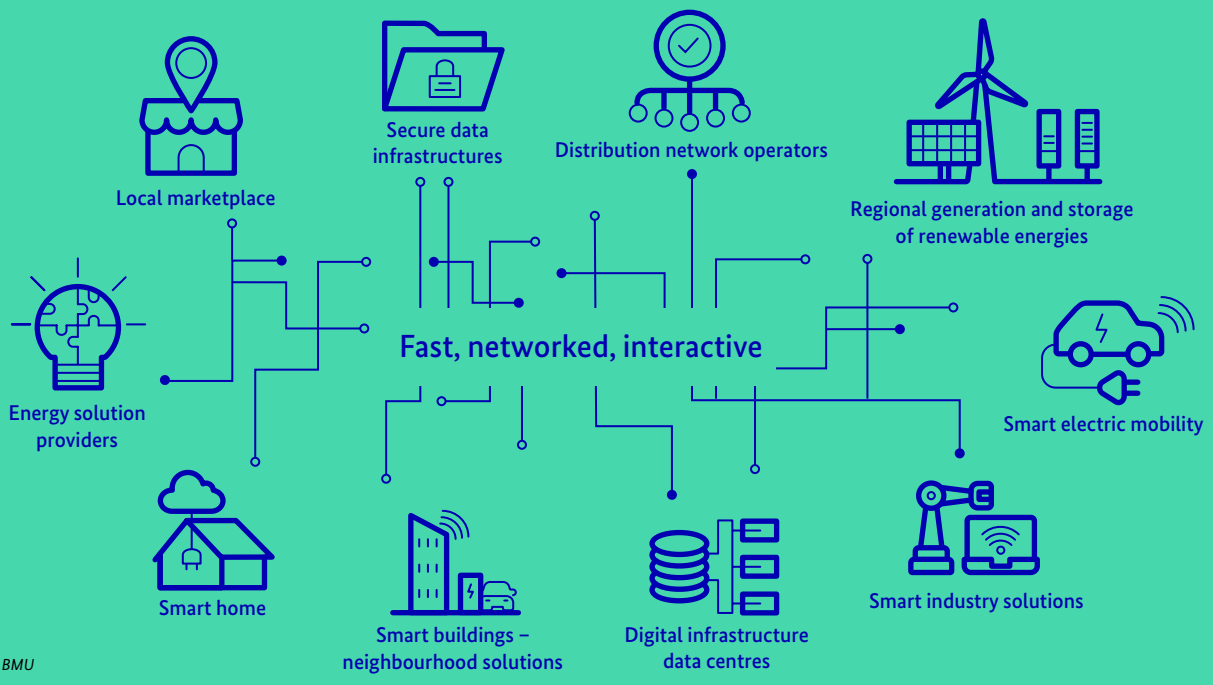
The only way to make digitalisation environmentally compatible is for installations and infrastructure like data centres to switch to carbon-free electricity. Much has already been accomplished in Germany thanks to the accelerated expansion of renewables and the decision to phase out nuclear and coal-based power generation.

The focus now is to set the course for the next phase of the energy transition. The future will be decided decentrally: at local level with communities in cities and in rural areas. This is where regional generation of renewable energy and heat-power cogeneration meets flexible demand in private households, business and industry. Highly efficient solutions for buildings and traffic are interactively integrated into the system and smart grids can leverage the potential of new storage technologies. One important task will be to integrate data centres and other digital infrastructure elements into these structures and implement innovative system solutions, for example, for the use of waste heat, on a large scale.

Digitalisation is an essential prerequisite for the far-reaching changes to the structure of the energy system. Complex systems can only be reliably operated, controlled and continuously improved through data-driven networking of installations and grids. Progress in data evaluation, for example, through big data analytics, offer completely new possibilities for forecasting trends, optimising business strategies and responding to unforeseen events. At the same time, digital solutions are accelerating the shift in the energy supply industry from the traditional value chain to the "Internet of energy". With new challenges, opportunities and business models, both for the traditional energy supply industry and industry as well as for new energy service companies and private households. For example:

- Intelligent, responsive load management of buildings and industrial facilities
- Savings/sufficiency gains by preventing unnecessary workarounds and unnecessary consumption
- Marketing of decentralised energy to consumers
- Direct transactions between end customers (or peer-to-peer solutions)
- Increased establishment of virtual power plants (comprised of decentralised units) and emphasis on the flexibility of these power plants
- Trade platforms and local markets to offset bottlenecks in the energy grid

