

# The Digital Revolution and Sustainable Development: Opportunities and Challenges

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Key Messages of the  
*2nd Report by The World in 2050 Initiative*

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# The Digital Revolution and Sustainable Development: Opportunities and Challenges

- **A new era in human history is emerging! After Neolithic and Industrial, the Digital Revolution is the next era!** Sustainability transformations need to be developed, implemented, and rethought in this newly configured context of the Digital Age, which we might call the Digital Anthropocene. What are the key elements for describing the opportunities, turbulences, and challenges ahead and how can humanity render the Digital Anthropocene a sustainable era for all?
- **Digital technologies can enable a disruptive revolution toward a Sustainable Anthropocene!** We propose six essential mechanisms that can link digital dynamics with sustainability strategies to enable the Six Transformations (TWI2050 2018): (i) *shifting innovation vision and patterns* by creating sustainable digitalization perspectives in the science, research, and R&D communities; (ii) *mobilizing market forces* by getting the prices right, for example, through carbon pricing and ecological tax reforms that incentivize the mobilization of digital innovations in support of sustainable solutions; (iii) helping to *shift markets* and planning processes in a sustainable direction by using digitalization to visualize and establish transformation roadmaps that include sharper definitions of clear goals and milestones for energy, mobility, land use systems, cities, and industrial sectors; (iv) *investing in digital modernization programs at the state level* to massively increase digital knowledge in public institutions in order to build governance capacities in the Digital Anthropocene; (v) *transforming sustainability research* by supporting and scaling up strong networks with the digital research communities; and (vi) *creating dialogue structures* with the private sector, civil society, science, and the state to develop joint perspectives on institutional, social, and normative guardrails in the Digital Anthropocene.
- **Governance is urgently needed! The disruptive dynamics of digitalization are challenging the absorptive capacities of our societies and threaten to erode social cohesion.** If not shaped appropriately and geared to the 17 SDGs of the 2030 Agenda and the associated Six Transformations, digitalization could magnify already existing problems in many societies. We see four major challenges or “slippery slopes”: (i) *inequalities* (e.g., in the labor market, in education systems, and in the division of labor at the international level) and dissipative forces within society could further increase; (ii) *economic, and by extension political, power* could become even more concentrated (consider, for example, the significance of the “big five” – Amazon, Apple, Facebook, Google, Microsoft for digital transformation); (iii) *data sovereignty and civic rights* could be restricted further and the monitoring of citizens and consumers (“social scoring”) stepped up, especially in authoritarian societies and irresponsible companies; and (iv) *governance capacities* of public organizations could erode further, since, for example, it is already very difficult to regulate big digital business and essentially impossible in virtual environments, particularly because digital knowledge is still very limited in most governments and public institutions.
- **The Digital Revolution opens the door to a quantum leap for human civilization!** Autonomous technical and decision-making systems, based on learning machines and general-purpose artificial intelligence, will fundamentally transform all areas of society and the economy in the near future. Linking human and artificial intelligence and creating ‘meaningful artificial intelligence’ geared to the goals of sustainable human development is set to become a major task for humanity in the first half of the 21st century. The next decades will be characterized by numerous digitally driven, deep structural changes and related uncertainties. Sustainability pathways need to be developed, shaped, and governed within the context of these deep societal transitions and high degrees of uncertainty.
- **We need to resolve the paradox of the Digital Anthropocene.** Digitalization is creating the essential preconditions for TWI2050 Six Transformations toward sustainability, yet it is also endangering them! How can we exploit the potential of digitalization and the associated wealth of new knowledge in order to tackle the major challenges facing humanity in the 21st century, while avoiding the daunting risks of accelerated technological changes running out of control? These questions make clear that

fundamental transformations in our systems of education and global knowledge transfer are urgently needed.

- **Human enhancement and augmentation present an uncertain future for our species!** *Homo sapiens* is being transformed into *Homo digitalis*. Digitalization offers incredible possibilities for freeing humanity from physical toil and for augmenting and enhancing cognitive and physical capabilities. The future is open, but the direction of change is unknown. Steering change and possibilities toward the Sustainable Anthropocene for all must, therefore, become the highest priority.
- **We need to understand and overcome the “retarding moments” of innovation breakthrough!** Historically, large-scale, fundamental, and disruptive technological innovations often resulted in societal and economic turbulence, or even crises, backlashes, or conflicts, before societies learned to mobilize their welfare potential. How can we learn to overcome the historical law of ‘retarding moments of radical and disruptive technological innovations without experiencing deep crises in the first place?
- **We need to build responsible knowledge societies capable of moving toward sustainability in the Digital Age!** We will be able to exploit the opportunities of digitalization, virtual realities, and artificial intelligence, and to curb their potential risks and link the digital and the sustainability transformations, only if the digital and sustainability research communities converge.
- **The clock is ticking toward 2030 – we have only 10 years to meet our Sustainable Development Goals!** There are only 10 years to go to mobilize and leverage the digital opportunities to build sustainable societies. Trend reversal is urgent as the world is at a crossroads. We have only 10 years to learn how to manage and positively use the societal impacts of digitalization and artificial intelligence, to merge virtual and physical spaces and realities, and to avoid further erosion of social cohesion. If we do not manage to get the two fundamentals right – that is, digitalized green economies, and stable, equitable, open digitalized societies – the world will run into a serious impasse instead of developing further sustainability transformations. And if that happens, the window of transformation toward a Sustainable Anthropocene would be closed. Time is a very precious and scarce resource that must be used wisely.

