German Environment Agency

August 9, 2024

Digitalisation and natural resources

Analysis the resource intensity of the digital transformation in Germany (‘DigitalRessourcen’)

The DigitalResourcen research project has analysed the resource intensity and greenhouse gas potential of the digital transformation in Germany at both **micro** and macro level. The resource intensity of digital applications was calculated in ten case studies using LCA methodology (see Table 1 for examples). At the **macro level**, the raw material consumption (RMC), the raw material input (RMI) and the carbon footprint of digitalisation for the years 2000-2020 were calculated and analysed for the ICT sector using a multi-regional input-output model (see Figs. 1 and 2). In a further step, a **modelling** of the digital transformation in Germany up to the year 2050 was carried out in seven different scenarios (see Fig. 3). Finally, **fields of** action with example measures for more sustainable digitalisation and further research needs were identified. The project (2020 - 2023) will be continued in a follow-up project (2024 – 2027).

Table 1: Analyses at micro level (example) on resource and CO_2 footprint according to LCA methodology: video conferencing home office, private 3D printing, crypto currency, e-sports

Digital case (selection)	* Results by indicators	
Participation of 1 person in a 1-hour video conference professional context	RMI: 116 g CED: 1,03 MJ WDP: 0,85 L	TMR: 134 g GWP: 70 g CO_2-Äq. LOP: 0,0044 m^2a
1 hour use of a 3D printer for home use	RMI: 4,6 kg CED: 29 MJ WDP: 0,014 m^3	TMR: 5,7 kg GWP: 1,9 kg CO_2-Äq. LOP: 0,12 m^2a
Operation of the Bitcoin network over 1 year	RMI: 38,1 Mt CED: 641 PJ WDP: 0,16 km^3	TMR: 44,8 Mt GWP: 33,7 Mt CO_2-Äq. LOP: 618 km^2a
1 hour of gaming and streaming ´League of Legends´	RMI: 3,1 kg CED: 45 MJ WDP: 0,02 m^3	TMR: 3,9 kg GWP: 2,5 kg CO_2-Äq. LOP: 0,13 m^2a

* RMI = primary material input; TMR = total primary material input; CED = cumulative energy demand; GWP = carbon footprint; WDP = water footprint; LOP = land-use potential

Source: Milde K et al. (2023)

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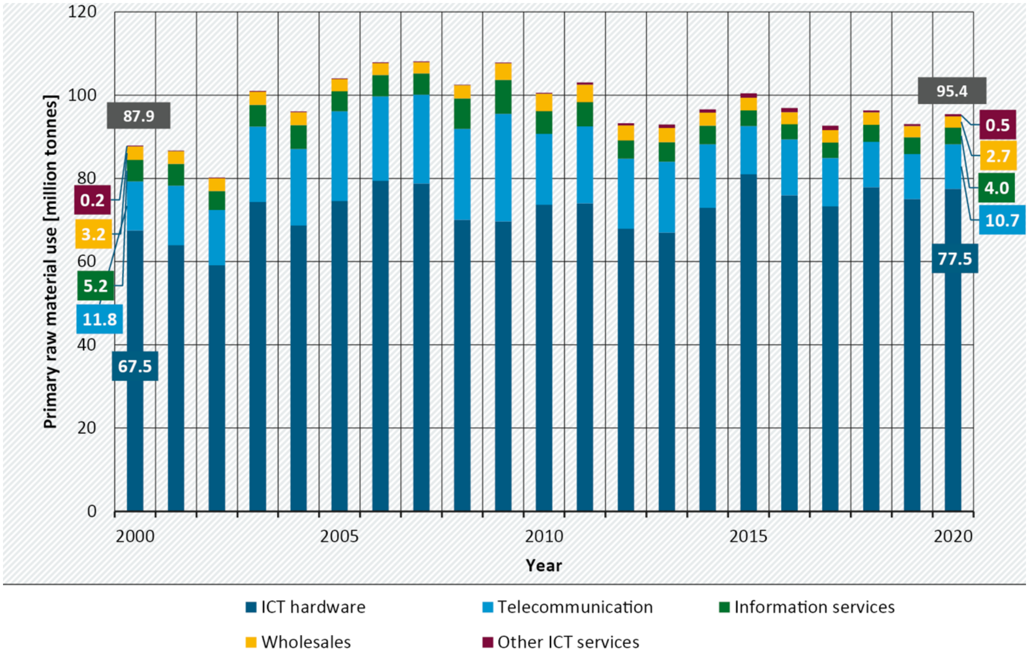
Raw material consumption in the entire digitalisation "sector" in Germany ($RMC_{Dig.}$) amounted to 95.4 million tonnes in 2020. It **increased by 8.5 %** between 2000 and 2020. The most important influencing factor is hardware (see Fig. 1). The ICT sector's share of total German raw material consumption is around 5.6 %. The geographical analysis shows that ICT is mainly imported from the Far East. Figure 2 shows an analogous analysis of the $CO_{2,\ Dig.}$ footprint, which has fallen slightly since 2000; its share of CO_2, total, on the other hand, has increased.