THE INTERNET OF ENERGY



Source: BMU

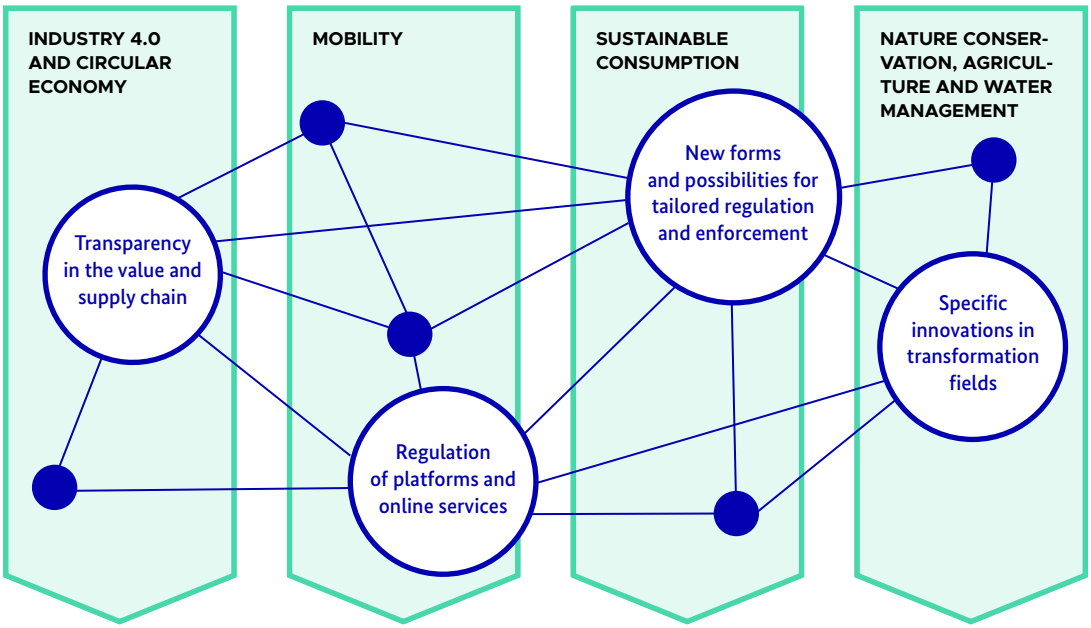
Transformation fields: how and where digitalisation is driving social and environmental restructuring

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. The Digital Policy Agenda for the Environment covers four fields particularly relevant to digitalisation.

_ Industry 4.0 and circular economy
_ Mobility
_ Sustainable consumption
_ Nature conservation, agriculture and water management



Digitalisation as driver and facilitator of social and environmental restructuring

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: 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.

_Industry 4.0 and circular economy

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.

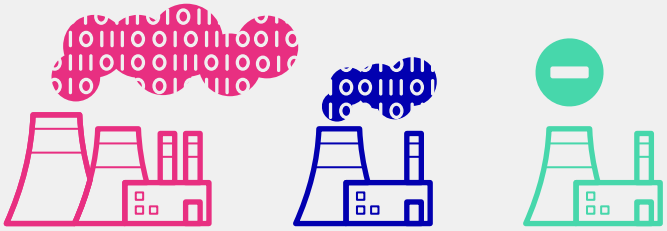
TARGET VISION

The goal of a greenhouse gas-neutral and resource-efficient economy combines carbon free energy supply with the potential of industry 4.0 in the areas of climate action and energy and resource efficiency. Digital technologies can optimise energy needs, close material and data flows and interconnect and evaluate all these aspects. Product designs and production can be geared towards longevity, responsible resource management, recoverability and recyclability.

Better recycling processes can raise the share of recycled raw materials in production and reduce the use of newly extracted raw materials. This presents particular opportunities for Germany as a hub of industry: with their expertise on technologies and the core processes of industrial manufacturing, German businesses are leaders in environmental innovations. They are exploring new markets and thus securing a leading position in global competition.

GERMANS THINK THAT INCREASING DIGITALISATION OF INDUSTRY WILL CONSUME MORE RESOURCES.

Will the digitalisation of industry (likely) lead to a higher or lower consumption of resources and energy?

