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INFORMATICS EUROPE

Aligning the Digital Transformation with the UN Sustainable Development Goals

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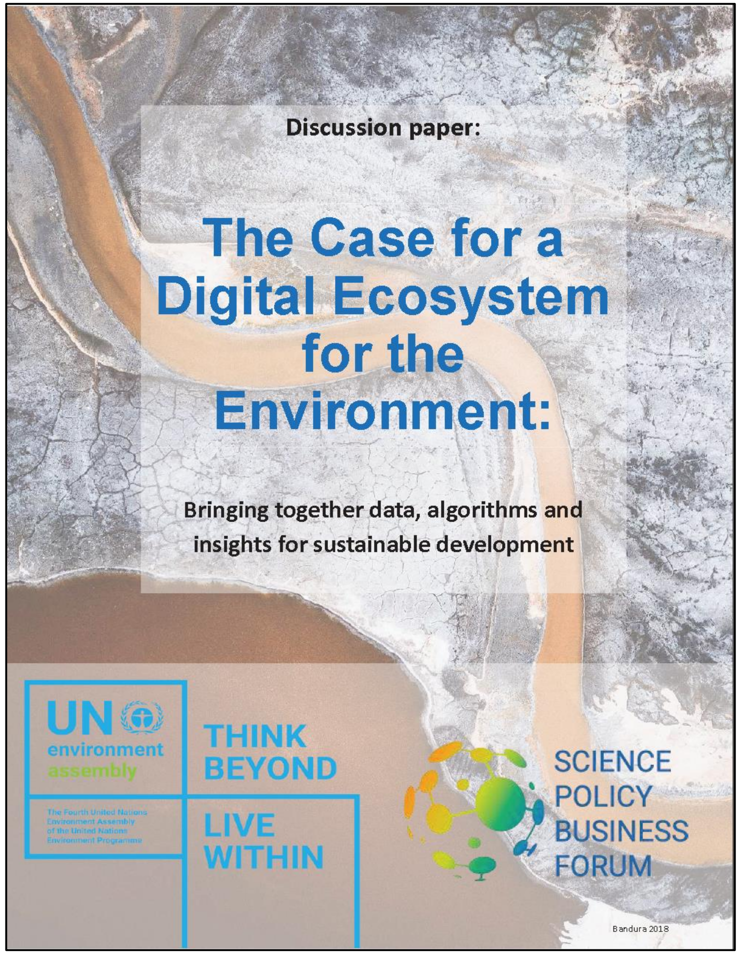
SUSTAINABLE DEVELOPMENT GOALS

Growing Political Interest in Aligning Digitalization with Sustainability

World Economic Forum, 2018/19



United Nations Science Policy Business Forum, 2020

German Advisory Council on Global Change, 2020

Questions

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What is Sustainable Development (SD) and why is it difficult to achieve?

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What role has digital transformation played so far
in achieving the UN Sustainable Development Goals (SDGs)?

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The report that coined the term “sustainable development”

The UN report ”Our Common Future” introduced the term with the following definition (also known as the “Brundtland definition”):

“Sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs.”

World Commission on Environment and Development (UN-WCED), 1987

The UN Agenda 2030 and the Sustianable Development Goals

In 2015, all 293 United Nations Member States adopted the 2030 Agenda for Sustainable Development.

It contains the 17 Sustainable Development Goals (SDGs), which are intended to “stimulate action over the next fifteen years in areas of critical importance for humanity and the planet”, namely the “five P”:

– People

– Planet

– Prosperity

– Peace

– Partnership

The SDGs address different levels of the overall human-environment system

17 Partnerships for the goals

Economy:

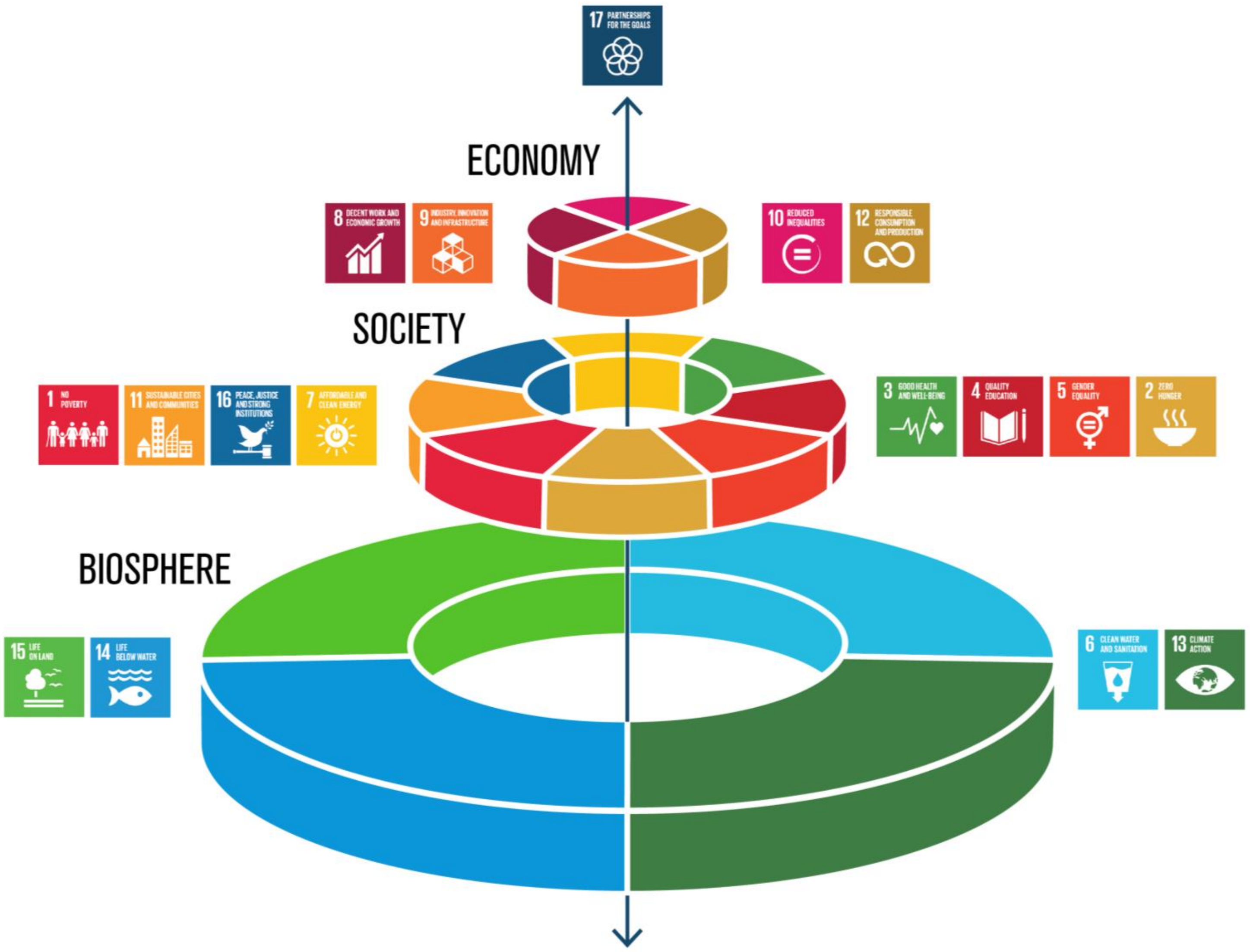
8 Decent work, economic growth
9 Industry, innovation, infrastructure
10 Reduced inequalities
12 Responsible production & consumption