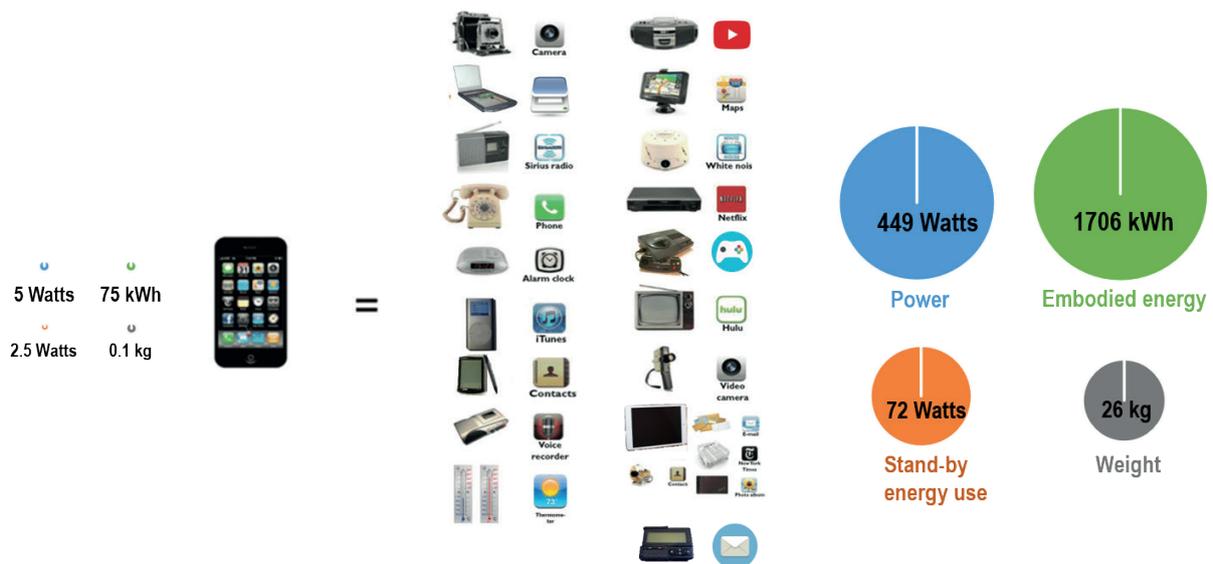
## THE DIGITAL REVOLUTION

Perhaps the greatest single enabler of sustainable development in the coming years would be the digital revolution, constituted by ongoing advances in AI, connectivity, digitization of information, additive manufacturing (3D printing), virtual reality, Internet of things (IoT), machine learning, block chain, robotics, quantum computing and synthetic biology. The digital revolution rivals the steam engine, internal combustion engine, and electrification for the pervasive effects on all parts of the economy and society. It has been made possible by an interconnected set of discoveries and inventions, including semiconductors, logic gates, computer architecture, integrated circuits, microprocessors, packet switching, the Internet, mobile broadband, public-key cryptography, and global positioning system (GPS), among others.

The pace of advance continues exponentially with imminent breakthrough prospects for AI, quantum computing, virtual reality, 5G broadband, and other technologies. As in the industrial revolution

that initiated explosive development through the convergence of steel, steam and railways, coal and textile and other new manufacturing process, it was the convergence of these technologies, institutions, settlement patterns and lifestyles that generated the deep transformations. Likewise, the convergence of new digital technologies could be even more explosive with great winners and losers.

An enormous success among many development failures is that mobile phones reach four-fifths (World Bank, 2016) of the world’s 7.6 billion people (UNDESA, 2017). This was fundamental in improving the lives of many including those previously excluded. Ironically, one billion phone owners do not have access to electricity! The mobile phone revolution may lead to ‘leap-frogging’ of the developing world ahead of the most industrialized countries with the diffusion of new services such as mobile money and more effective financial services for establishing businesses.