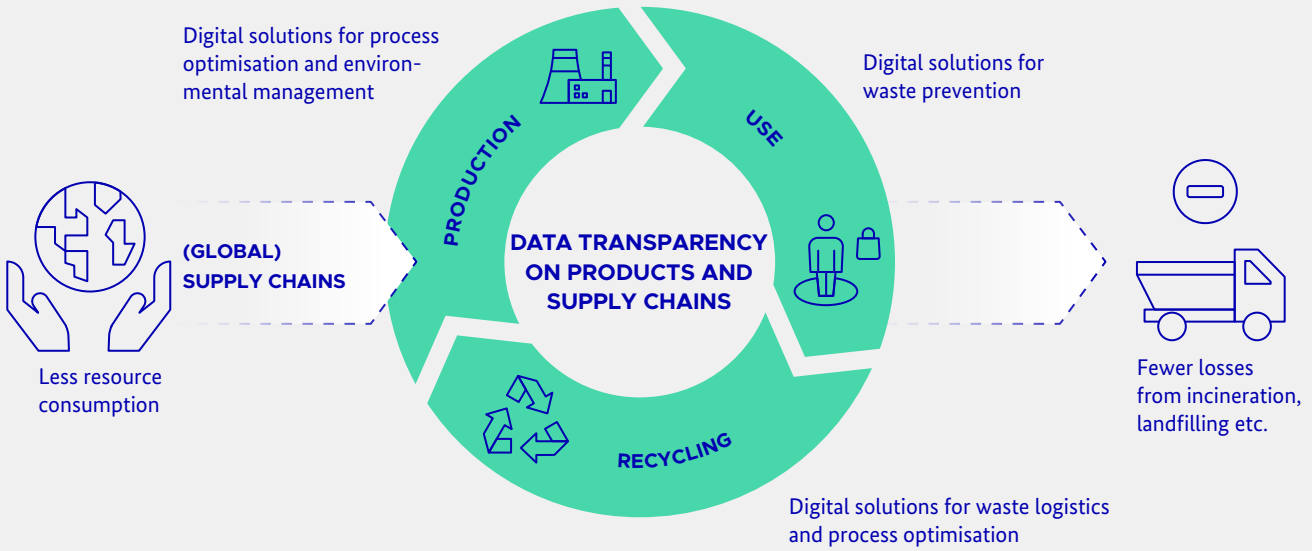


48,6 %
Higher

23,3 %
Lower

23,2 %
Neither

Undecided 4.9% / Source Civey representative survey; number of people surveyed: 5,004; January 2020



Source: BMU

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.→ ***from p. 52***

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. → ***see also p. 46 on CO_2 monitoring systems***

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.

Digital solutions are good examples of integrated solutions in the waste management sector as they offer new possibilities 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 pilot projects in a living laboratory for digitally networked model municipalities. These projects will also help create data standards for a uniform data base.

LIGHTHOUSE PROJECT

CO_2 MONITORING SYSTEMS IN INDUSTRY

Today, climate action is already an important part of the sustainability strategy of companies. Additional impetus is provided by legal requirements, but also by the higher expectations of consumers and finance sector.

Many companies extensively document their direct greenhouse gas emissions in their sustainability reports and to a large extent in accordance with the international Greenhouse Gas Protocol. Conversely, indirect emissions that are produced, for example, in the upstream supply chain are still seldom recorded. However, a large share of emissions from German companies actually stems from the upstream supply chain. That is why action is needed and the potential for climate action is equally great.

Digital solutions can improve the information base throughout the entire supply chain. Broad and internationally based platforms allow for CO_2 emissions to be disclosed for suppliers, business partners and buyers and made usable. This makes it possible to effectively take account of climate compatibility when setting up supply chains and taking procurement decisions.

The BMU dialogue forum on industry and climate action prepared a discussion paper on CO_2 monitoring systems in the supply chain that is due to be published shortly.

Further information in German can be found on *www.wirtschaft-macht-klimaschutz.de*

Wirtschaft macht KLIMASCHUTZ

_Industry 4.0 and circular economy measures

now 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

new 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

next 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

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. App-based digital transport schedule information and booking options make it more convenient to use public transport and combine different modes of transport. Sensor technology and artificial intelligence create the conditions for automated and, in future, self-driving and electric vehicles.

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. → ***p. 19***

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.

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.

TARGET VISION

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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 being lowered. Secondly, municipal traffic planning benefits from data on the use of the service. The data is available in real-time and makes it possible to manage transport and services in line with needs.

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 will require new infrastructure and the corresponding digital skills at municipal level.

Municipal know-how and experimental spaces for transport sector transformation

The BMU is therefore committed to building up the necessary know-how in the municipalities for a sustainable transformation of the transport sector. In addition, it is assessing 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 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.

LIGHTHOUSE PROJECT

COMPETITION ON THE FUTURE OF SUSTAINABLE MOBILITY

In spring 2020, the BMU is organising a national competition on the future of sustainable mobility for better environmental protection and climate action in the transport sector. Projects selected will receive support for the implementation of measures. The competition is intended to help local stakeholders to actively and creatively tackle current and future challenges in traffic planning and formulate concrete development prospects. One focus of the competition will be digitalisation in transport. In this context, a network of municipalities committed to the goal of sustainably transforming the transport sector is to be established.

GERMANS DO NOT CONSIDER CAR SHARING, E-SCOOTER OR NEW TAXI SERVICES TO BE ENVIRONMENTALLY FRIENDLY.

How do you think the use of sharing services, e-scooters and new taxi services in cities impacts on the environment?

22,3 %
Positive

36,4 %
Undecided

41,3 %
Negative

Source: Civey representative survey; number of people surveyed: 5,002; January 2020

3 questions for Professor Dr Stephan Rammler

Scientific Director of the Institute for Future Studies and Technology Assessment (IZT) in Berlin

Professor Rammler, how can digitalisation help us travel in a more environmentally benign way?
Generally, we should use digitalisation in a way that gives rise to new economies, new lifestyles and new forms of mobility. The transport sector transformation is a historic opportunity to do just this. Our society is trapped by fossil fuel based mobility. The only way to get out of this trap is the same way we entered it: through political management and cooperative strategies between policy-makers, companies and civil society.

