UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

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Digital economy report

Shaping an environmentally sustainable and inclusive digital future

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UN trade & development UNCTAD | 60 years

Rapid transformation of the digital economy amidst challenges to planetary boundaries

Higher speed

Cloud computing

Platformization

Exponential data growth

Growing virtuality

Planetary boundaries

6/9 already breeched

Digital divides

2.6 billion offline

Global greenhouse gas emissions per sector

1.5–3.2%

2%

Average fixed Internet speed

Developed economies

LDCs

4.7 x

Use of Internet

90% Developed economies

36% LDCs

Sources: Richardson et al. (2023), IPCC (2023); ITU (2023);

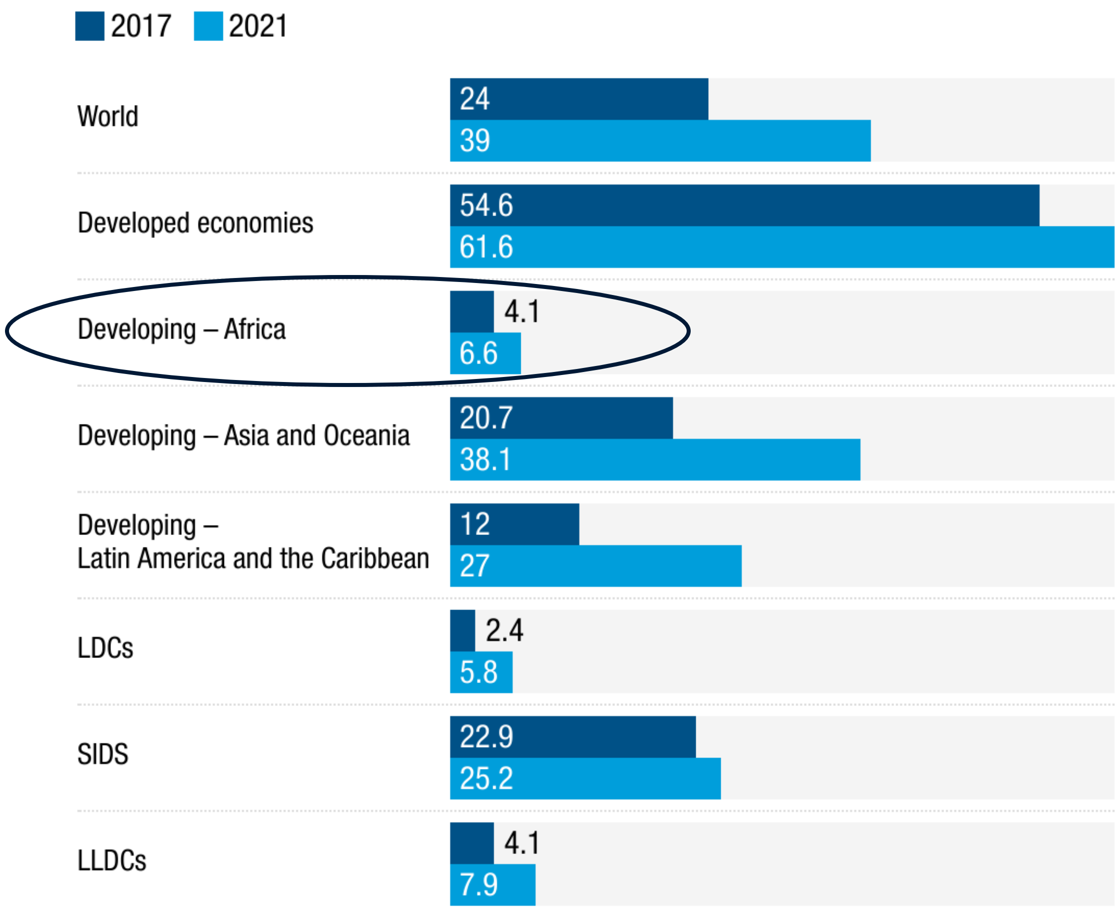
Gaping digital and e-commerce divides...

- Share of people **using the Internet**
  - High-income countries: 93%
  - **Africa**: 37%
- Share of people with a **mobile broadband subscription**
  - High-income countries: 148%
  - **Africa**: 48%
- Share of people **covered by 5G** mobile network
  - High-income countries: 89%
  - **Africa**: 6%

Source: ITU (2023).