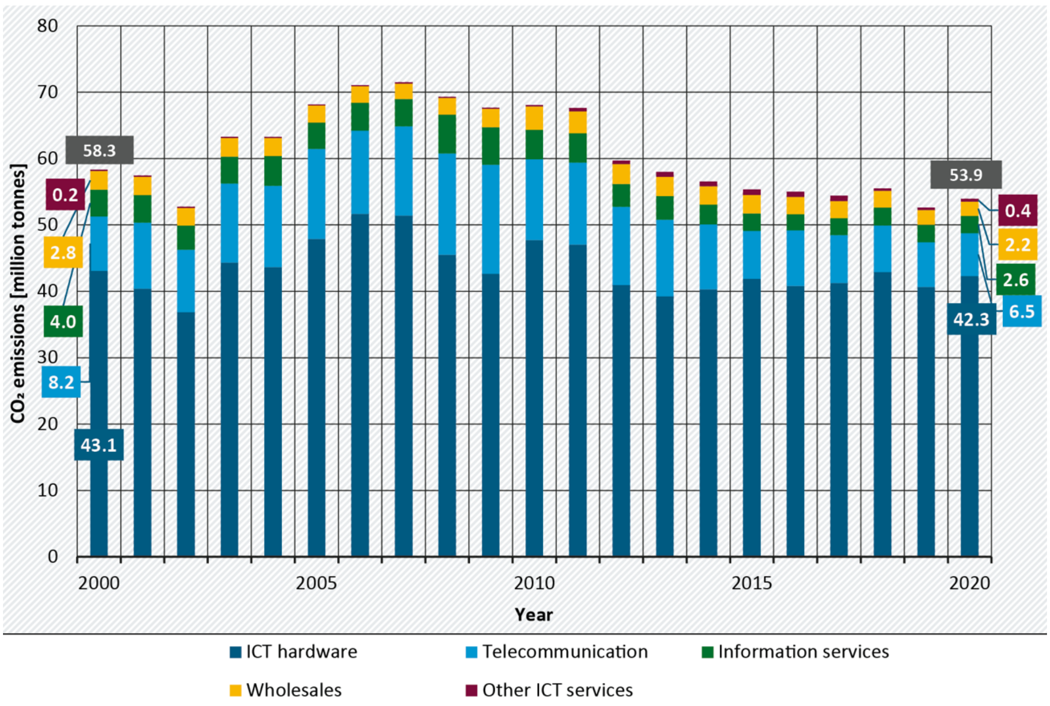
Figure 1: Analysis of raw material consumption ($RMC_{Dig.}$) of digitalisation in Germany



$RMC_{Dig.}$: Global use of primary raw materials for the production of ICT goods and services for domestic consumption, investment, and production activities.

Source: Milde K et al. (2023)

Figure 2: Analysis of the $CO_{2,\ Dig.}$ footprint of digitalisation in Germany



Source: Milde K et al. (2023)