What would this management entail?
On average, cars transport 1.2 people per journey and are stationary 23 hours per day. Although digital telematic solutions and parking management concepts can improve efficiency, this is not enough. As consumers we tend to reinvest the time and money we have saved. These rebound effects can make the situation even worse. We therefore also need levy systems that absorb these savings. For example a city toll charge. This money could be invested in something like local public transport.

What do you think the Digital Policy Agenda for the Environment can achieve?
One thing can now be said for certain: digitalisation can be both a blessing and a curse for the environment. The Digital Agenda builds on this knowledge and is geared towards a sustainable digital policy for the future. With the help of the Agenda, lifestyles, values and systems can be developed that combine digitalisation and the environment. The aim of digitally reinventing mobility through policy is to achieve a similar level of mobility, i.e. accessibility of life opportunities, with much lower traffic volumes.

_Mobility measures

now 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 self-driving vehicles; 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, like private cars in combination with mobility services, that can contribute to sustainable urban transport

new 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

next 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 carpooling as a practical addition 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

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.

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.

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 perpetual 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.

→ ***from pp. 44***

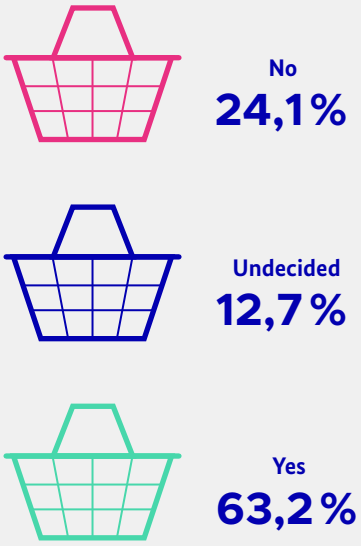
Enabling informed consumer choices

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. → ***see next page***

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. Particularly when it comes to online shopping, it is essential to make user-friendly information available to help consumers make sustainable purchasing decisions. 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. → ***see box***

GERMANS WOULD MAKE MORE SUSTAINABLE PURCHASES IF RELEVANT PRODUCT INFORMATION WERE READILY AVAILABLE.

Would you change your consumption habits if you could instantly compare the environmental and climate impact of similar products?



Source: Civey representative survey; number of people surveyed: 5,001;

LIGHTHOUSE PROJECT

DIGITAL POLICY AGENDA FOR SUSTAINABLE CONSUMPTION

The German government set up the Competence Centre on Sustainable Consumption (KNK) with an office at the Federal Environment Agency (UBA) to accompany the National Programme on Sustainable Consumption (NPNK). The Competence Centre supports the implementation of the National Programme on Sustainable Consumption and provides information and networking possibilities related to 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. Together with interested parties, solutions will be developed for achieving sustainable consumption habits and lifestyles in society against the backdrop of the new digital age. Approaches are being elaborated for the following topics: sustainability in online retail, algorithms, filters and engines, digital initiatives for sustainable consumption and new digital skills for consumers.

LIGHTHOUSE PROJECT

KI4NK: MAKING SUSTAINABLE CONSUMPTION EASY WITH AI

Through the KI4NK project (artificial intelligence for sustainable consumption), the BMU is supporting the development of an innovative concept to promote sustainable consumption in search engines, on comparison websites and in online shops. Data-driven technology and artificial intelligence play a key role here. The concept requires product information on the ecological and social footprint or on sustainability labels to be made available and for the perspectives of companies and customers to be considered together. The key elements here include, for instance, algorithms for search queries and product suggestions, which take account of energy efficiency, ecolabels and filter settings for green products (green by default). Knowledge-based systems and methods of pattern analysis and recognition will be used to provide consumers with alternative products.

Project partners are ConPolicy GmbH and Fraunhofer IAO (Fraunhofer Institute for Industrial Engineering). To incorporate the perspective of companies Google Germany, Idealo, Otto Group, search engine provider Cliqz, Avocado Store and the federal association E-Commerce und Versandhandel Deutschland e.V. are participating in the project.

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 new EU 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. → ***p. 68***

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 EU Council Presidency.

_Sustainable consumption measures

now measures already underway

→ **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

→ **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

new 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

next 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, 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

→ **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

→ **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. → ***p. 68***
The National Centre for Biodiversity Monitoring, 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 platforms

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.

2 questions for Peter Hettlich

Head of the project group dedicated to digitalisation and sustainability in agriculture and food at the Ministry for Environment, Agriculture, Conservation and Consumer Protection of the State of North Rhine-Westphalia.

Mr Hettlich, how can the federal government and the federal states systematically integrate environmental protection into agriculture?
By incorporating environmental data into our decisions as much as possible. In most cases, it is not the data basis that is the problem. However, this data is stored at various authorities, often in different formats and can only be integrated with considerable effort. This is why we joined the GeoBox infrastructure. GeoBox provides a single interface, allowing data pools to be merged and enabling direct communication between users from the agriculture, environmental and nature conservation sectors.

How can GeoBox contribute to smart and environmentally sound agriculture?
GeoBox Viewer maps distance requirements for pesticide use and generates a data set for operation. On this basis, smart machines will be able to apply pesticides only where necessary and permitted with an accuracy of within 1 or 2 cm. In future, we also want to link the system to a data-supported early detection system for plant diseases and pests. This will enable operators to respond very early and just treat the specific infestation.