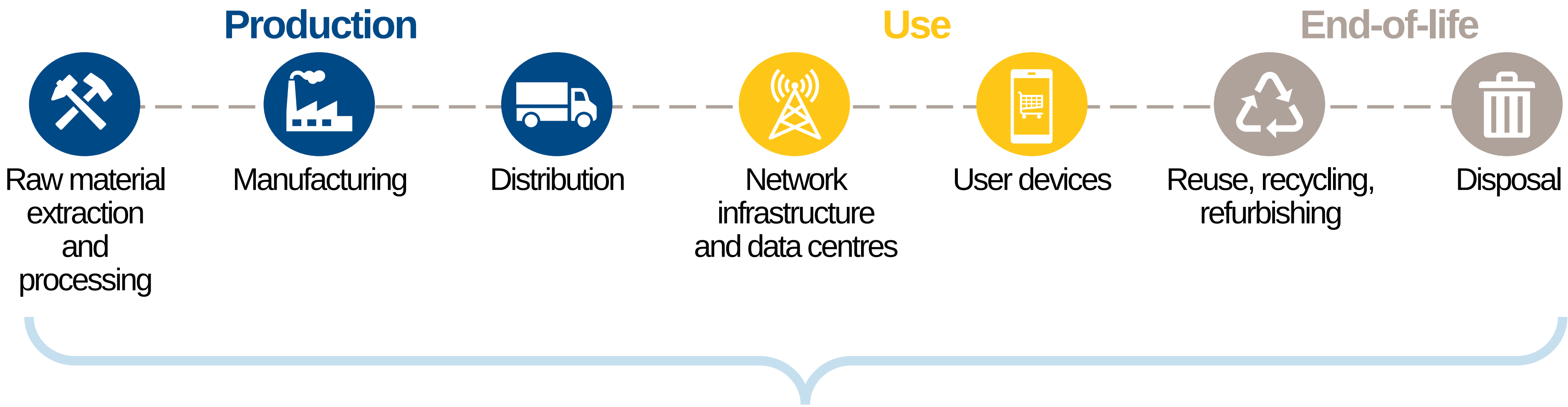
Uneven increases in e-commerce adoption across regions

Share of population (aged 15+) shopping online, by regions and country groupings (in %)



Source: UN Trade and Development (UNCTAD), based on World Bank Global Findex 2021.

Environmental impacts are generated along the whole digitalization life cycle



Direct effects

Natural resource depletion
Energy use
Water use
Greenhouse gas emissions
Pollution
...

Indirect effects

Substitution
Optimization
Rebound
Induced consumption
Societal effects
Systemic transformations

Environmental footprint of ICT

Production phase: Digitalization has a heavy material footprint

- Heavy reliance on **raw materials**, including minerals and metals, plastics, glass and ceramics
- **Complexity** of devices is increasing – more elements from the periodic table used
  - Phones: 10 elements used in 1960, 27 in 1990 and 63 in 2021
- **Challenge**: low-carbon and digital technologies largely compete for the same minerals
  - Material resource extraction could increase 60% between 2020–2060 (UNEP and IRP, 2024)
  - Demand for cobalt, graphite and lithium is expected to increase by 500% until 2050 (Hund et al./World Bank, 2020)

Sources: Justice et Paix (2019); Le Monde Diplomatique (2021)

