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Sustainable development as the framework for digital transformation

Recommendation of the German Council for Sustainable Development (RNE) to the German federal government

Sustainability strategy: Digitalisation has the potential to engender disruptive developments in the business world as well as society as a whole that carry both great opportunities and significant risks. The digital transformation therefore also translates to new challenges for societal cohesion, democracy and inclusive culture. At the same time, however, it can play an important and supportive role in achieving the far-reaching goals of the German Sustainable Development Strategy. We therefore recommend that the principle of sustainable development serve as the political framework for digital transformation **(recommendation 1)**.

Innovation and research: There are no precise predictions as to what impact digital transformation will have on natural resources, sustainable business practice or the future of work. Sustainable development research and innovation policy therefore have important roles to play in order to evaluate impact, facilitate change and foster knowledge transfer by creating links to societal reality. We therefore recommend that there be practical research formats that facilitate trialling as well as long-term systematic research into digitalisation in relation to the sustainability goals **(recommendation 2)**.

Exploiting enabler powers: The opportunities to use digitalisation to achieve the sustainability strategy goals, to position them as the enablers of sustainable development and to avoid risks and disadvantages remain largely untapped. We recommend that the federal government systematically change the underlying conditions in order to make far greater use of the enabler powers of digital solutions above and beyond the framework of the digital strategy, in particular regarding the energy transition, resource efficiency and "green technologies" **(recommendation 3)**.

Education to safeguard the future: Digital education is the foundation of sustainable societal development in the area of digitalisation and for safeguarding the labour market. We recommend that the federal government follow a precautionary principle regarding education policy. This should enable people of all ages, from childhood to old age, to comprehensively participate in digital society. It must do its part to close the digital divide **(recommendation 4)**.

Vision of Europe: We recommend that the federal government establish a vision of Europe as a sustainable living and economic area in partnership with other member states **(recommendation 5)**. The federal government should, in particular, use Germany's 2020 Presidency of the Council of the European Union to this end.

The following opinion examines the key recommendations in greater detail.

1. Principles

A fair society is founded on democratic decisions. Digital transformation can play an important and supportive part in advocating democratic processes and as a driver of sustainability. This calls for digitalisation to be systematically focused on promoting emancipatory potential, access to information, decentralised participation, open innovation and engagement of civil society through democratic structures.

Digitalisation is fundamentally changing society and reshaping key areas of life, from communication and information structures to the working world and global value chains. It is increasingly becoming a question not of *whether*, but of *how* digitalisation should happen. It's about the basic values and the goals that the digital society should be based on and how it can stand its ground in the face of global competition from models such as Silicon Valley, Japan's Society 5.0 and an emergent China. Here, Europe has the pressing task – and societal obligation – to champion a *sustainable* digital development and to put in place the political parameters for this. Digital transformation is characterised by a high degree of dynamism and requires society, science, politics and business to come up with new methods and procedures for foresighted action and a forward-thinking focus for their decisions. The German Council for Sustainable Development (RNE) has a fundamentally positive attitude towards digital transformation and emphasises the clear ethical compass which sees digitalisation as a means rather than a purpose in itself.

Three things are currently lacking: a) a broad participatory debate backed up by empirical research on the impacts of the technological developments leading to transformation within society, academia, politics and business; b) a thorough consideration of the sustainability strategy (goals, management rules) during digital transformation; c) a European strategy for a sustainable digital policy.

In the opinion of the Council, the digital policy must be based on the German Sustainable Development Strategy and must promote implementation of the 2030 Agenda "within, with and by" Germany.

The Council is hoping for additional input from the German Advisory Council on Global Change (WBGU) here, including input extending further ahead in time, based on its broad-based work.[1]

The Council is also hoping that the federal government's Data Ethics Commission will make some significant contributions to the above-mentioned debate.

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[1]WBGU (2018): "Digitalization: What we need to talk about", cf.: https://www.wbgu.de/fileadmin/user_upload/wbgu.de/templates/dateien/veroeffentlichungen/weitere/digitalisierung_en.pdf (10 December 2018).