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.

LIGHTHOUSE PROJECT

FUTURE FOREST – FOREST CONVERSION WITH AI

As part of its AI lighthouse project initiative, the BMU is supporting the Future Forest project (FutureForst). The project uses artificial intelligence to examine different forest conversion scenarios. To this end, the project aggregates and evaluates environmental and weather data as well as data on pest development and air pollution and correlates this data. With a view to pressures such as climate change, decision-making aids to help achieve sustainable forest conversion will be developed in order to preserve forest ecosystems for future generations. The project will be carried out by wetransform GmbH.

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 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, agriculture and water management

now 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

new 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).

next 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 a view to the potential arising from use and automated exchange of data from environmental and nature conservation administration 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 as a contribution to improving 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

Innovations for social and environmental progress

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. → ***p. 8***

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. → ***p. 40***

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 (→ ***next page***) and a Platform for Social (→ ***p. 65***) and Environmental Innovation will create new institutions that advance digital solutions as innovations for a sustainable future.

FEATURE

TECHNOLOGIES FOR SUSTAINABLE FINANCE

The financial market is also an important area for digital innovations. Redirecting capital flows along more sustainable paths can help bring about social and environmental steering effects that go beyond the finance sector in the real economy. Digital financing instruments (FinTech) can help to open up the capital market by attracting new investors through social and environmental projects and businesses, for example, through crowdfunding. Technologies play a key role in sustainable finance in particular. Digital services provide institutional and private investors with environmental and social data as a basis for decision-making. Technologies that speed up and make compliance with legal obligations easier (RegTech) are especially important for the financial market. With the increasing integration of sustainability aspects in financial market regulation, RegTech could lead to greater acceptance of new regulations.

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 the 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.

GERMANS IN FAVOUR OF BOOSTING SUPPORT FOR MORE ENVIRONMENTALLY FRIENDLY PROJECTS IN INDUSTRY.

Should the government provide greater support for environmentally friendly projects in industry or lay down obligations for industry through more stringent laws?

51,7 %
Greater support

26,3 %
More stringent laws

20,9 %
Neither

1,1 %
Undecided

Source: Civey representative survey; number of people surveyed: 5,006; January 2020

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.

3 questions for Hannah Helmke

Co-founder and CEO of the tech start-up right. based on science.

Ms Helmke, what are the biggest challenges in developing innovations to benefit environmental protection?
Embedding economic realities which, in some cases, are marked by market failures. This would mean we would have to have more time and patience for trial and error. But that is expensive. Another aspect is personnel. Start-ups need very well trained people, but they are also expensive and hard to find. And so at a certain point, start-ups have no other choice but to let themselves be bought out or accept venture capital. This can destroy important innovations and autonomy.

How does the start-up and digital scene need to adapt to these challenges?
All sides have a part to play, administration too. Stronger cooperation would facilitate better networks. We also need much more expertise to combine environmental protection with the finance sector and real economy. The government should provide unbureaucratic assistance in the form of a small financing package of, for example, 5,000 euros like in Switzerland. Overall, we need less trimming of high-priced exits and more trust in the "environmental protection x digital x start-up" business model. This will shift the focus to technical aspects and good solutions.

What opportunities do you see in developing a hub for digital tool for climate action?
A hub would bring together a range of different experts from crucial disciplines, such as DeepTech, the finance sector, real economy and environmental engineering. Hubs facilitate immediate practical support for ideas and help those with the ideas to establish independent networks. In this way, the first functional products emerge much more quickly, which in turn inspires people to help with the next steps: with capital, staffing and customer base.

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, finding solutions and 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.

3 questions for Dr Michael Mischke

Founder and current elected member of executive board of WECHANGE eG. He is responsible for strategy and concept.

Dr Mischke, where do you currently see the greatest need for digital innovations geared to the common good?
First off, we have to understand that this cannot be done with smaller-scale digital innovations, but that we need an entire infrastructure dedicated to the common good. Secondly, to achieve this goal we need to establish and curate standardised technical interfaces to ensure that various analogue and digital stakeholders can use this infrastructure equally. Finally, we need a central stakeholder that is familiar with and can network decentralised innovations, that will operate living laboratories and transparently measure and present their effectiveness and tackle arising challenges through public calls to tender and by providing funding for solutions. This is how a functioning complete system is built out of existing individual solutions. This stakeholder must take a co-creative and participative approach in order to generate support, commitment and dedication.

What do digital stakeholders need to enhance the development and scaling of their ideas in line with the common good and sustainability?
We have to make social challenges and grassroots initiatives more visible. Smaller stakeholders are often not eligible for support. Here, public calls for tender and funding need to be adapted, especially start-up finance. In terms of the overall system, the central stakeholder I mentioned before is best positioned to identify niches in the market that are barely filled if at all, and to fill these niches by creating financial incentives.