Society:

1 No poverty
11 Sustainable cities & communities
16 Peace, justice, strong institutions
7 Affordable & clean energy
3 Good health and well-being
4 Quality education
5 Gender equality
2 Zero hunger

Biosphere:

15 Life on land
14 Life below water
6 Clean water & sanitation
13 Climate action



Credit: Azote Images for Stockholm Resilience Centre

The system levels are connected through social metabolism

The socio-economic system acts like an organism that

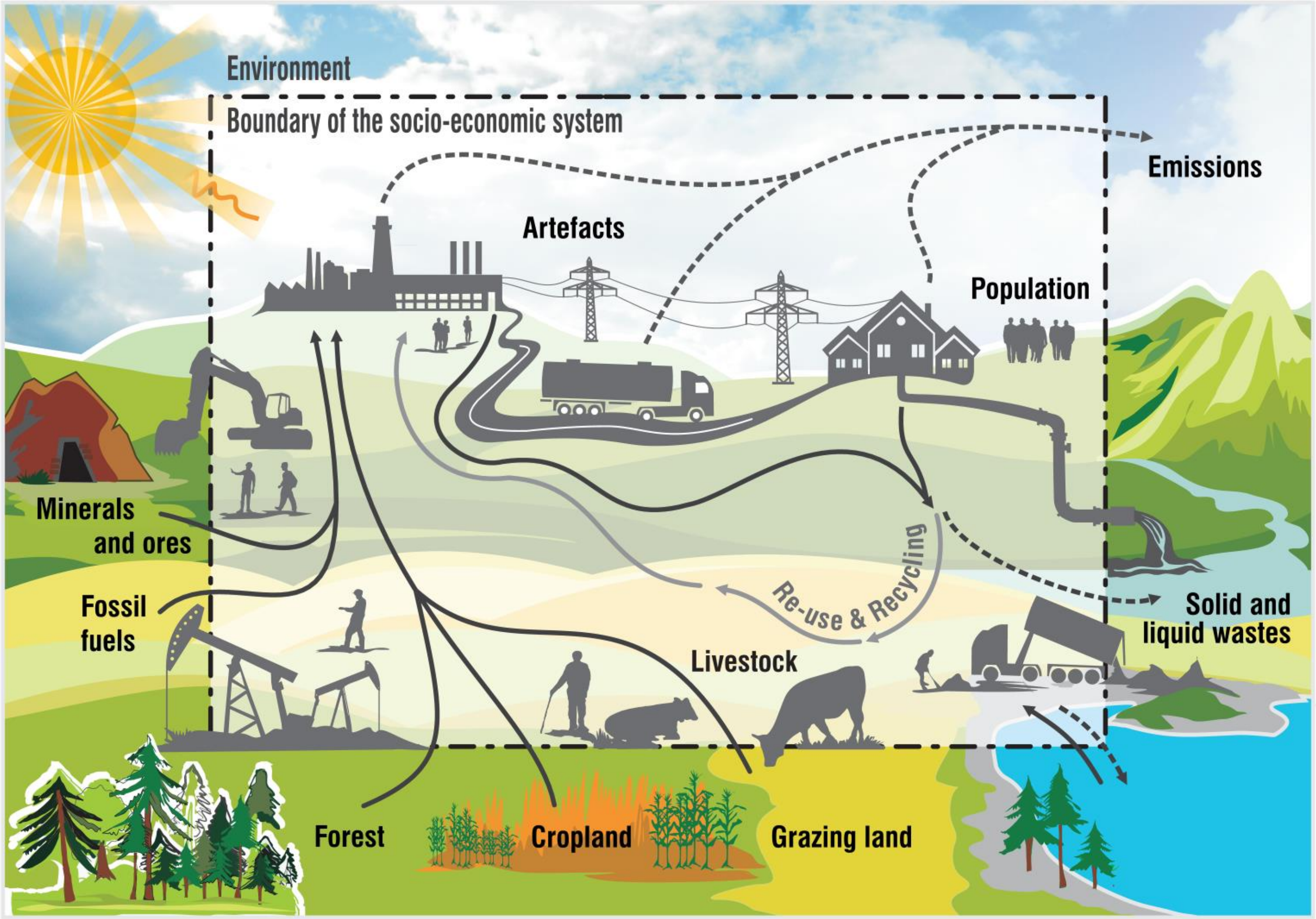
- absorbs substances from the environment,
- transforms them, and
- releases them back to the environment

Inputs:

- minerals and ores, fossil fuels
- biomass
- water

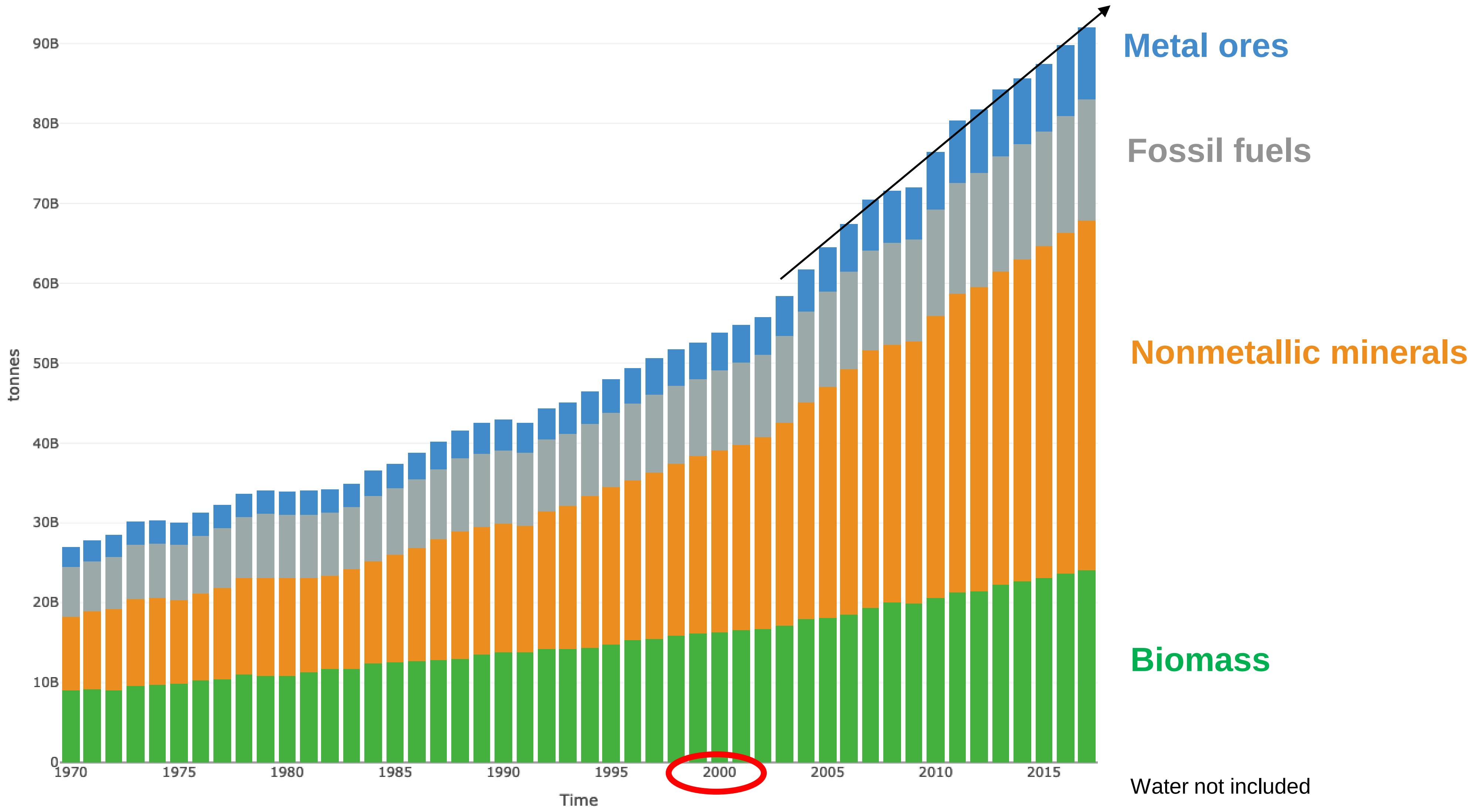
Outputs:

- emissions into air
- solid and liquid wastes into soil and water



Source: Haberl, H., Wiedenhofer, D., Pauliuk, S., Krausmann, F., Müller, D.B., Fischer-Kowalski, M., 2019. Contributions of sociometabolic research to sustainability science. Nature Sustainability 2, 174 https://doi.org/10.1038/s41893-019-0225-2 Image courtesy of Miljana 'Manja' Podovac.

Input rate still growing: global material extraction at 90 billion tonnes/year



Water not included

Based on: WU Vienna (2020): Material flows by material group, 1970-2017.
Visualisation based upon the UN IRP Global Material Flows Database.
http://www.materialflows.net/visualisation-centre/

The 2018 SRC/BI Report to the Club of Rome: How to achieve the SDGs within planetary boundaries

“Despite rapid technological changes, digitalisation in particular, the data from the last decades shows that most rates of socio-economic change are slow. […] this pace of progress proves insufficient to deliver on the SDG targets by 2030 nor 2050.” (p. 13)

Jorgen Randers, Johan Rockström, Per Espen Stoknes, Ulrich Golüke, David Collste and Sarah Cornell (2018): How to achieve the SDGs within planetary boundaries. Report to the Club of Rome from Stockholm Resilience Centre and BI Norwegian Business School.

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Strategies for achieving sustainable development

Efficiency	More units of useful output per unit of input (e.g., energy, material, time, money)	Necessary to enable growth under under resource constraints.
Sufficiency	"Seeking enough when more is possible" (Princen, 2005)	Necessary to avoid rebound effects that compensate for efficiency.
Consistency	To make social metabolism consistent with nature's metabolism	Necessary to enable long-term compatibility of social and natural metabolism.