Fast growth in ICT demand and Internet use pushes the material footprint

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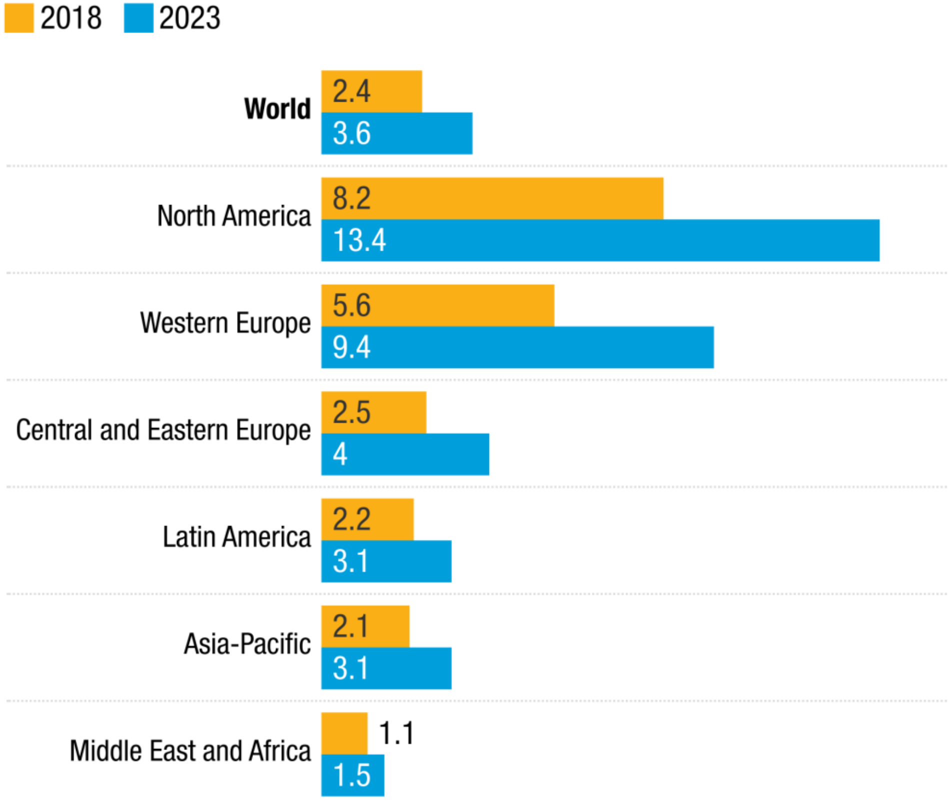
Significant increase in devices per capita in developed countries

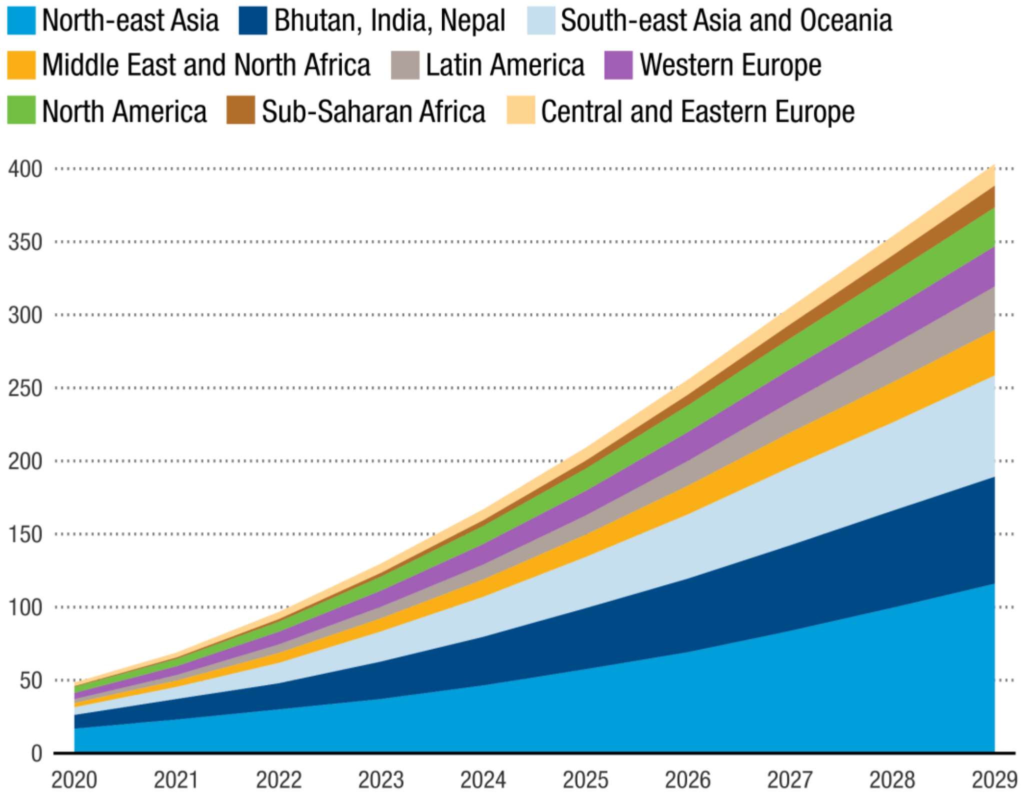
Average number of devices and connections per capita, by region, 2018 and 2023



Source: UN Trade and Development (UNCTAD) calculations based on Cisco.
Note: Country groups are those of the source.