2. Current situation

Initial analyses of digitalisation and sustainability outline the challenges and shortcomings in the areas of politics, education, the economy, the environment and social affairs from a sustainability perspective.[2] The Council has likewise presented initial discussion results.[3] The fundamental shortcoming becomes evident in a comparison with the discussion surrounding the climate. The challenges and opportunities of climate policy impact on the entire population, businesses and politics in a similarly fundamental and cross-cutting way. But whereas there are numerous, extensive, empirically proven studies on and research into the opportunities, solutions, costs and benefits related to the issue of climate – including and above all comparative appraisals of alternatives – thus allowing for public debate, the same can by no means be said for the topic of digitalisation. Rather, opinions, attitudes and everyday experience are required to compete directly with highly specialised expertise here. This neither nurtures nor qualifies public debate. What we digitalise and how has an impact on how our society develops. The course has already been set with the 2030 Agenda and its 17 goals. Digital solutions should support and enable this transformation. They are being applied and implemented more rapidly than ever before. This makes new demands in terms of the pace, foresightedness and comprehensive understanding as the basis of political decision-making. Both the positive and negative effects need to be identified and elucidated, as demonstrated by the following examples:

- It is hard to predict exactly how the massive production of data, its analysis and algorithm-based decision-making will change society as a whole and what implications this will have, though developments such as China's social scoring system expose the risks of re-evaluating individuals without their having a right to privacy and without fundamental civil rights being observed. This gives real shape to the danger of digital totalitarianism, making the need for a digitalisation strategy based on sustainability goals and humanist values urgent.[4] Ethical frameworks for the use of artificial intelligence systems[5] have an important part to play here, as does the definition of guidelines for the application of algorithm-based decision-making methods.[6]

- There is still no overarching data governance that takes into account the actual price of data usage (e.g. environmental costs of operating server farms, exchange value of data in "free"

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[2] Lange, Steffen, Santarius, Tilman (2018): "Smarte grüne Welt? Digitalisierung zwischen Überwachung, Konsum und Nachhaltigkeit", Munich, Oekom; and Sühlmann-Faul, Felix, Rammler, Stephan (2018): "Der blinde Fleck der Digitalisierung. Wie sich Nachhaltigkeit und digitale Transformation in Einklang bringen lassen", Munich: Oekom.

[3] IFOK GmbH (2016): "Industrie 4.0 und Nachhaltigkeit: Chancen und Risiken für die Nachhaltige Entwicklung", cf.: https://www.nachhaltigkeitsrat.de/wp-content/uploads/migration/documents/20161230_IFOK_Bericht_Industrie_4-0_und_Nachhaltige_Entwicklung.pdf (10 December 2018).

[4] The Weizenbaum Institute for the Connected Society is an important instrument here for advancing research in this area and to expand the knowledge base for the scientific community, the public and policymakers.

[5] OpenAI, cf.: https://openai.com/about/ (10 December 2018) and Nida-Rümelin, Julian, Weidenfeld, Nathalie (2018): "Digitaler Humanismus. Eine Ethik für das Zeitalter der Künstlichen Intelligenz", Munich: Piper.

[6] SVRV (2018): "Verbrauchergerechtes Scoring", Berlin, cf.: http://www.svr-verbraucherfragen.de/wp-content/uploads/SVRV_Verbrauchergerechtes_Scoring.pdf and SVRV (2017): "Digital Sovereignty", Berlin, cf.: http://www.svr-verbraucherfragen.de/dokumente/digitale-souveraenitaet/ (10 December 2018).

online services), that regulates access rights (open data, application programming interfaces [API] for developers) and that explicates the concept of data as a public asset in the sense of social sustainability.[7]

- The 2030 Agenda's concept of leaving no one behind in the transformational development toward a sustainable future is neglected in the modern digital age. There is a lack of adequate digital training and professional development for the digitally illiterate and the digital chasm is expanding. Women, the elderly and the educationally disadvantaged social strata are particularly affected by this, making the digital chasm a social one too.[8] Gender and diversity aspects are therefore incredibly important when it comes to sustainable digitalisation. The digitalisation of administration (e-government), which has been planned for years and which is slowly being realised, will further exacerbate this conflict as digital skills will then be needed by everyone if they wish to exercise their fundamental civil rights and duties.