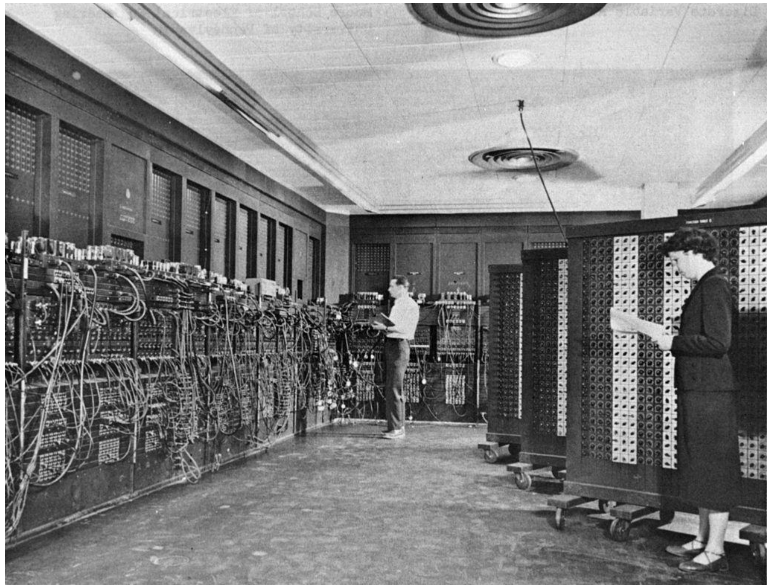
"The transformation of traditional industrial structures […] implies major or basic technological innovations, as being different from incremental efficiency increasing change." (Huber, 2000, p. 269)

Joseph Huber. Towards industrial ecology: sustainable development as a concept of ecological modernization, Journal of Environmental Policy and Planning, 2:4, 269-285, DOI: 10.1080/714038561

Thomas Princen. The Logic of Sufficiency. MIT Press, 2005

Energy efficiency of computing (Koomey's Law)

The number of computations produced per energy input has doubled every 1.57 years since the time of tENIAC, the first programmable electronic computer.



Source: Koomey, J., Berard, S., Sanchez, M. & Wong, H. (2011): Implications of Historical Trends in the Electrical Efficiency of Computing. Annals of the History of Computing, IEEE, 33 (3): 46-54