Mobile data traffic is expected to more than double within the next 5 years

Data traffic by region, exabytes per month, 2020–2029



Source: UN Trade and Development (UNCTAD), based on Ericsson Mobility Visualizer.
Note: Country groupings are as defined by the source.

Geopolitics may exacerbate digitalization's environmental footprint

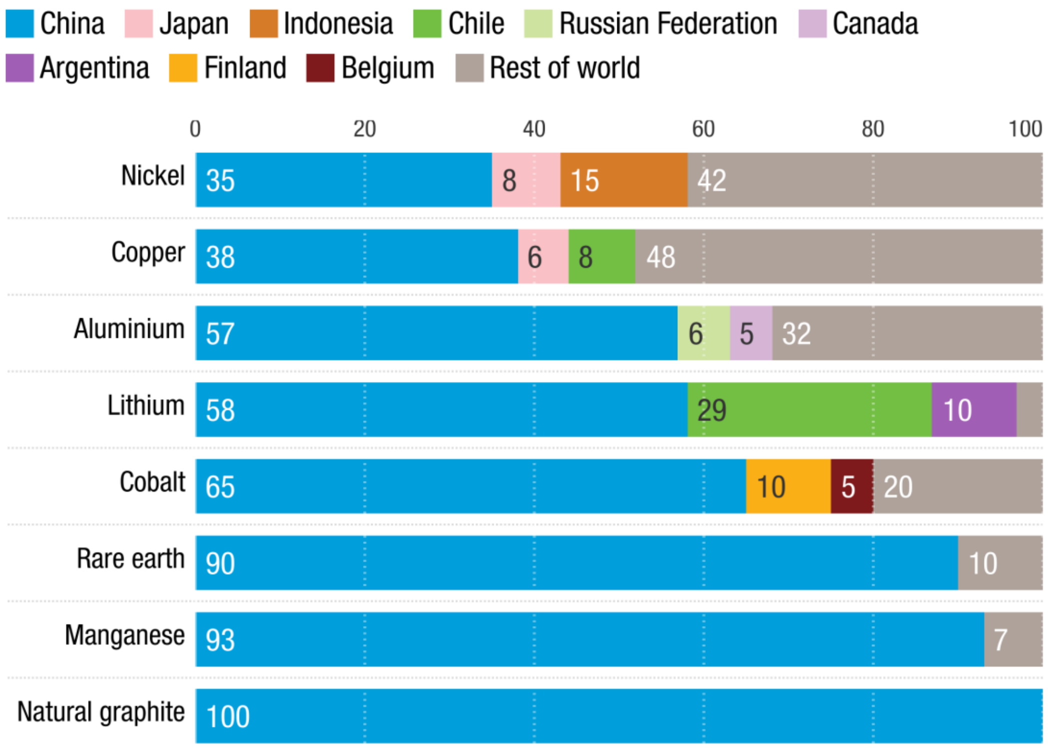
- High geographic concentration of mineral and metal reserves, extraction and processing
- For example, world production in 2023:
  - 74% of cobalt – in the Democratic Republic of the Congo
  - 59% of manganese – in Gabon and South Africa
  - 24% of bauxite – in Guinea
- Most raw materials are exported for processing

Strategic interest in transition minerals leading to new industrial policies in many countries

Risk of an expanded environmental footprint through hoarding and overcapacity

China leads in critical mineral processing

Share of top mineral processing countries in world total for selected minerals



Source: UN Trade and Development (UNCTAD), based on OECD (2023a).

