UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

2024

Digital economy report

Shaping an environmentally sustainable and inclusive digital future

OVERVIEW

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Note

Within the UNCTAD Division on Technology and Logistics, the E-commerce and Digital Economy Branch carries out policy-oriented analytical work on the development implications of information and communications technologies (ICTs) and electronic commerce (e-commerce). The branch is responsible for the preparation of the *Digital Economy Report*, previously known as the *Information Economy Report*. The E-commerce and Digital Economy Branch promotes international dialogue on issues related to ICTs for development and contributes to building developing countries' capacities to measure e-commerce and the digital economy and to design and implement relevant policies and legal frameworks. The branch also manages the eTrade for all initiative.

In this report, the terms country/economy refer, as appropriate, to territories or areas. The designations of country groups are intended solely for statistical or analytical convenience, and do not necessarily express a judgement about the stage of development reached by a particular country or area in the development process. Unless otherwise indicated, the major country groupings used in this report follow the classification of the United Nations Statistics Division. These are:

Developed economies: member countries of the Organisation for Economic Co-operation and Development (OECD) (excluding Chile, Colombia, Costa Rica, Mexico and Türkiye), European Union member countries that are not OECD members (Bulgaria, Croatia, Cyprus, Lithuania, Malta and Romania), as well as Albania, Andorra, Belarus, Bermuda, Bosnia and Herzegovina, Liechtenstein, Monaco, Montenegro, North Macedonia, the Republic of Moldova, the Russian Federation, San Marino, Serbia and Ukraine, plus the territories of Faroe Islands, Gibraltar, Greenland, Guernsey and Jersey.

Developing economies are all countries not specified above.

A file with the main country groupings used can be downloaded from UNCTADstat at http://unctadstat.unctad.org/EN/Classifications.html.

References to China do not include data for Hong Kong (China), Macao (China) or Taiwan Province of China.

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The term "dollars" ($) refers to United States dollars, unless otherwise indicated.

The term "billion" signifies 1,000 million.

The following symbols may have been used in the tables:

Two dots (..) indicate that data are not available or are not separately reported.

A slash (/) between dates representing years, e.g. 1994/95, indicates a financial year.

Use of an en dash (–) between dates representing years, e.g. 1994–1995, signifies the full period involved, including the beginning and end years.

Annual rates of growth or change, unless otherwise stated, refer to annual compound rates.

Details and percentages in tables do not necessarily add up to the totals because of rounding.

Preface

Digitalization continues to move at warp speed, transforming lives and livelihoods. At the same time, unregulated digitalization risks leaving people behind and exacerbating environmental and climate challenges.

The *Digital Economy Report 2024* highlights the direct environmental impact of our increased reliance on digital tools – from raw material depletion, water and energy use, air quality, pollution, and waste generation. These are accentuated by emerging technologies such as artificial intelligence and the Internet of things.

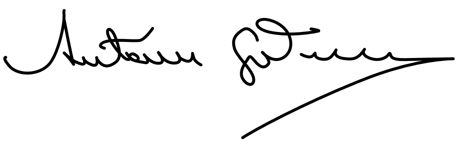
A just and sustainable digital economy requires just and sustainable policies.

Yet many developing countries continue to face obstacles in accessing digital technologies for their development needs, while bearing the brunt of environmental depletion, waste and climate change.

We cannot address digitalization and environmental sustainability in silos. This report calls for more comprehensive data on the environmental impact of digitalization, and digital policy frameworks that advance the Sustainable Development Goals and honour climate commitments.

As we prepare for the Summit of the Future and the Global Digital Compact, the United Nations offers a natural platform to bring together stakeholders from the digital and environmental communities.

Together, we can harness the benefits of digitalization while closing the digital divide and protecting our planet. This report is an important resource as we strive to build a just and sustainable digital future for all.