- Above all, the monopolistic structures of the major platform companies which have evolved over the past two decades in the digital economy in particular pose new challenges in terms of the economic and social sustainability of traditional business models and raise questions concerning corporate taxation. It makes sense for these platforms to be taxed, although there are structural questions concerning the basis of tax collection and place of taxation. The aim must be to achieve a fair taxation policy ideally at the global and at least at the OECD level. If this is not possible in the near future, an arrangement at the European level should be sought. A taxation policy of this kind should give the platform economy a regulatory framework and enable global competition in all its diversity.

- From an environmental perspective, the question is how digitalisation contributes to climate protection and to the sustainable use of natural resources. As well as the reverse: how can policy and the business sector counter the risks that go along with greater energy and resource consumption. How can digitalisation support for example the mobility transition? The lack of correlation between these questions is demonstrated by, for example, autonomous driving concepts being presented as urban mobility solutions on the basis that traffic density will be increased efficiently, however without taking into account the fact that only by being aligned with sustainability goals can they constitute a sustainable future scenario in which air quality is improved and the volume of traffic is reduced. Simply replacing traditional vehicles with autonomous ones will not improve the situation and is actually at odds with sustainable urban development. There is currently a lack of data-based scenarios for the future that consider mobility concepts holistically and on the basis of sustainability criteria and that involve the various societal groups with all their differences in the decision-making processes.

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[7] Handelsblatt (2018): "Wir müssen Daten, den Rohstoff für Innovation, breiter streuen", cf.: https://www.handelsblatt.com/politik/international/oxford-professor-viktor-mayer-schoenberger-wir-muessen-daten-den-rohstoff-fuer-innovation-breiter-streuen/23170246.html?ticket=ST-24142-CVwbp3rKD5E5zxEVucIb-ap6 (10 December 2018).
[8] Initiative D21 (2018): "Digital Index 2017/2018: Jährliches Lagebild zur Digitalen Gesellschaft", cf.: https://initiatived21.de/app/uploads/2018/01/d21-digital-index_2017_2018.pdf (10 December 2018).

- The increasing production of new technologies results in global consequences. The way in which digital technologies are produced currently divides the world into raw materials countries and production countries. Africa is rich in mineral resources, in particular metals and rare earth elements. These are indispensable as the material basis of digitalisation, but the African continent barely benefits from their value added.[9] At the same time, the digitalisation of everyday life in Africa has the greatest potential to serve as a springboard into the future, as illustrated by Information and Communications Technologies for Development (ICT4D)[10] projects and the project iNethi.[11] Mobile telecommunications technologies such as Kenya's M-Pesa, a mobile payment system launched in 2007, are used here as a vehicle with which to balance out a lack of broadband infrastructure or PC hardware ownership, guaranteeing people in rural regions access to information and to secure payment methods too. The exploitation of the raw materials countries and their sustainable development opportunities through digitalisation are at odds with one another yet are happening concurrently. An economy which supplies raw materials without enjoying high-quality value added at the same time is inherently not viable. In the global context, this contradiction is a source of corruption, human rights violations, war and flight.

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[9] GIZ (2017): "Regional Resource Governance West Africa: Using mineral resources for peace and development", Eschborn, cf.: https://www.giz.de/en/downloads/giz2017-en-resources-management-westafrica.pdf (10 December 2018).
[10] Cf.: www.ict4d.cs.uct.ac.za (10 December 2018).
[11] "iNethi" stands for "network" and comes from isiXhosa, one of the 11 official languages of the Republic of South Africa. For more information on the project, see: www.inethi.org.za (10 December 2018).

3. Key points for sustainable digitalization

3.1. Positioning Europe as a sustainable living and economic area

Germany and Europe must bring digitalisation and sustainability together if the promise of prosperity made to the people combined with the preservation of natural resources is to be kept. Right now, there is a window of opportunity to position Europe as a sustainable living and economic area which is characterised by a competitive and innovative business sector, intact ecology, assumes social responsibility and safeguards the diversity of cultural identities and their development.