Sources: United States Geological Survey (2023)

Resource-rich developing countries need to benefit more

Challenges

Developing countries engage in low value-added activities of the ICT value chain

- Risk of deepening commodity dependence
- Persistent unequal ecological exchange
- Environmental and social concerns from mining

- Address trade and rent imbalances
- Regional cooperation for better exporter representation in negotiations
- International cooperation for
  - Sustainable sourcing practices
  - Balancing stakeholder needs
  - Ethical mineral supply chains

Opportunities

- Leverage rising mineral demand for development
- Scope for diversification along the value chain and structural transformation

Use phase: Digitalization is boosting energy and water consumption

Data centres and networks

- Backbone of the digital economy
- Bulk of emissions and energy footprint in the use phase

Energy efficiency and rebound effects

- ICT sector is consuming more energy
- Higher speeds and new applications increase use and traffic
- Rebound effects lead to more total consumption

User devices

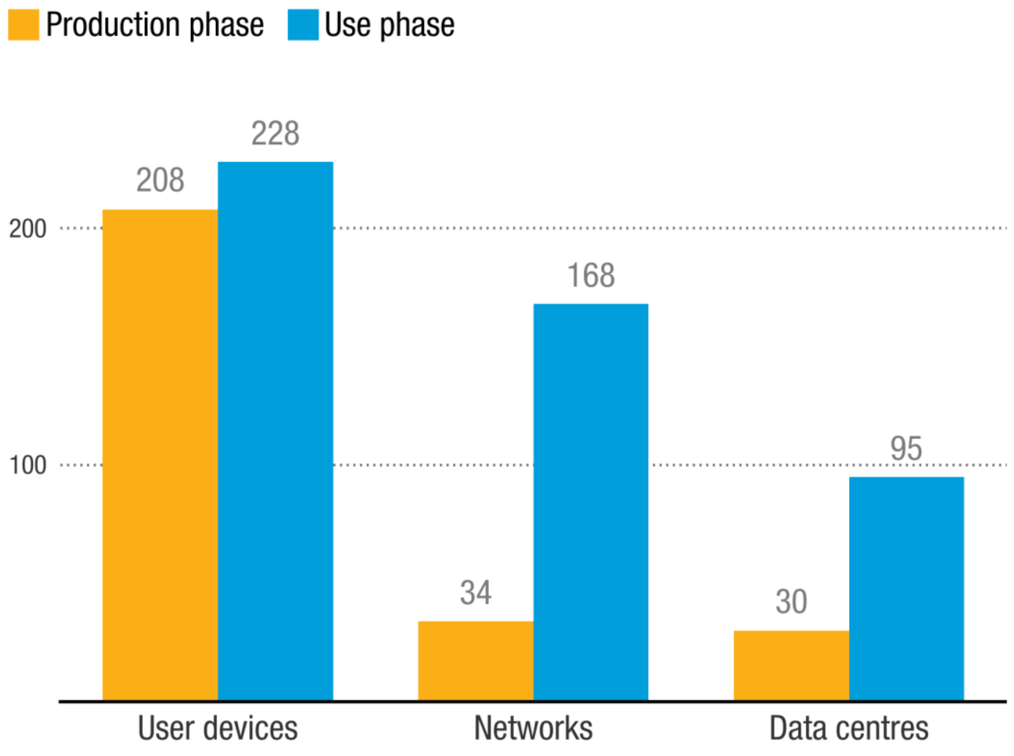
- Highly energy efficient per device
- Sheer number of devices leads to large impact

Water consumption

- Data centres' water use for cooling expands with sector growth

Higher CO2 emissions from use phase across ICT infrastructure

Life-cycle greenhouse gas emissions, by ICT infrastructure type, megatons of CO2 equivalent emissions, 2020



Source: UN Trade and Development (UNCTAD), based on Malmodin et al. (2024)

Data centres have an impact both globally and locally

Data centres globally consume an estimated 460 TWh of electricity – similar to that of France