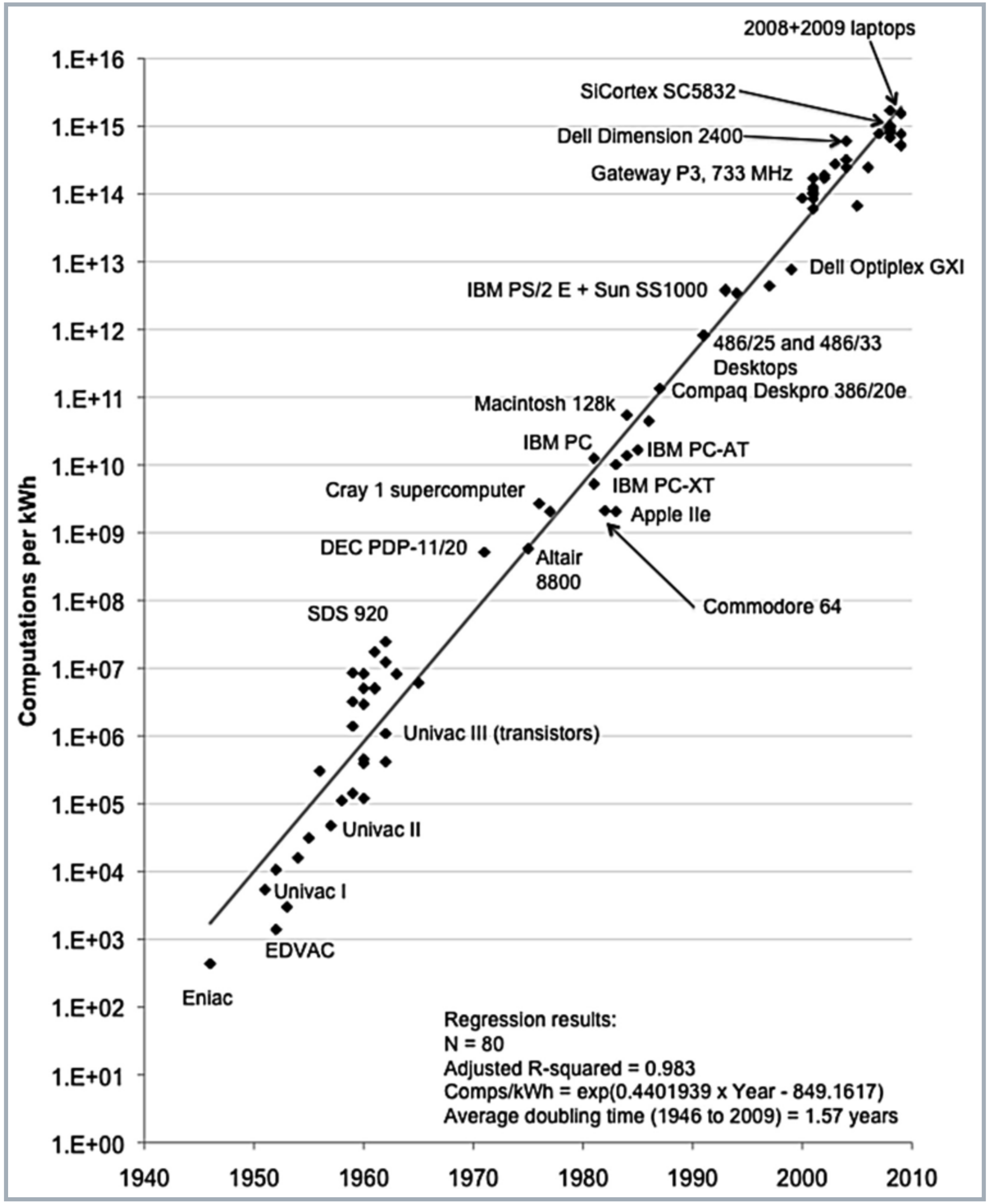
Quadrillion

Trillion

Billion

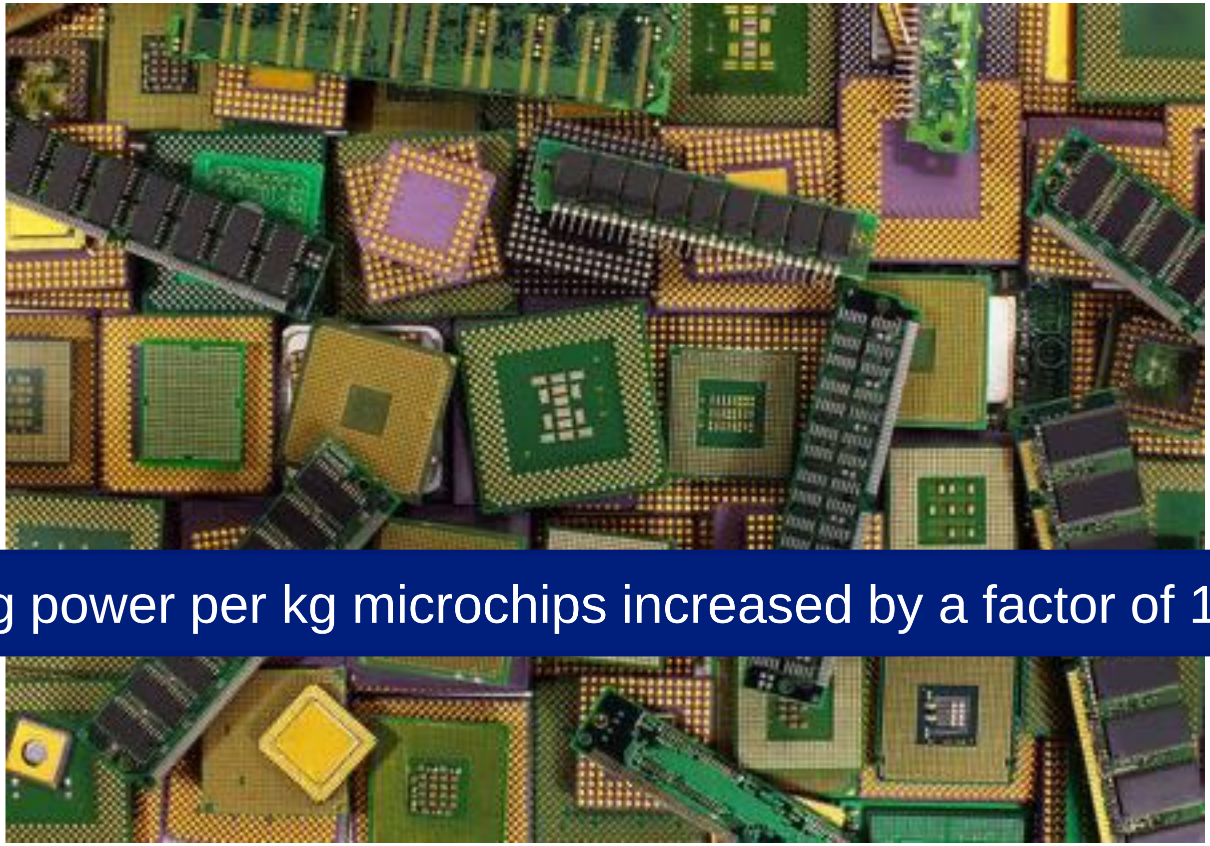
Million

Thousand



Material efficiency of computing

1970



2020

Computing power per kg microchips increased by a factor of 100 million

Example: Planned 5G network infrastructure for 2030 in Switzerland

- Greenhous gas efficiency in GB transfered per kg CO_2e emitted will **increase by a factor of 6.7** to 222 GB/kg (or 4.5g/GB)

- Capacity is planned under the assumption that data traffic will **increase by a factor of 9.3**

It follows that the CO_2 emissions of the mobile network will **increase by 39 %.**

Source: Bieser, J., Salieri, B., Hischier, R., & Hilty, L. M. (2020). Next generation mobile networks: Problem or opportunity for climate protection? University of Zurich, Empa, Swisscom, Swisscleantech. https://www.zora.uzh.ch/id/eprint/191299

Materials Complexity of ICT Hardware

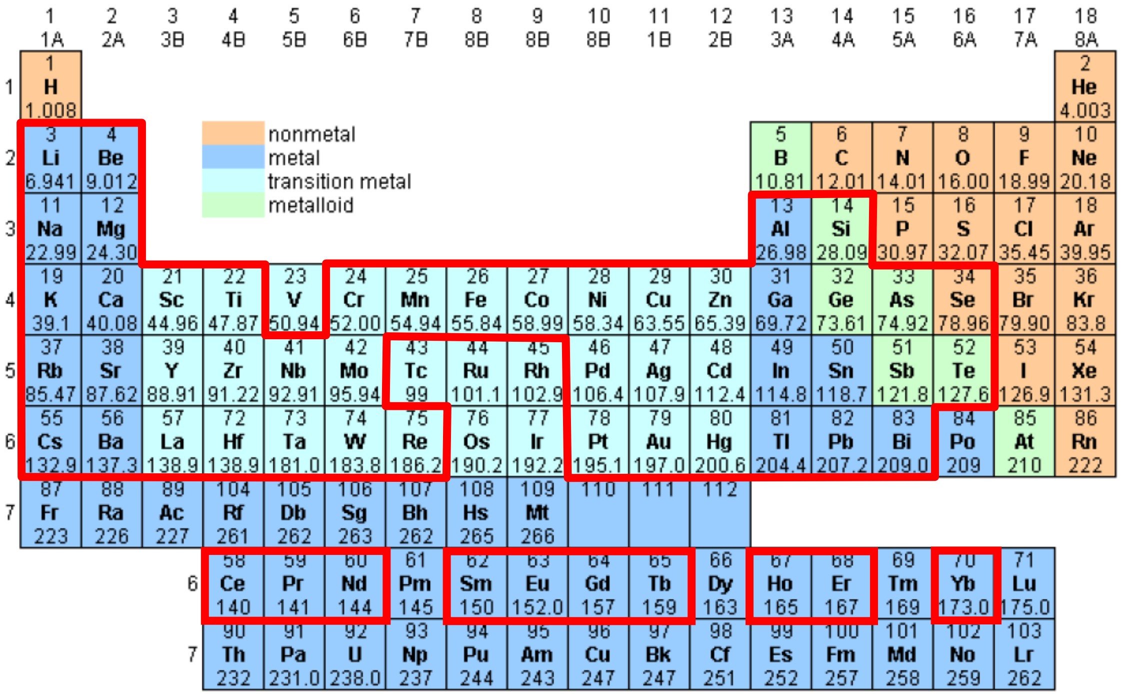
Chemical elements used today to build digital electronic devices

Base metals, e.g.:
- Aluminum (Al)
- Iron (Fe)
- Copper (Cu)

Scarce metals, e.g.:
- Gold (Au)
- Silver (Ag)
- Palladium (Pd)
- Indium (In) …

Critical metals, e.g.:
- Gallium (Ga)
- Germanium (Ge)
- Indium (In)
- Tantalum (Ta)
- all Rare Earth Elements (Sc, Y, La, Ce–Lu)

The red line indicates the elements that are in use for building microprocessors and related electronic components today.