In its recommendation regarding updating the German Sustainable Development Strategy,[12] the Council recommends championing an EU sustainability strategy at the European level and stimulating this together with other EU member states. EU-wide cooperation is also indispensable when it comes to shaping digital transformation in Europe and this urgently needs to be intensified because no member state can afford to strike out alone in the digital sphere. At the same time, Europe should define a common framework for action and values which differs to the transnational developments in, for example, the USA and China. The German federal government should use Germany's 2020 Presidency of the Council of the European Union to forge a link between Europe's digital agenda and the 2030 Agenda for Sustainable Development and to foster achievement of the Sustainable Development Goals (SDGs) in the remaining ten years. For the presidency trio, Germany should develop an 18-month programme together with Portugal and Slovenia that redefines the framework for digitalisation and triggers the concurrent mainstreaming of digital and sustainability policy within EU strategies and initiatives.

The establishment in 2018 of the EU-wide protection of personal data while maintaining the free movement of data within the European Single Market (thanks to the GDPR[13]) is an important step in the direction of such a European framework. This needs to be further expanded – the ideas put forward by Germany, France, Italy and Spain at the Tallinn Digital Summit in September 2017 highlight the important areas of action, but these need to be complemented by a focus on sustainable development. Between now and 2030, Europe should position itself with a Digital Single Market based on the SDGs. Europe should work on other alternatives to the platform economy with its dominant monopolies. In this regard, networked Industry 4.0 production has a key role to play in terms of future competitive ability as well as for safeguarding jobs and prosperity. The aim here will be to link digitalisation with full employment. As such, the social consequences of potential job cuts are to be cushioned against as well as implementing

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[12] RNE (2018): "Gegen den Stillstand im Gesamtsystem: Stellungnahme des Nachhaltigkeitsrates zum Konsultationspapier der Bundesregierung 'Aktualisierung der Deutschen Nachhaltigkeitsstrategie 2018'", Berlin, cf.: https://www.nachhaltigkeitsrat.de/wp-content/uploads/2018/06/20180622_RNE_Stellungnhame_Konsultation.pdf (10 December 2018).

[13] GDPR stands for the General Data Protection Regulation, which came into force on 27 May 2018 on the basis of Regulation (EU) 2016/679, cf.: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02016R0679-20160504 (10 December 2018).

sustainable data governance. Strengthening the circular economy[14] is another important approach here, to harness socio-ecological potential in particular. For this to happen, however, the data pool and data quality must be improved to make it possible to estimate the real environmental, economic and social costs on the basis of evidence.[15] There is also a great deal of potential in the area of the agrarian economy and food production, both of which can be made more sustainable by digitalisation, among other things with the sensor-based efficient use of fertilisers and pesticides, with precise weather forecasts and with optimised supply chains.[16]

3.2. Policy of digitalisation for sustainable development

Digitalisation is working its way into societal and economic processes at a rapid pace and is fundamentally changing them. Political decision-making processes are structurally reactive and now appear in part too slow when compared with the dynamism of the developments. This circumstance presents some fundamental challenges for the parliamentary political system. The paces of technological developments and political decision-making are drifting further and further apart, resulting in challenges for democracy.

The peer review of the German Sustainable Development Strategy calls for more systemic thinking, for example regarding the implications of digitalisation for social cohesion and for decent jobs. There is a lack of analysis of the impact of digitalisation on the goals of the Sustainable Development Strategy and of the usefulness of digital strategies for the sustainability goals. This raises some fundamental questions: what options do the policymakers have to promote the German Sustainable Development Strategy by means of digital solutions and to minimise the dangers that jeopardise the goals? The digital policy must create a link to the German Sustainable Development Strategy. When updating and developing the German Sustainable Development Strategy further, greater consideration needs to be given to the effects of the digitalisation trend on sustainable development.