Pressure on local electricity grids is growing

- Ireland: 18% of total electricity consumption
- Singapore: 7%

Other local impacts

Water use climate and location dependent

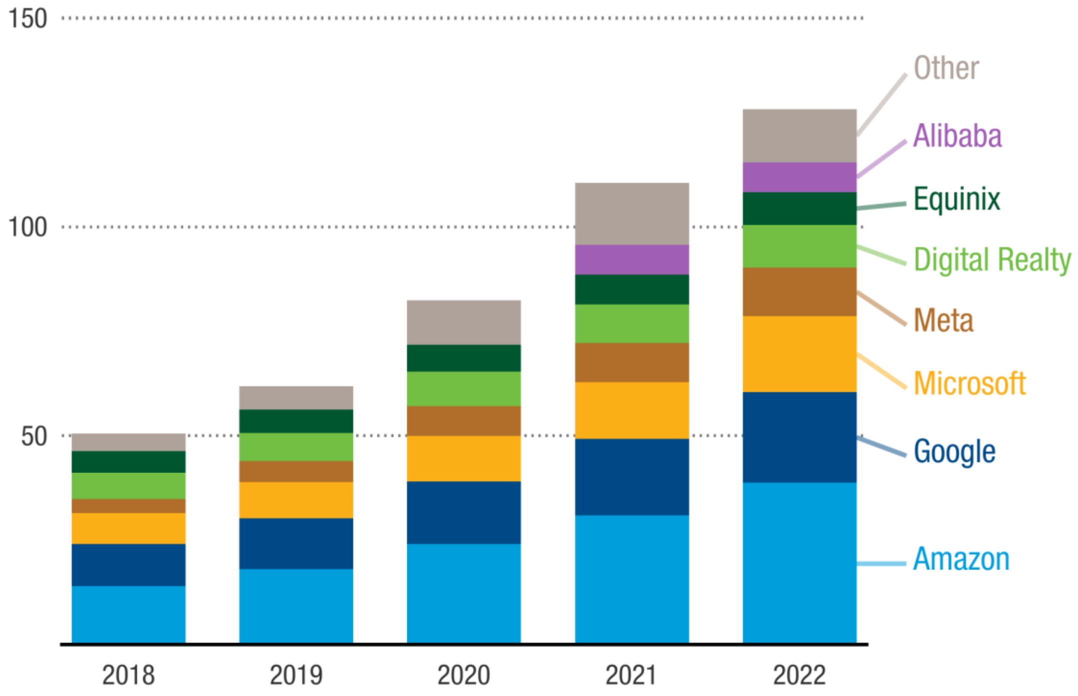
Noise

Measures to reduce impact

- Enhance energy and cooling efficiency
- Allow higher operation temperatures
- Make code more efficient and tailor software
- Address storage of rarely used data
- Switch to low-carbon energy sources

Electricity use by 13 of the world's largest data centre operators more than doubled between 2018 and 2022

Annual electricity consumption by selected data centre operators, terawatt hours, 2018–2022



Source: UN Trade and Development (UNCTAD), based on company reports.
Note: Other includes: Apple, Baidu, Chindata, GDS, Tencent, VNET.

Sources: IEA (2024), Ireland CSO (2023), Singapore MCI (2021).

Compute-intensive technologies

AI, blockchain, 5G and IoT increase data processing needs and the environmental footprint of ICTs

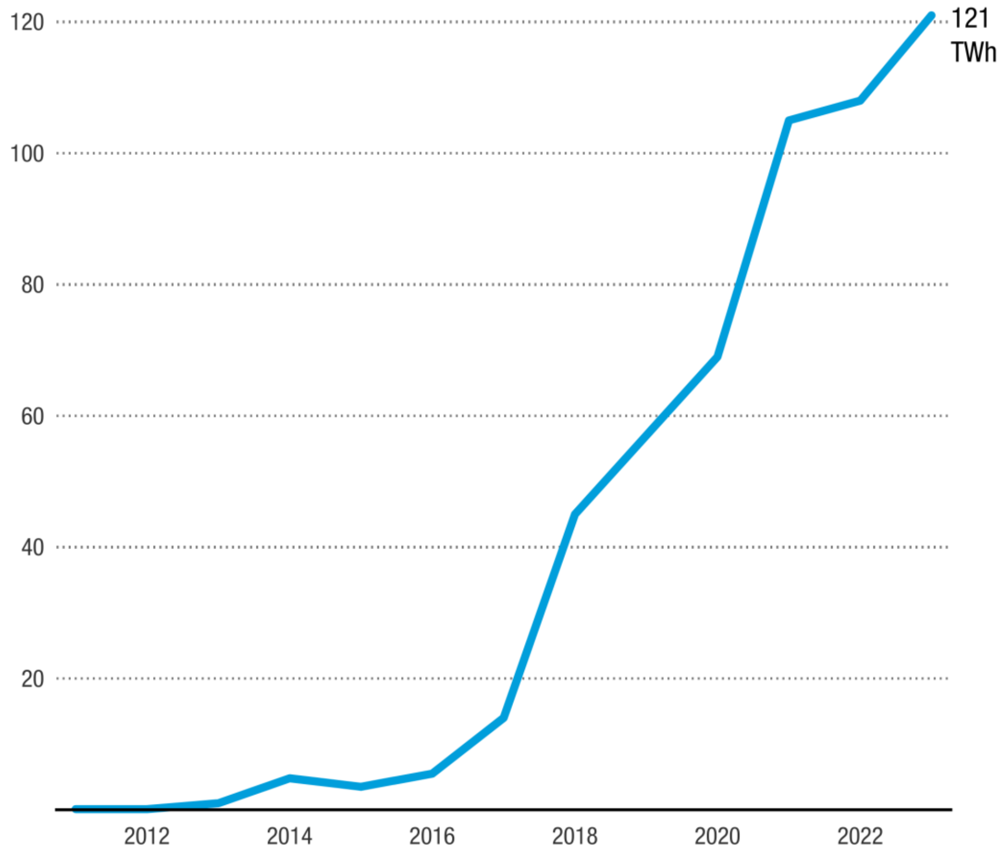
- Meta's machine-learning demand has doubled annually
- Blockchain energy demand expected to increase by 50% between 2022–2026