António Guterres
Secretary-General of the United Nations

Foreword

The digital economy, often praised for its virtual and intangible nature, has created the illusion of a world unburdened by material waste. However, this Digital Economy Report 2024 starkly reveals the fallacy of this perception. The information and communications technology sector's carbon footprint in 2020, estimated at between 0.69 and 1.6 gigatons of carbon dioxide (CO_2) equivalent emissions, accounted for 1.5 to 3.2 per cent of global greenhouse gas emissions – at the upper range, slightly below the entire shipping industry's contribution to CO_2 emissions. The production of a single 2 kg computer requires the extraction of a staggering 800 kg of raw materials.

These figures are only set to rise, with the production of minerals essential for the digital transition, such as graphite, lithium and cobalt, projected to surge by 500 per cent by 2050 to meet the growing demand for digital and low-carbon technologies. Data centres, the backbone of the digital world, consumed an estimated 460 TWh of electricity in 2022, a figure projected to double by 2026. The number of semiconductor units quadrupled from 2001 to 2022 and continues to grow. Fifth-generation mobile broadband coverage is expected to increase from 25 per cent of the population in 2021 to 85 per cent by 2028, while the number of Internet of things devices is projected to grow from 16 billion in 2023 to 39 billion in 2029. This expansion, coupled with the growing popularity of e-commerce, which saw business sales rise from $17 trillion in 2016 to $27 trillion in 2022 in 43 countries, paints a complex picture of the digital economy's environmental impact.

This report serves as a wake-up call, urging us to confront the environmental consequences of our digital lifestyles.

The environmental impact of digitalization is a global issue, but its effects are not evenly distributed. Developing countries, often rich in the resources needed for digital technologies, bear a disproportionate burden of its costs while reaping limited benefits. For example, discarded smartphones, laptops, screens and other electronic devices grew by 30 per cent between 2010 and 2022, reaching 10.5 million tons globally. Developed countries generated an average of 3.25 kg of e-waste per person, compared to less than 1 kg in developing countries and 0.21 kg in least developed countries. Shockingly, only 24 per cent of this waste was formally collected globally in 2022, with a mere 7.5 per cent collected in developing countries.

Another point to consider is the impact of the extraction of minerals essential for digital technologies on environmental and social sustainability. Such extraction is often sourced through artisanal and small-scale mining, which is often associated with unsafe working conditions, environmental degradation and exploitation of vulnerable communities, including children. These circumstances highlight the urgent need for greater transparency and responsible sourcing practices within the digital supply chain, ensuring that the pursuit of technological progress does not come at the expense of vulnerable communities or the environment.

Yet, despite these challenges, digitalization also holds immense potential for environmental good. Digital technologies can drive energy efficiency, optimize resource use and enable innovative solutions for climate change mitigation and adaptation.

This report emphasizes the need for a balanced approach. We must harness the power of digitalization to advance inclusive and sustainable development, while mitigating its negative environmental impacts. This requires a shift towards a circular digital economy, characterized by responsible consumption and production, renewable energy use and comprehensive e-waste management.

As we navigate this complex landscape, international cooperation is paramount. We must strive for equitable distribution of the benefits and costs of digitalization, ensuring that no one is left behind in the digital age. We must work together to establish comprehensive global governance frameworks that promote sustainable digital practices and empower developing countries to participate fully in the digital economy.

The Digital Economy Report 2024 draws attention to an important area. It underscores the urgent need for action at all levels – from Governments and businesses to international organizations and civil society. We must embrace a new mindset that considers sustainability at every stage of the digital life cycle.

I am confident that this report will provide valuable insights and recommendations for policymakers, industry leaders and all stakeholders committed to building a sustainable digital future. The choices we make today will determine the kind of world we leave for generations to come. Let us seize this opportunity to create a digital economy that thrives in harmony with our planet.