3.3. The environment, the energy transition, resource efficiency and "green technologies"

Digitalisation effects can potentially boost the efficient use of energy. They can also contribute to the specific conservation of materials and resources or can present new ways in which to uncouple the production and sale of goods from the utilisation of raw materials and energy. A smart and forward-thinking interconnecting of industrial production (cf. Industry 4.0), for example the linking of digital production data with material flows and user data while taking into account the

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[14] Hofmann, Florian, Zwiers, Jakob, Jaeger-Erben, Melanie, Marwede, Max (2018): "Circular Economy als Gegenstand einer sozialökologischen Transformation?". In Rogall, Holger et al. (2018): Jahrbuch Nachhaltige Ökonomie, 217–229, Marburg, Metropolis, cf.: https://challengeobsolescence.info/wp-content/uploads/2018/10/Hofmann-et-al_2017_Circular-Society_Druckfahne.pdf (10 December 2018).
[15] Climate-KIC (2018): "How can digitalisation unlock the circular economy's potential?", cf.: https://www.climate-kic.org/in-detail/digitalisation-circular-economy/ (10 December 2018).
[16] Cf. the Internet of Things and radio frequency identification (RFID) technologies.

necessary data protection, offers great potential for the environmental and social impacts of products to be evaluated and for innovation processes throughout the value chain to be managed. Production which is closely dovetailed with information and communication technologies can boost resource efficiency.

The public sector can likewise benefit from digitalisation. For example, the systematic digitalisation of administrative processes offers huge savings and efficiency increase potential if combined with a consolidation of e-government.[17] The federal government, the federal states and municipal authorities should serve as role models here, putting in place political parameters that promote resource efficiency on the basis of digitalisation.

At the same time, absolute energy and resource consumption continues to rise with the increasing spread of information and communication technologies. Even if smart city concepts, smart grids and smart metering can improve resource efficiency, digitalisation is still at risk of having a negative impact on the environmental footprint. What are the opportunities and risks of digitalisation regarding the necessary reduction of our energy, land and resource consumption? The benefit of digital solutions must be weighed up against undesirable environmental and social effects and rebound effects must be avoided. Digital services have a material basis that must be taken into account in terms of sustainability aspects. The vast volumes of electrical waste caused, among other things, by consumer goods being fast-moving and by new digital devices being purchased frequently are another problem. Sufficiency is a key concept here in order to achieve an absolute reduction in resource consumption, assuming the general necessity of a product or service above and beyond the need for greater efficiency can be addressed and reduction potential can be harnessed.

Digitalisation has particular innovation potential in the area of the so-called green technologies for environmental technology and resource efficiency. The green tech industry contributes to the environmental sustainability goals. Experts estimate that the industry can generate enormous additional market volume with digital solutions – market volume that has substantial potential for achieving reductions in harmful emissions. It can be assumed that this applies to an even greater extent to the sustainable business practices of those companies across all sectors that align their business fields and practices with sustainable development goals. This potential being tapped is dependent on the one hand on an improvement in the digital situation of the companies themselves and on the other on the targeted promotion of technology and the simplification of market access for start-ups or assistance with financing innovations. The question of sufficiency – is the digital solution truly the expedient solution in terms of lower energy and resource consumption? – is to be kept in mind as well.

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[17] Fromm, Jens, Welzel, Christian, Nentwig, Lutz, Weber, Mike (2015): "E-Government in Deutschland: Vom Abstieg zum Aufstieg", Berlin: Kompetenzzentrum Öffentliche IT, cf.: https://www.oeffentliche-it.de/documents/10181/14412/E-Government+in+Deutschland (10 December 2018).

3.4. Sustainable business practice

The Council believes that digital technologies (also) have the potential to facilitate the transition to sustainable business practice. This applies not only to the private sector, but also to municipal and local utilities and to the market impact of public procurement – on the way to achieving a carbon-neutral public sector. Digitally aided disclosure can also help to record external effects[18] and report on them transparently.

Digitalisation of the economy must offer a benefit to society and must help reduce the environmental burden. Negative effects for the labour market and society must be absorbed. Greater use should be made of the Sustainability Code to this end.