In view of expansion of compute-intensive technologies

- Essential to use low-carbon electricity, enhance data centre efficiency and manage equipment waste
- Improve availability of data on environmental footprint

Bitcoin's energy consumption has risen steeply over last decade

Annual bitcoin energy consumption, terawatt hours (TWh), 2010–2023



Source: UN Trade and Development (UNCTAD) calculations based on Cambridge Centre for Alternative Financing (2023).

Sources: Meta (2022), Li, Yang, et al. (2023), IEA (2024).

Data centres in developing countries

Africa

- Less than 1% of global capacity, 2/3 of which is in South Africa
- **Electricity outages** remain an obstacle
- **Growth drivers:** Rising Internet users and data sovereignty
- Electricity demand to rise from 1 to 5 TWh (2020–30)
- **Market value** may reach $3 billion by 2025
- Opportunity to **jointly develop grid and ICT infrastructure**
- **Spearhead integration of sustainability metrics** in data centre development

Asia

- **Market value** may reach $28 billion by 2024
- **Growth drivers**: Global cloud providers, social media, video streaming, e-commerce, banking
- **Main countries**: China, India, Singapore, Indonesia, Malaysia, and Thailand
- Drive towards **sustainability policies** for data centres to address emissions and concerns linked to tropical climate

Latin America and the Caribbean

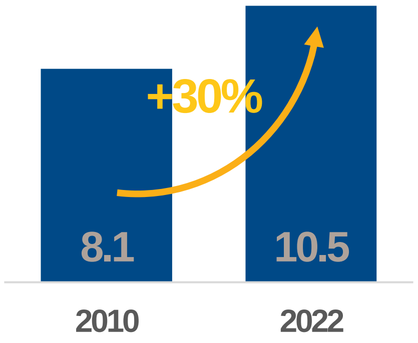
- Around 30 data centres with 15–20 MW capacity
- **Main countries**: Brazil leads, followed by Chile, Colombia and Mexico
- **Investments** of $9 billion expected (2021–2027)
- Hyperscale data centres under civil society pressure for cleaner operations
- Concerns over high water use
- Brazil: Initiative to study data centre development and renewable energy

Sources: Kadium Limited (2022), Africa Data Centres Association (2021), IEA (2022d); EcoBusiness Research (2020), Digital Centre (2021); Echeberría (2020).

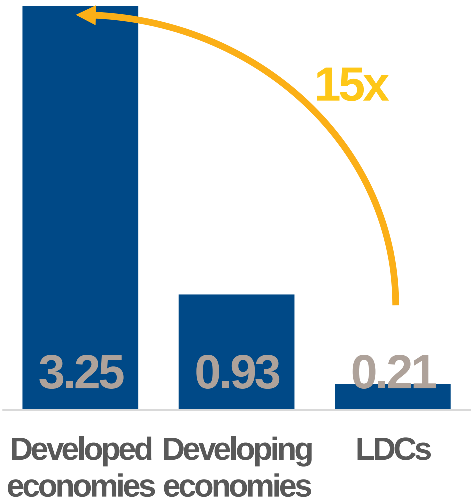
Digitalization-related waste is growing, with uneven regional implications