What role do public stakeholders like the BMU play here?
I would like to see a commitment to open source and solutions from democratically led providers. Public stakeholders could also promote regional networking and at cross-regional level, exert their influence to encourage an online culture of participation and digital public engagement. A stakeholder like the BMU can generate publicity with its resources, communicate best practices, drive ethical principles forward and promote the scaling of existing solutions.

_Social and environmental innovations measures

now measures already underway

- **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.
- **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

new 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

next 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

Environmental policy 4.0

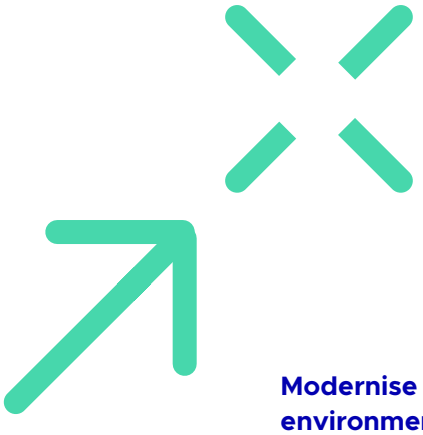
Environmental policy shapes the digital world and digitalisation enhances data-driven, transparent and robust environmental policy.

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. → ***p. 57***
- 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.

Some work is still needed to tap the potential of the new technical solutions for environmental policy.



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 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, must 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. (→ ***p. 52***) 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

The use of digital instruments for enforcement

In information and communications technology (ICT) cannot 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 envisag-

3 questions for Dr Ulf Kämpfer

Mayor of the city of Kiel.
In 2017, he launched the Kiel Digital Week.

Mr Mayor, Kiel relies on digital solutions in the transport sector, for example, bike and car sharing and digital traffic management systems. What happens to the data collected in this context?
In theory, we do in fact have a large amount of data which turns the transport system into a sort of living laboratory for us. But, so far, this data is very dispersed. In addition, we do not have a legal foundation for evaluating the data. I'm referring here, for example, to mobile phone data or data from navigation systems. This unfortunately means that we, as a city, are unable to regulate many scenarios on the basis of real-time data even though this would already be technically possible. Instead, mobile phone data falls into the hands of just a few large companies. I don't think this is right. This is a question of public services and the common good – we need a data for public interest approach.

What role could municipalities play to improve how this data is handled?
Municipalities would have to play the role of the honest broker and ensure that this data benefits the common good. To achieve this, municipalities could formulate provisions on the use of data. For instance, for traffic management we could stipulate that in traffic jams, alternative routes should not go past childcare facilities or care homes. Or the municipalities could pull the strings Then they would have full control of central utilisation and could make data available for the common good. We need to discuss these approaches.

To this end, the city of Kiel launched Digital Week, among other things. This digital festival is aimed at experts from administration and the tech scene, but also at the inhabitants of Kiel. What role do ethical issues play here?
Ethical issues play a huge role. Many of our citizens are concerned about their personal data. During Digital Week we have the opportunity to address these concerns and build up trust in the advantages of digitalisation. I am optimistic that a set of values will be developed in the coming years. This is also what happened with earlier technical innovations. Society is capable of learning and adapting. Bad experiences are just part and parcel of the journey.

es 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.

FEATURE

OUTSTANDING SUSTAINABLE DEVELOPMENT MONITORING VIA SATELLITE

During the UN Sustainable Development Summit in September 2015 in New York, the heads of state and government adopted the 2030 Agenda for Sustainable Development and the global Sustainable Development Goals (SDGs). Progress is tracked through indicators laid down for the 17 goals and 169 targets.

These are primarily based on statistical data or data collected from environmental monitoring networks, models and surveys. The 2030 Agenda is implemented in Germany through the Germany government's Sustainable Development Strategy. The strategy contains a total a 63 key indicators. The project initiated by the Federal Environment Agency (UBA), Cop4SDGs, examines how to record and verify sustainable development indicators using satellite remote sensing and data from the Copernicus Earth Observation Programme of the EU. The project received the Group on Earth Observations Sustainable Development Goals Award in 2020. Earth observation data was used to calculate selected SDG indicators e. g. the proportion of a country's total land area covered by forest, green area cover in mountains and the proportion of publicly accessible areas broken down by gender, age and people with disabilities.

With its awards each year, the Group on Earth Observations (GEO) recognises productivity, ingenuity, skill, innovation and model communication of findings and experiences regarding the use of Earth observation data to support sustainable development.