Modelling the raw material consumption of the digital transformation

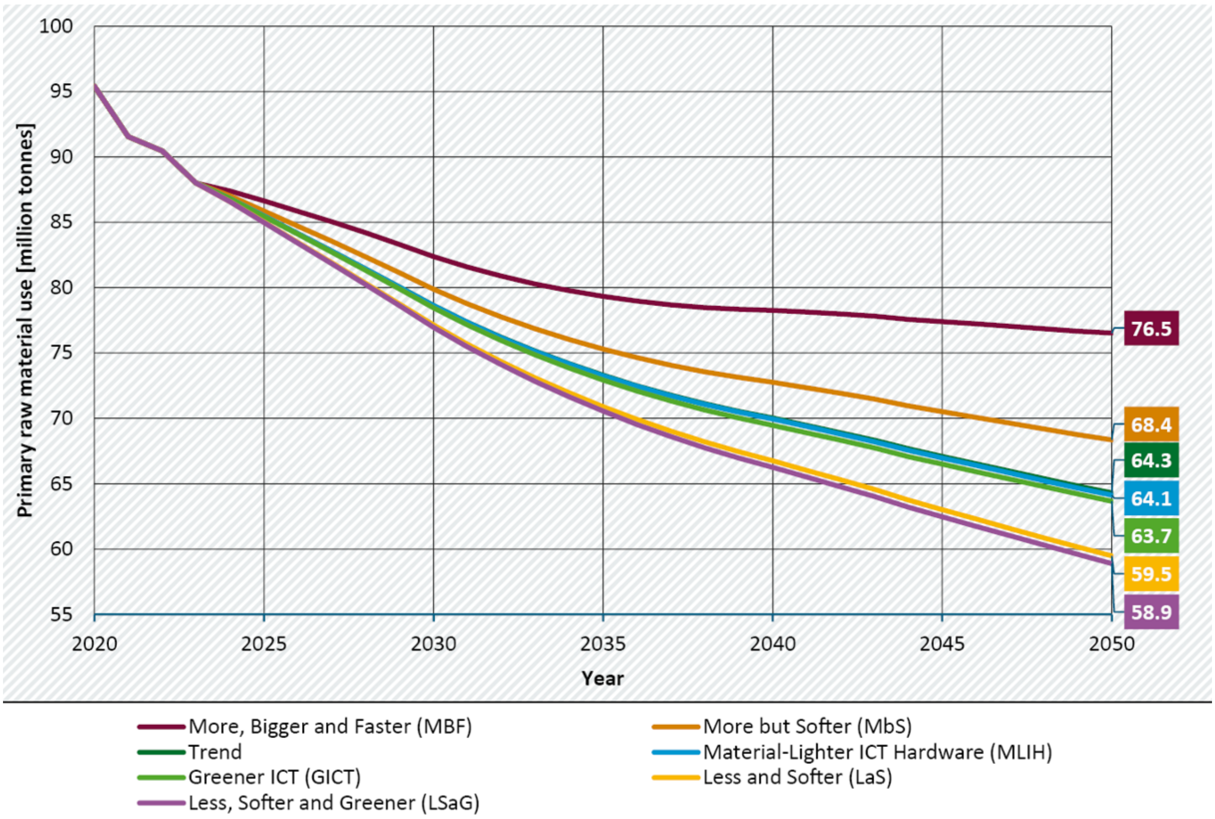
A trend scenario was initially calculated for modelling the raw material consumption of the digital transformation ($RMC_{Dig.}$) in Germany from 2020 to 2050. Parameters independent of digitalisation were based on international projections of global developments (including gross domestic product and population development). In the trend scenario, an **absolute decoupling** from economic growth is achieved by 2050 both for the German RMC_{total} as a whole and for the $RMC_{Dig.}$.

Based on this, six alternative future scenarios were defined and calculated (see Fig. 3). The most ecologically ambitious scenario was defined with the 'Less, Softer and Greener' (LSaG) scenario (including reduced product demand, increased demand for services, less material-intensive production, lower energy consumption).

Over the entire period 2020 - 2050 (see Fig. 3), the primary raw material use of digitalisation **decreases in all scenarios**, starting from 95.4 million tonnes in 2020. In the 'Less, Softer and Greener' scenario with the strongest decrease, the $RMC_{Dig.}$ in 2050 is then 58.9 million tonnes (minus 38%). The 'More, Bigger and Faster' scenario has the highest primary raw material utilisation. The difference between this scenario and the 'LSaG' scenario amounts to around 17.6 million tonnes of raw materials in 2050.

Analogous scenario analyses were carried out in this research project for the **carbon footprint of digitalisation** in Germany (see references at the end of this factsheet).

Figure 3: Development of raw material consumption ($RMC_{Dig.}$) of digitalisation in Germany for different ambitious scenarios in the period 2020 to 2050



Source: Milde K et al. (2023)

Fields of action and further research needs for more sustainable digitalisation

1. Circular economy - reduce raw material consumption, use products for longer
2. Pay particular attention to raw materials relevant to digitalisation (e. g. gallium, tantalum)
3. Global supply chains - enable transparency and international cooperation
4. Reduce rebound effects - realise real efficiency and sustainability effects
5. Reduce energy requirements of appliances and infrastructure, increase renewable energy
6. Relevant sectors: Pay particular attention to the hardware product group
7. Consider sufficiency in consumption and purchasing behaviour
8. Improve data situation and transparency
9. Impact assessment - sharpen understanding of the environmental impact of digitalisation
10. Further research: case studies on “AI”, sector/demand field analyses, stakeholders dialogue

References:

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www.umweltbundesamt.de/en/digitalresources

Imprint

Publisher

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Status: August/2024