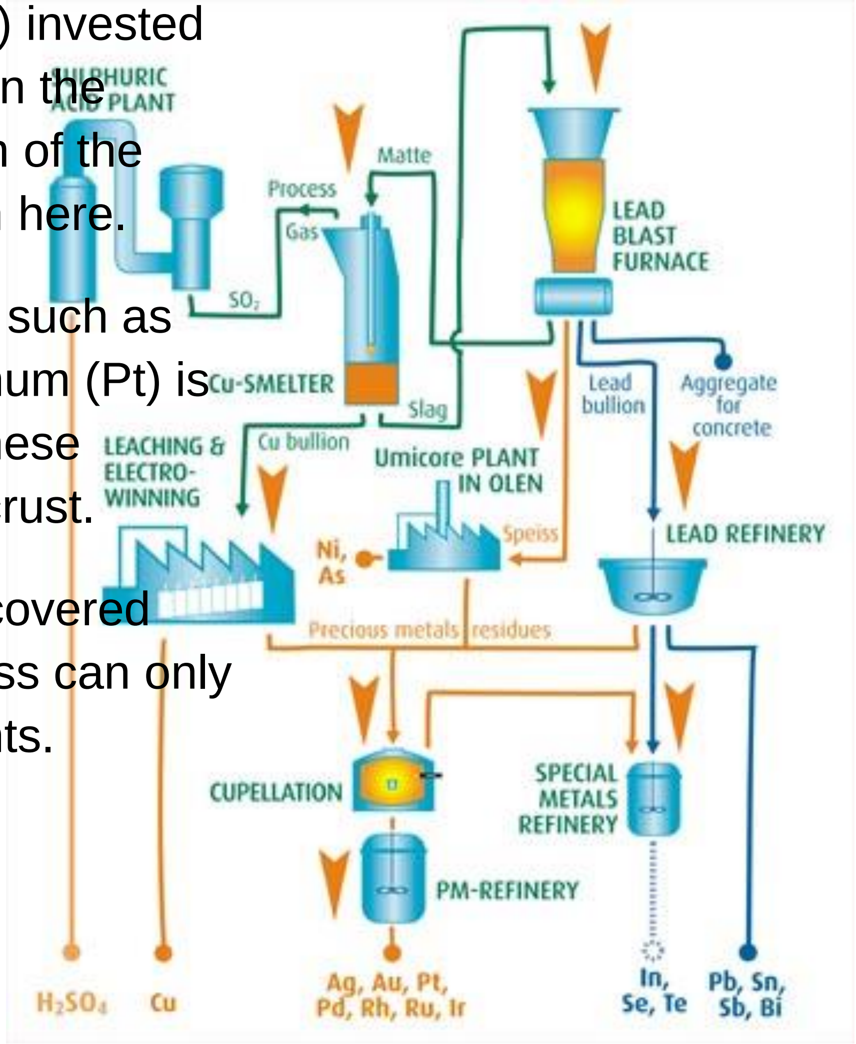





An element is called **"critical"** if there are high supply risks (for geological, technical, environmental, social, political or economic reasons) *and* the prospective impact of supply restrictions is high.

Metallurgical recovery of metals from e-waste

- Example: Umicore (Belgium) invested more than 100 million Euro in the development and installation of the metallurgical process shown here.
- Recovering precious metals such as Gold (Au), Silver (Ag), Platinum (Pt) is more efficient than mining these metals from from the earth crust.
- Not all critical metals are recovered due to trade-offs: The process can only target a subset of all elements.