Copernicus
Europe's eyes on Earth

ZIELE FÜR NACHHALTIGE ENTWICKLUNG

_Environmental policy 4.0 measures

now 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

new 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

next measures to be developed next

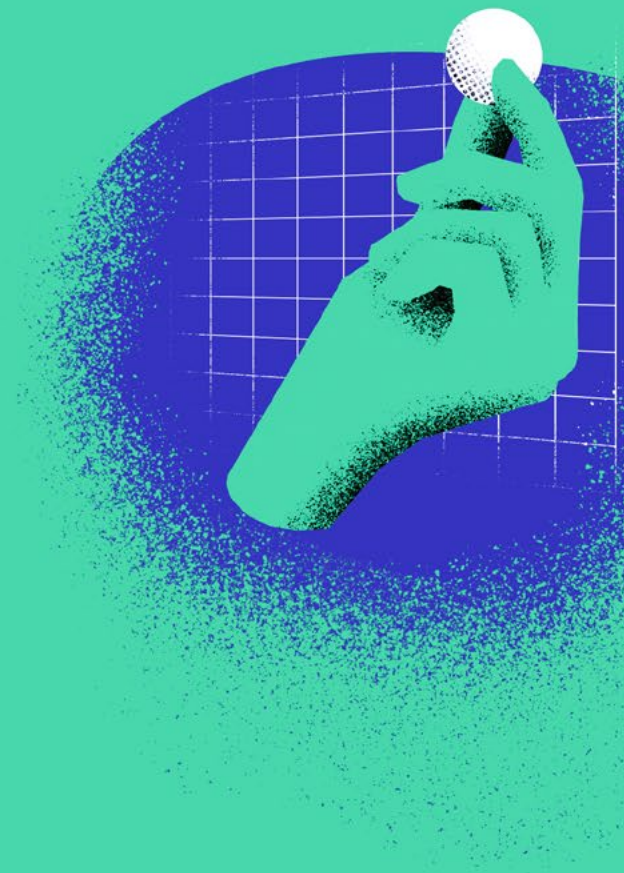
→ **Addition of the application lab for artificial intelligence and big data to the Satellite Remote Sensing Competence Centre**
Expansion of the Satellite Remote Sensing Competence Centre in UBA to support enforcement, analysis of satellite and sensor data and the development of automated analysis processes; 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

→ **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

→ **Digital fitness check of environmental legislation**
Review of relevant environmental provisions to determine applicability to digital enforcement options/digital technologies

now

measures already underway



new

measures to be initiated

next

measures to be developed next

Overview of measures

now 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 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 self-driving vehicles; development of regulatory concepts and framework conditions for sustainable mobility; sharing research findings with municipalities, the automotive industry and mobility providers

AREA	MEASURES
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** 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

AREA	MEASURES
Environmental policy 4.0	→ **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
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

new 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** Establishment of a research network to explore and analyse future research needs in order to develop strategic solutions related to digitalisation and sustainability

AREA	MEASURES
Innovation strategy	→ **Support agenda for digital innovation for the environment** Analysis of the 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** Formulation 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 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)

AREA	MEASURES
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 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** 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 Federal Environment Ministry 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

next measures to be developed next

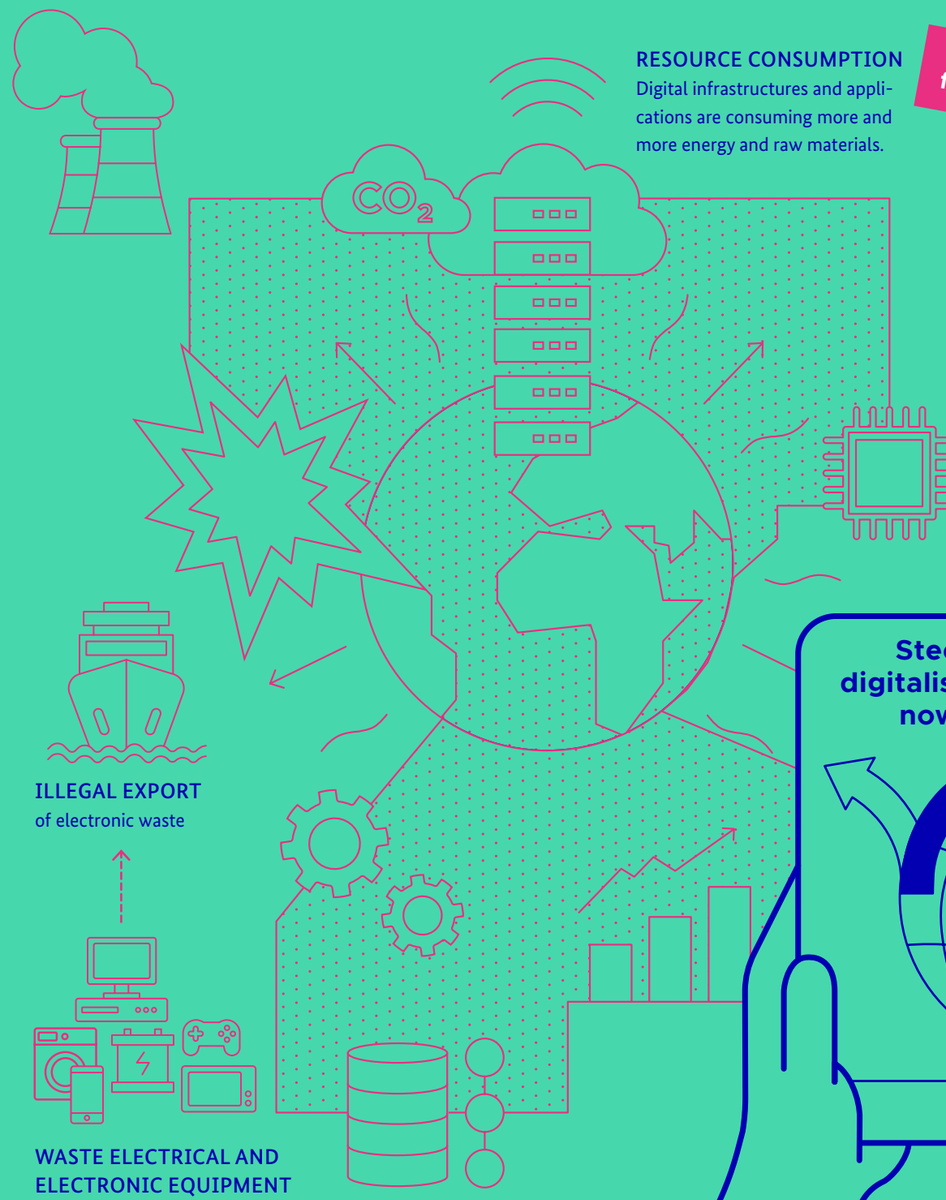
AREA	MEASURES
Industry 4.0 and circular economy	→ **Corporate Social Responsibility (CSR)** Initiative supporting consideration of environmental impacts along supply and value chains
Industry 4.0 and circular economy	→ **Living laboratory for networked model municipalities in circular economy** Establishment 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 carpooling as a practical addition 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)
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