Rebeca Grynspan
Secretary-General of UNCTAD

Acknowledgements

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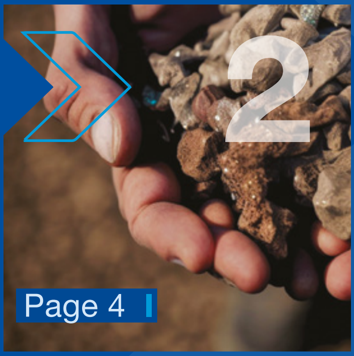

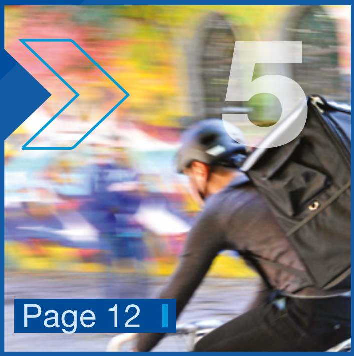

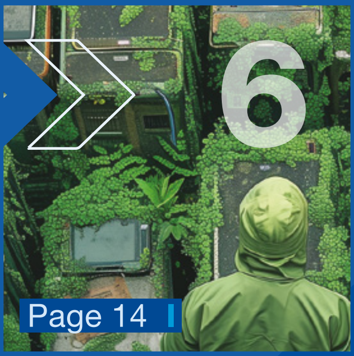

The *Digital Economy Report 2024: Shaping an Environmentally Sustainable and Inclusive Digital Future*

highlights the urgent need for sustainable strategies throughout the life cycle of digitalization. From raw material extraction and usage of digital technologies to waste generation, the report explores the nature and scale of the sector's environmental footprint, which remains largely unassessed. What is apparent is that developing countries are suffering disproportionately from digitalization's negative environmental effects, as well as missing out on economic developmental opportunities due to digital divides. UNCTAD calls for global policies involving all stakeholders to enable a more circular digital economy and reduced environmental footprints from digitalization, while ensuring inclusive development outcomes.

SECTION 1

Understanding the nexus of digitalization and environmental sustainability is increasingly important

Digitalization continues to transform the world economy and society, creating both opportunities and challenges for sustainable development.

Previous editions of the *Digital Economy Report* have largely focused on the implications of digitalization for inclusive development, the importance of bridging digital and data-related divides, enabling value creation and capture in developing countries and fostering better governance of data and digital platforms.

The *Digital Economy Report 2024* turns attention to the environmental footprint of digitalization. The topic is timely, not to say overdue. Digital transformation is taking place in parallel with growing concerns related to the depletion of raw materials, water stress, climate change, pollution and waste generation, which are all linked to planetary boundaries.

The rapid pace and expanding scope of digitalization make it increasingly important to understand the relationship between digitalization and environmental sustainability. How the world's ongoing digital transformation is managed will greatly influence the future of humanity and the health of the planet.

Environmental impacts are generated along the whole digitalization life cycle

Direct environmental impacts from digital devices and from information and communications technology (ICT) infrastructure occur along the life cycle, taking place during the production phase (raw material extraction and processing, manufacturing, distribution), the use phase and the end-of-life phase. The direct effects on natural resources, including on transition minerals, energy and water, as well as greenhouse gas (GHG) emissions and waste-related pollution, constitute the "environmental footprint" of the ICT sector.

There are also indirect environmental effects from the use of digital technologies and services in different sectors of the economy. These extend beyond digitalization's direct footprint and can be both positive and negative. For example, digital technologies can help to improve energy efficiency, reducing demand across all sectors. Digital technologies can be used to cut GHG emissions in the transportation, construction, agriculture and energy sectors. However, the potential gains may be reduced or counterbalanced by "rebound effects", in that digitalization may increase the consumption of goods and services, with negative effects on the environment as a result. Policies can greatly influence the net impact.

Digitalization is evolving rapidly, leaving a growing environmental footprint

Internet users have increased from 1 billion in 2005 to 5.4 billion in 2023

In the past two decades, the world has experienced a digital shift few would have anticipated at the time of the World Summit on the Information Society in 2005, creating new opportunities for economic and social development, as well as new challenges. According to the International Telecommunication Union, the number of Internet users surged from 1 billion in 2005 to 5.4 billion in 2023. Between 2010 and 2023, estimates of annual shipments of smartphones more than doubled, from 500 million to about 1.2 billion.