Companies must improve their digital readiness in order to make Germany as a provider of systemic solutions a stronger partner for digital systemic sustainability solutions too. This applies equally to associations and other organisations. Economic policy measures should foster and create space for innovation in which these sustainability goal solutions can be developed and put to the test. Innovation laboratories as proposed within the Sustainable Economy programme of the German Federal Ministry of Education and Research (BMBF) should be picked up on, as should the experience and findings of the "nachhaltig.digital" platform for sustainability and digitalisation competence among SMEs established by the German Environmental Management Association (B.A.U.M. e. V.) and the German Federal Environmental Foundation (DBU). Social impact investment contributions should also come into play.

Germany should lead the way within Europe. It should be determined at the European level whether and how the opening up of access to the (anonymised) data of the major digital platforms can be realised, enabling third parties to access this data, use it and, if applicable, create their own business models on the basis of it. It should be a matter of course for a user to have the option of accessing their own data, as well as modifying it, erasing it and using it themselves. The aim must be to establish a framework at the European level that promotes growth of the digital economy while safeguarding alignment with the common good, participation and sustainability.

Expansion of the digital infrastructure is the first step, after which the state and businesses must digitally connect other sectors. Structural policy must give shape both to decarbonisation and digitalisation. The state should present itself as an active investor in sustainable infrastructure here.

3.5. The labour market and social welfare

Changes in business models and in the labour market also lead to questions concerning the future labour market situation and the financing of social welfare. There are some contradictory study results in this area, as predicting labour market developments is difficult due to the market's high dynamism. Nonetheless, there are already signs that certain occupational groups and job profiles

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[18] External effects are monetary impacts on environmental and social affairs and on long-term economic strength which are not covered by company accounting and for which the general public is liable or which are not covered at all.

will increasingly disappear. Many citizens therefore have very serious concerns about the security of their jobs.

There needs to be a differentiated consideration of the effects of digitalisation on the labour market. The social sustainability of digitalisation will be dependent on whether an increasingly digitalised working world generates more jobs overall. A forward-looking labour market policy has to recognise the direct and indirect impacts of digitalisation on the economy and on education. A broad initiative to boost digital skills in training and professional development so as to ensure that people are qualified for an ever-changing labour market is long overdue. Moreover, a joint federal–state initiative is needed to safeguard future viability with regard to this central education topic. A reorganisation of the social welfare systems is necessary as well in order to more closely incorporate and protect people who execute assignments and projects for companies without being salaried employees, such as self-employed individuals, clickworkers and crowdworkers, and labour nomads. There is the urgent need for a broad societal debate about the parameters for an opportunity-oriented future of work, with a common target founded on equal opportunities, the possibility of participating and development potential, in particular with regard to Europe. The debate should also consider how the potential of non-profit and social work, family work and nursing could be incorporated into the definition of work. Profit participation models and stakeholder participation in platform and digital cooperatives also constitute part of the new working world, representing socially sustainable safeguarding and development, and these need to be discussed.

3.6. Digital education

Education opportunities that teach digital skills are still not sufficiently widespread in Germany – from childhood right through to old age, services of this kind are barely available to an appropriate degree and in the appropriate quality. According to the OECD, two thirds of the population in developed countries lack the digital skills needed for learning and working in a digital society. The digital chasm is growing ever deeper. Approximately 12 million people in Germany classify themselves as "digitally marginalised" – and this number continues to increase. On the one hand, it is a question of acquiring digital skills as the basis for participation in an increasingly connected world and for a self-determined life, good work and access to knowledge formats. On the other hand, it is about the skills of an education for sustainable development (ESD) for the transformation into a sustainable society – to make critical analysis possible, enable people to make decisions and to teach them how to deal with the downsides of digitalisation such as fake news and hate speech. Women in particular are affected by the increasing inequality, thus further widening the gender gap online.

The federal government should work with Germany's state governments to initiate education and qualification drives in order to establish the parameters for fair participation in digital progress in Germany. Digital education opportunities starting in childhood and based on open standards need to be developed and implemented. Informal and formal places of education address people of all

generations and they must therefore be supported and be given the ability to create appropriate opportunities for the acquisition of digital skills. There also needs to be a strategy of lifelong learning that affords people access to the networked society all the way through to old age. There should be a review of digital education programmes to determine whether education for sustainable development can be incorporated into them.