AREA	MEASURES
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 Earth Observation Programme of the EU) 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 arising from the use and automated exchange of data from environmental and nature conservation administration and machine learning
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 data base 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

BIG PICTURE

Digitalisation and environmental protection:

On the path to social and environmental restructuring



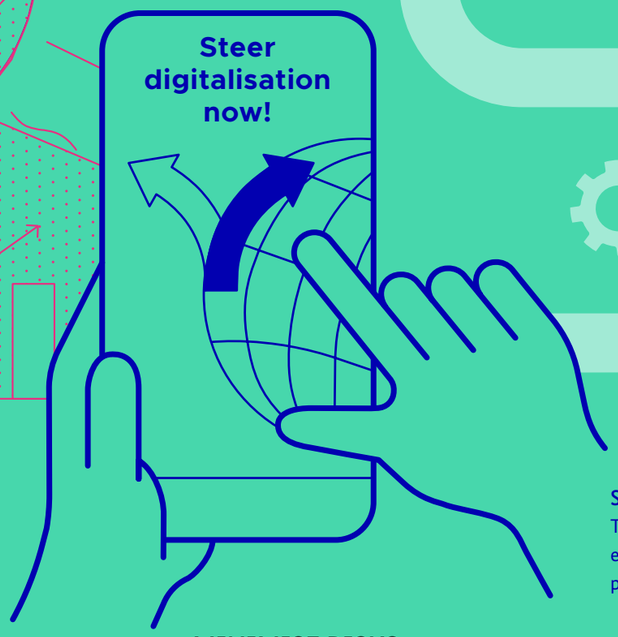
RESOURCE CONSUMPTION
Digital infrastructures and applications are consuming more and more energy and raw materials.

ILLEGAL EXPORT
of electronic waste

WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT

Environmentally friendly digitalisation

Efficient data centres and algorithms, modern networks and durable devices are the prerequisite for digitalisation to reach its full potential for environmental protection and climate action.



TRANSFORMATION FIELD

INDUSTRY 4.0 & CIRCULAR ECONOMY
Digital technologies reduce resource demand and close material flows. They interconnect data flows and evaluate them. Product design, production and waste management are geared towards longevity, responsible resource management and recycling.

Innovations

New technologies have to be designed to provide positive impetus for social change. The interplay of digital innovations and new solutions for industry, policy-makers and civil society will make progress possible.

Driver of social and environmental restructuring

Environmental policy 4.0

SHAPING POLICY
This determines whether digitalisation will exacerbate social and environmental crises or provide a set of tools for a sustainable future.

TRANSFORMATION FIELD

NATURE CONSERVATION, AGRICULTURE AND WATER MANAGEMENT
Digitalisation helps preserve ecosystems. It supports viable and sustainable agriculture that protects species, soil, water and air, and also mitigates climate change. In terms of water management, it contributes to improved general public services.

TRANSFORMATION FIELD

MOBILITY
Digital solutions reduce air pollutants and the climate impacts of transport. They create affordable, reliable mobility in urban and rural areas. They contribute to a better quality of life and also to a competitive mobility and transport sector in the future.

TRANSFORMATION FIELD

SUSTAINABLE CONSUMPTION
Information on the environmental impacts of products and services is widely available in digital form. Smart assistance systems help make sustainable consumption decisions easier. Clear rules apply for platforms and online services, ensuring consumer autonomy.

UNCONTROLLED DIGITALISATION — MINIMISE RISKS — TAKE ADVANTAGE OF OPPORTUNITIES

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