The rapid progress of information and telecommunication technologies could be an indication of the path-breaking potential of next-generation digital technologies and their clustering in new activities and associated behaviors. A smartphone needs between 2.2 Watts in standby to some 5 Watts in use, while the numerous devices portrayed in the figure that it replaces need up to a hundred times more power. There is about a factor 25 reduction of embedded energy required to produce the devices and a proportional reduction in emissions. Bundling of services from various devices in the smartphone can be regarded as an example of the power of the Digital Revolution and its huge potential to increase resource efficiencies through new technologies and behaviors.

## Social Implications

Technological change plays a key role in long term social transformations. The changes currently underway – such as the digital or sharing economy – are significant. With the advent of ‘knowledge societies’, many current technological transitions favor non-material benefits that support human wellbeing.

The digital revolution is already reshaping work, leisure, behavior, education, and governance. Digital technologies are disrupting production processes in nearly every sector of the economy, from agriculture (precision agriculture), transport (self-driving cars), mining (autonomous vehicles), manufacturing (robotics, 3D printing), retail (e-commerce), finance (e-payments, AI trading strategies), media (social networks), health (AI diagnostics, telemedicine), education (online learning), public administration (e-governance, e-voting) and the IoT.

In general, these contributions of digital technology can raise labor, energy, resource, and carbon productivity, lower production costs, expand access, dematerialize production (from physical books to e-books, for example), improve matching in markets (such as on electronic market places),

enable the use of big data (disease epidemiology and drug design), and make public services more readily available (online voter registration, licenses and permits).

## Challenges and trade-offs

Yet there are also clear dangers and downsides to the digital revolution, including the loss of jobs, rising inequality, and the further shift of income from labor to capital. Processes of automation have been underway for decades, and one important consequence, it appears, is the net reduction of demand for lower-skilled workers. With advances in AI and robotics, many more workers, even those highly skilled, may find their jobs and earnings under threat. While new jobs might replace old ones, the new jobs may come with lower real earnings and working conditions. The fears about rising inequalities have given rise to a new interest in a guaranteed minimum income.

There are several other perceived threats from the digital revolution. Digital identities can be stolen, or artificial identities can be created. Digital information can be stolen especially with the

diffusion of 3D printing where complete information about manufacturing is stored digitally. At the same time, this information can be used to circumvent export and import barriers by simply manufacturing locally with 3D printing.

Governments and private businesses can invade privacy and monitor individuals against their will or without their knowledge and in extreme cases destroy real identities. A few digital portals may use their advantages in amassing big data to gain a dominant monopoly position in their respective markets (e-commerce, digital advertising, social media, cloud services, *etc.*). Cyberattacks can interrupt or degrade private and public service delivery. Cyberwarfare can paralyze a society by disrupting the flows of information, or destroy machinery connected to the Internet. Social media can be manipulated, undermining democratic processes.

The personal use of online technologies can be addictive and cause the onset of depressive disorders. AI codes can incorporate statistical discrimination that may be hard to identify. Instructions for 3d printing in the additive manufacturing can be stolen and applied elsewhere to produce identical parts and products. Special danger relates to advanced weapons. The most fundamental question is whether the digital revolution as a self-evolving evolutionary process that has generated huge global monopolies is even amenable to 'social steering'.

The digital revolution will have even deeper impacts on our societies, creating a next generation of sustainability challenges. General purpose AI will be used in more and more decision making processes embedded in devices (like self-driving cars), in our economies (in banks, trading firms, stock markets) and in our societies (in courts, in parliaments, in health care organizations, in security organizations

such as police and army), complementing, substituting, challenging human driven decision making processes. We need to learn to manage and control the next generations of AI, machine learning, and semi) autonomous technical systems and to align those with our normative settings. Moreover, the digital transformation will redefine our concept of us as humans.

## The way forward

In the Anthropocene humans became the main drivers of Earth system changes. In the digital Anthropocene humans also start to transform themselves, enhancing cognitive and brain capacities, thinking about how to program brains, how to enhance human capacities. Humanity is moving toward new civilizational thresholds. Super-intelligent machines might even develop a life of their own, with the capacity to harm human agents. The digital transformation calls for a comprehensive set of regulatory standards and normative frameworks, physical infrastructure, and digital systems, to capture the benefits of the digital revolution while avoiding the many potential downsides. An essential priority should be to develop science, technology and innovation roadmaps to better understand the potential benefits and dangers of digitalization. The principles of digital transformation for sustainable development have yet to be written.

Research is needed to further the understanding of technology systems; studying the patterns, drivers, constraints, and impacts of technological change is needed to identify viable options and policies that will accelerate the transformation of society toward a sustainable future. While technological change will always occur, high uncertainties remain about which technologies succeed.

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