3.7. Digital consumption

How can citizens, businesses and authorities be assisted in identifying and minimising the environmental impact of digital services and products? There is still a lack of understanding of the positive and negative ethical, social and environment-related impacts of digital consumption, even though these are becoming more and more prominent within the sustainability policy agenda. The potential and costs need to be empirically researched and the consequences weighed up. More sustainable digital consumption can be promoted by raising people's awareness of their high energy and resource consumption. In contrast to other areas of consumption, the volumes of energy and resources used because of digital consumption are less visible and less comprehensible. Digital service providers therefore bear a particular responsibility here to, for example, introduce default settings and energy efficiency measures. So far, the digital economy appears to be dissociated from this discourse, which in other technical areas and industries has been going on for decades. The National Programme on Sustainable Consumption of Germany's Federal Ministry for the Environment (BMU) should be further developed with regard to the transformations caused by digitalisation to reflect changing consumption behaviour and to leverage the sustainability potential of online services, digital processes and changing value chains.

3.8. Health

Digitalisation engenders major transformations in the health care sector, including in the areas of telemedicine, the management of electronic health data and artificial intelligence (AI)-based research, such as automated image recognition for tumour diagnosis. There is often friction between these developments and data protection, in particular the protection of patient data. Insurance companies are therefore developing new business models based on their customers' own health data measurement, allowing them to offer customers modified tariffs – sometimes to the benefit of the (healthy) consumer and sometimes to the detriment of the principle of solidarity. In extreme cases, people who are ill, who smoke or who do not engage in physical activity can find themselves facing fundamental disadvantages in a system of this kind, with these expressing themselves not only financially, but also socially. At the same time, digital services pose other risks as well, such as the electromagnetic fields generated by mobile telecommunications. The effects of digitalisation on health therefore need to be examined on the

basis of research, and the risks must be minimised using the precautionary principle. It is also a question of analysing the economic, environmental and social impacts of digitalisation on the health care sector to be in a position to boost the potential, for example with more efficient management of patient data, more transparent processes and improved health care in rural regions.

3.9. Mobility

Digital technologies offer potential in the area of developing a mobility system that go far beyond merely substituting traditional vehicles with electrically powered automated vehicles. Digital solutions should be used to change the modal split in such a way that the transport sector develops in the direction of the goals of the sustainability strategy. The role played by digital rail logistics is central both for passenger services and freight traffic, and examples of sustainable smart city concepts are important too.

4. Fresh thinking

The German federal government should establish a framework for innovation programmes within, for example, the Federal Ministry for Economic Affairs and Energy (BMWi) and the Federal Ministry of Education and Research (BMBF) that allows digital solutions and technical developments to promote the transformation processes needed in order to achieve the sustainability goals. These should be incorporated into the framework programmes as the aims.

In the context of the sustainability strategy, societal problems and needs are driving forces that are on a par with research and science, technological development or social innovations. The future tasks as outlined by the High-Tech Forum – from working worlds to mobility and security – illustrate the range of challenges for which the use of digital technologies is crucial.[19] Digital innovations can serve as the solutions to social and environmental challenges, but this calls for innovation policy to be oriented toward and focused on the goals of the 2030 Agenda.

4.1. Building bridges between disconnected debates

The impacts and the real potential of digitalisation in relation to the goals of the sustainability strategy should be specifically researched in all the application areas and the findings should be fed into practical implementation quickly. However, the dynamics of the digital agenda call for more and specific co-design and co-evolution processes and also for time management which significantly supplements, if not entirely replaces, the usual research promotion steps. The federal government should also adopt sustainability as a cross-cutting topic of the new agency for the promotion of breakthrough innovations.

German industry is important globally, boasting a strong SME segment, excellent research achievements and a qualified societal debate regarding sustainability and the future. This is supported by innovation policy measures. The German Sustainable Development Strategy notes that spending for research and development as a proportion of the gross domestic product has increased by 0.5% since 2000. However, it remains to be seen whether this induces innovations that actually promote sustainable development.[20]

Digital enterprises are already reducing their time frame for internal planning and management down to fewer than 12 months. By doing so, they aim to ensure that they avoid technology lock-ins and can keep pace with technological development, which they believe is not longer foreseeable. This must have methodological impacts on the promotion of research.