Regional disparities are significant and mirror digital divides

Waste from screens, monitors and small IT equipment
(million tons)



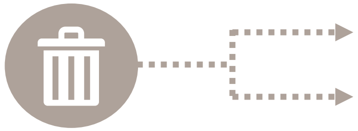
Waste per capita
(kg in 2022)



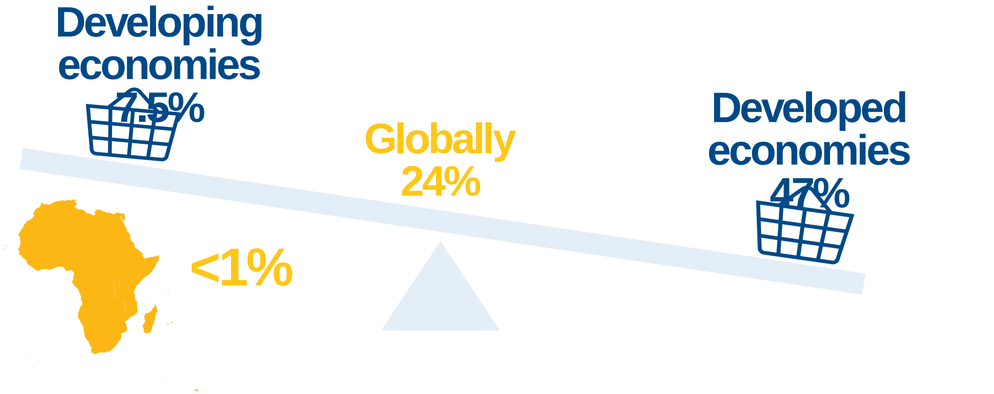
Top contributors

Top contributors

Digitalization-related waste



Formal waste collection rates



- Lack of formal collection systems
- Few developing countries have relevant waste legislation, only 20% of African countries

Source: UN Trade and Development calculations based on UNITAR-SCYCLE.

Towards environmentally sustainable digitalization that works for inclusive development

Policy actions

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UNCTAD

A new policy mindset is required to address key challenges

Innovative approaches needed

Embrace new business models and strategies that maximize digitalization’s positive impacts while minimizing the negatives

Reduce consumption
to optimize scarce resource use without harming future generations

Leverage digitalization-related waste
to transform waste into opportunities for recovery, recycling and reuse within a circular economy

Cut carbon emissions
to prevent catastrophic climate change

Shifting towards a circular digital economy for inclusive and sustainable development

Boost opportunities through business growth and job creation

Use low-carbon energy

Build adaptive and resilient infrastructure

Recover resources from devices

Reduce wasteful use of digital networks, products, services

Prioritize repair, reuse, refurbishment and recycling

Key actions along the digital life cycle

- **Design for sustainability**: create platforms and products that foster sustainable consumption
- **Encourage resource efficiency**: promote sufficiency and frugality to curb overconsumption
- **Maximize resource value**: facilitate recovery and reuse

Addressing the double bind of developing countries

Developing countries bear the brunt of the costs of digitalization, while developed countries capture most digital economy value

Raw material extraction | **Digital waste** | **Climate vulnerability** | **Digital divides**

Common but differentiated responsibilities reflecting

- Historical responsibilities
- Countries' capabilities
- Level of development

Policy implications:

- Digitally-developed countries need to lead in ensuring the global transition towards an inclusive and sustainable digital future
- And support developing countries in building capacities to harness digitalization

Bold action is needed at national and international level

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National level

- Integrate digital strategies with economic inclusion and environmental sustainability strategies
- Focus on reducing GHG emissions, conserving water and minimizing waste using digital solutions, while considering the environmental footprint of digitalization

International level

- Strategies and policies that recognize diverse needs and priorities for all countries, recognising opportunities for esp. for developing ones
- Development partners should support to low-income countries to strengthen capabilities for digitalization, circularity and environmental sustainability

Upcoming policy dialogues

Summit of the Future
Our Common Agenda
Global Digital Compact

working together towards 2025
World Summit on the Information Society
Turning targets into action
Geneva 2003 | Tunis 2005 | New York 2015

2030 Agenda for Sustainable Development

“

A just and sustainable digital economy requires just and sustainable policies

António Guterres
Secretary-General
United Nations

For more information

unctad.org/der2024