Source: Umicore

Informal e-waste recycling in Delhi, India

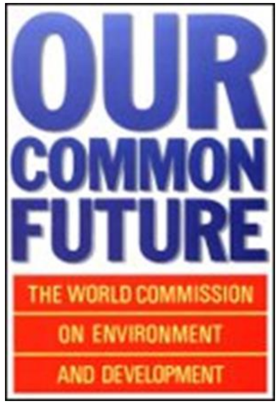
Source: Empa

Copper extraction in the backyard

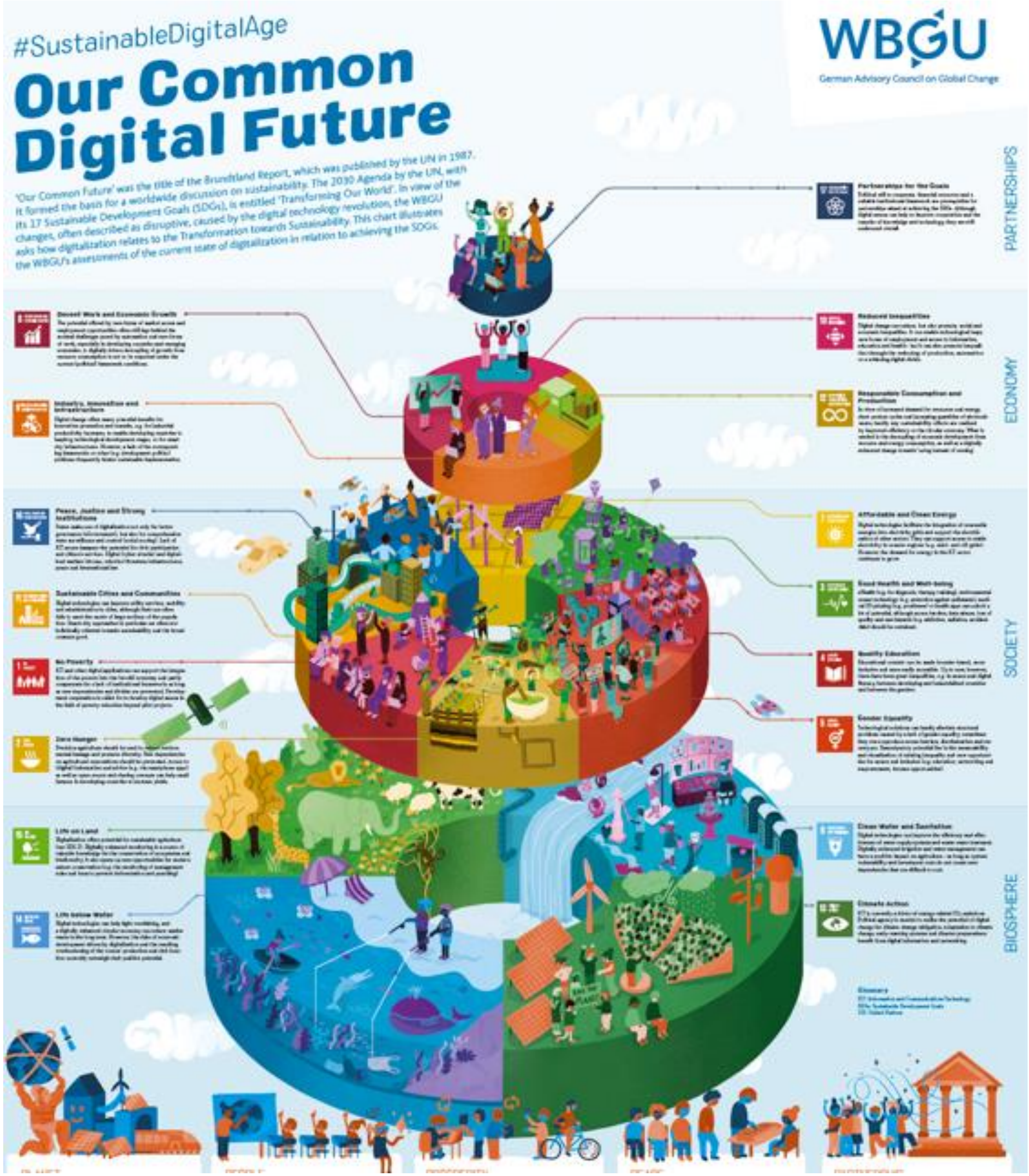
Source: Empa

Manual extraction of copper from printed wiring boards in Delhi, India. Typical backyard company with 12 workers. Yield: 1-2 tons/month

From “Our Common Future” to “Our Common Digital Future”



WBGU – German Advisory Council on Global Change: Towards Our Common Digital Future. Berlin, 2019.



Opportunities and risks of digitalization (1/4): economy level

#	SDG	Opportunities of digitalization	Risks of digitalization
8	Decent work, economic growth	New forms of **market access,** employment opportunities	Societal challenges posed by automation and new forms of work
9	Industry, innovation, infrastructure	Innovation promotion and transfer, e.g. to enable developing countries to **leapfrog** technological development stages, or for smart city infrastructures	Lack of the corresponding frameworks or other (e.g. development politics) problems which frequently hinder sustainable implementation
10	Reduced inequalities	Reduce inequalities through enabling technological leaps, new forms of employment and **access** to information, education and health	Promote inequalities through the reshoring of production, automation or a widening digital **divide**
12	Responsible production & consumption	Decoupling of economic development from resource and energy consumption, as well as a digitally enhanced change towards '**using instead of owning**'.	**Increased demand** for resources and energy, short product cycles and increasing quantities of electronic waste

Based on: WBGU – German Advisory Council on Global Change: Transforming our world in the digital age. Berlin, 2019.

Opportunities and risks of digitalization (2/4): society level

#	SDG	Opportunities of digitalization	Risks of digitalization
1	No poverty	Support the **integration** of the poorest into the (world) economy and partly compensate for a lack of institutional frameworks	New **dependencies** and **divides**
7	Affordable & clean energy	Integrate **renewable energies** into electricity grids; support the electrification of other sectors; support access to stable electricity in remote regions (e.g. mini- and off-grids).	Growing **energy demand** in the ICT sector
11	Sustainable cities & communities	Improve **utility services**, mobility and administration in cities	**Failing to meet the needs of large sections of the population**; smart-city approaches are often not holistically oriented towards sustainability and the broad common good
16	Peace, justice, strong institutions	States make use of digitalization for better **governance** (eGovernment)	State surveillance and control (social scoring); lack of ICT access hampers the potential for civic **participation** and citizen's services; cyber threats to infrastructures, peace, international law

Based on: WBGU – German Advisory Council on Global Change: Transforming our world in the digital age. Berlin, 2019.

Opportunities and risks of digitalization (3/4): society level (cont.)

#	SDG	Opportunities of digitalization	Risks of digitalization
2	Zero hunger	**Precision agriculture** can reduce environmental damage and promote diversity; access to (digital) information and advice as well as open-source and sharing concepts can help small farmers in developing countries to increase yields.	New **dependencies** on agricultural corporations.
3	Good health and well-being	eHealth; environmental sensor technology (e.g. protection against pollutants); **medical 3D printing** (e.g. prostheses); health apps	Access barriers, data misuse, loss of quality and new hazards (e.g. **addiction**, radiation, accident risks)
4	Quality education	Educational content can be made broader-based, more inclusive and more easily **accessible**.	**Inequalities in access** and digital literacy, between developing and industrialized countries and between the genders
5	Gender equality	Emancipatory potential in the measurability and visualization of existing inequality; new opportunities for **access** and inclusion	Reproducing **access barriers**, discrimination and stereotypes.

Based on: WBGU – German Advisory Council on Global Change: Transforming our world in the digital age. Berlin, 2019.

Opportunities and risks of digitalization (4/4): biosphere level

#	SDG	Opportunities of digitalization	Risks of digitalization
6	Clean water & sanitation	Efficiency and effectiveness of water-supply systems and **waste-water treatment**; digitally enhanced irrigation and water management	System vulnerability and investment costs creating new **dependencies**
13	Climate action	Potential for climate-change mitigation and adaptation to climate change; **early-warning systems** and disaster preparedness	**Driving energy-related** CO2 emissions
14	Life below water	Help fight overfishing; digitally enhanced **circular economy** can reduce marine waste in the long term	Driving a type of economic development that results in **overburdening** of the oceans’ production and sink function
15	Life on land	Sustainable **precision agriculture** (see SDG 2); monitoring for the conservation of ecosystems and biodiversity; new opportunities for nature conservation	See SDG 2

Based on: WBGU – German Advisory Council on Global Change: Transforming our world in the digital age. Berlin, 2019.