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[19] High-Tech Forum (2017): "Gemeinsam besser: Nachhaltige Wertschöpfung, Wohlstand und Lebensqualität im digitalen Zeitalter – Innovationspolitische Leitlinien des Hightech-Forums", Berlin, cf. http://www.hightech-forum.de/fileadmin/PDF/hightech-forum_leitlinien.pdf (10 December 2018).

[20] Walz, Rainer (2016): "Indikatorik von Innovationen im Kontext der deutschen Nachhaltigkeitsstrategie – Reflexion bisheriger Erfahrungen und Überlegungen zur Weiterentwicklung", Karlsruhe: Fraunhofer-Institut ISI, cf.: https://www.nachhaltigkeitsrat.de/wp-content/uploads/migration/documents/20160313_Fraunhofer_ISI_RNE_Studie_Indikatorik_von_Innovationen.pdf (10 December 2018).

For research activities and innovation processes to contribute to the sustainability strategy goals, their focus needs to already be set in the funding programmes. In autumn 2018, the BMWi requested proposals for a programme entitled "Digitalisierung als Enabler für Ressourceneffizienz in Unternehmen" (digitalisation as an enabler of resource efficiency in companies).[21] This strikes at the heart of the problem accurately, albeit in an unconnected way, in line with our argumentation. It would seem prudent to complement conventional programme tendering with new forms of an agile search for digitalisation and sustainability solutions within the meaning of the sustainability strategy which also incorporate digital skills from the business world and civil society. Environmentally oriented innovations are needed in order to implement the sustainability strategy, in particular to achieve the goals in the areas of climate protection, resource conservation, organic farming and sustainable consumption. A significant example is the circular economy, the innovation potential of which is closely related to digital solutions and in which new resource management concepts can be put to the test.

The interlinking of research and innovation programmes with the sustainability goals should also be reflected in events such as the annual research summit held by the Stifterverband association for the promotion of humanities and sciences in Germany, the Commission of Experts for Research and Innovation (EFI) and the Leopoldina German National Academy of Sciences. Sustainability should be addressed there as its own yet interconnected area of action.

4.2. Promoting practice-based formats and transfer

The transfer of practices and access to resources should be more deeply enshrined as principles in sustainability research programmes such as the BMBF's Research for Sustainable Development (FONA). A research agenda which places digital transformation within the context of sustainability needs to focus on the practices of companies, organisations and citizens – including "fast forward" practices which are not yet established in the mass market. This calls for concepts that guarantee the transfer of knowledge and research findings into societal, business and political practice, and that also consider the implications, because without transfer there can be no transformation.

The correlations between digitalisation and sustainability should therefore be researched in formats which are as realistic as possible. This approach has already proved its worth in real-world laboratories, "living labs" and innovation spaces, which need to be made a strategic component of the portfolio of instruments used in sustainability research. The measures promoted by the BMBF's "City of the Future" innovation platform to establish real-world laboratories in cities should be expanded to include, for example, "Regionalwert" strategies for enhancing regional economies and the data sovereignty of local authorities .[22] This should be taken into account when evaluating FONA

[21] Cf. https://www.evergabe-online.de/tenderdetails.html;jsessionid=3FFDE5330296314183E43AE9A41D3337.app202?0&id=210811 (10 December 2018).

[22] Cf. Barcelona Digital City, https://ajuntament.barcelona.cat/digital/en (10 December 2018), Heidelberg Digital City, cf. https://ajuntament.barcelona.cat/digital/en (10 December 2018) and Datenschule, Open Knowledge Foundation, cf. https://okfn.de/projekte/datenschule/ (10 December 2018).

and should be implemented for the next round. New avenues should also be tested to make findings and products available as open-access, open-source and open data, to ensure that the findings are subsequently used and further developed.

The formats should involve stakeholders with real-world experience and allow for direct and quick feedback into practice. The prerequisite for this is structures that facilitate trialling, thereby allowing the digital world of the future to be approached iteratively.