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The challenge of consistency in agriculture

Non-selective herbicides are sprayed to 100% of the plants on the field, although <10% would be sufficient if the application to weed would be selective.

The dramatic effects on biodiversity and human health show the extend if inconsistency.

Weed robots can save up to 90 % herbicides

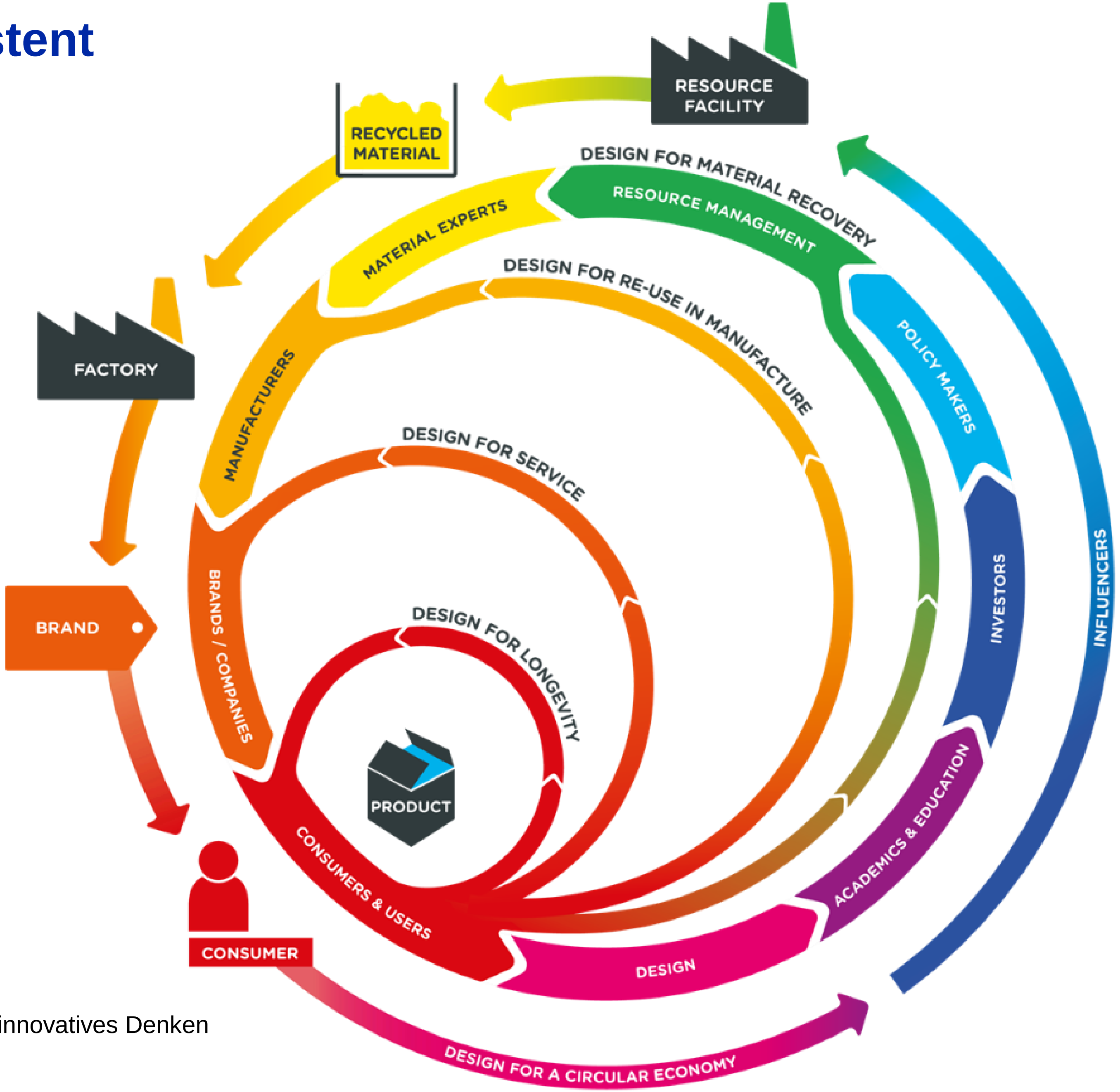
Project MARS, 2017

Eurobotics, 2020

Reducing the burden of inconsistent flows by circular economy

- Design for longevity
- Design for service (i.e. shareability)
- Design for re-use in manufacture
- Design for material recovery
- …

→ Many opportunities for digital technologies to play an enabling role.



Source: Aktionsprogramm für Nachhaltigkeit, Abfall und Ressourcen, innovatives Denken

Circular economy with recycling robots

Construction and demolition waste (Zenroboticx)

Zenroboticx (2016)

https://youtu.be/uaft5MR7GAc?t=71

Alphabet X 2019

The future: robot rats?

“Robot rats are the future of recycling

[…] Why don’t we have swarms of robots in our landfill yet, when most of the technological problems seem to be solvable? […] It’s clear robotic technology can develop pretty fast when given the right resources. […] The engineers work according to our priorities, so if we want to see progress, **we need to put our money where rubbish is.”**

Sunny Bains: Robot rats are the future of recycling. OUPblog, Oxford University Press’s Academic Insights for the Thinking World. August 8, 2019
https://blog.oup.com/2019/08/robot-rats-are-the-future-of-recycling/

Conclusion: Four Principles of sustainable digitalization

Promote efficiency with regard to energy or material resource input only when there is some constraint that hinders demand to grow faster than efficiency. (Combine efficiency with sufficiency.)

Use the ability of digital technologies to make efficient automated distinctions to reduce the inconsistency of social metabolism, not to induce more consumption. (Use efficiency for consistency.)

Promote accessiblity of information, markets and sharable resources only if this increases equality and reduces divides, and can be scaled up to large numbers of people in a world of finite material and energy resources. (Use the technology to reduce inequality.)

Avoid creating dependency and addiction of consuming specific services provided by digital technologies. (Preserve freedom of choice.)