From 2001 to 2022, the number of semiconductor units sold quadrupled, and these numbers keep expanding. Network infrastructure, including submarine cables and communications satellites, offers ever faster ways of connecting more people and machines. Fifth generation (5G) mobile broadband population coverage is expected by some market estimates to rise from 25 per cent in 2021 to 85 per cent in 2028.

Internet-connected objects are expected to increase from 13 billion in 2022 to 35 billion in 2028

Higher connection speeds enable more data to be generated, collected, stored and analysed, and this is central to emerging technologies such as big data analytics, artificial intelligence (AI) and the Internet of things (IoT). The number of Internet-connected objects is expected to rise from 13 billion in 2022 to 35 billion in 2028.

While digital technologies can be used to mitigate various environmental concerns, the growing numbers of end-user devices, investments in data transmission networks and data centres and more computationally intensive digital applications, such as AI and blockchain technology, are also translating into a growing environmental footprint. In the current highly linear digital economy production model – based on take/extract–make–use–waste – this leads to more demand for raw materials, water and energy, greater emissions of GHGs and more waste at the end-of-life phase.

It is difficult to assess the impact of digitalization on the environment

This report points to the need for building a stronger evidence base to allow for comprehensive assessments of the environmental effects of digitalization. There is a lack of timely, comparable and accessible data and there are few harmonized reporting standards. Analytical studies rely on a variety of sources that are quickly becoming outdated due to the speed of digital developments; for example, existing studies do not adequately capture the environmental impact of recent developments in AI or the shift to 5G mobile networks.

The ICT sector is estimated to have accounted for 1.5–3.2 per cent of global GHG emissions in 2020

In some sectors, there is also limited disclosure of impacts. Results diverge considerably due to variations in methodologies, assumptions or the models used to estimate environmental impacts. For example, estimates of the ICT sector's life cycle GHG emissions for 2020 vary widely, from 0.69 gigatons to 1.6 gigatons of CO_2 equivalent (CO_2e) emissions, corresponding to 1.5–3.2 per cent of global GHG emissions in that year.

The impact of the ICT sector on water use is often overlooked, and there is a need for more transparent and reliable information on this. Water use at all stages of the digitalization life cycle can severely impact local biodiversity and livelihoods. Similarly, mining, an integral component of the production phase of digitalization, is highly water intensive. This can lead to competition for water resources between mining operations, agriculture and local households.

Likewise, semiconductor production requires large amounts of extremely pure water, and data centres consume a lot of water both indirectly, to generate electricity, and directly, to cool servers. Water pollution can result from the final phases of the digitalization life cycle when contaminants from electronic components leach into groundwater due to improper e-waste disposal and dumping. This type of pollution can adversely affect biodiversity and human health.

SECTION 2

Digitalization’s promise of dematerialization has not yet materialized

Available research suggests that the production phase of digitalization has the greatest combined negative impact on the environment. This is due to mineral and metal production, the volume of GHG emissions generated and water-related impacts. For example, in the case of smartphones, around 80 per cent of GHG emissions are attributed to the production phase.

The shift to low-carbon and digital technologies is driving the growing demand for key minerals

Many consider the digital economy to be virtual, intangible or in the “cloud”, but digitalization heavily relies on the physical world and raw materials. Digital devices, hardware and infrastructure are composed of plastics, glass and ceramics, as well as dozens of minerals and metals. It has been estimated that making a 2 kg computer involves extracting 800 kg of raw materials.

The key minerals and metals used for digitalization include aluminium, cobalt, copper, gold, lithium, manganese, natural graphite, nickel, rare earth elements and silicon metal, and these are almost identical to those required for the shift towards a low-carbon economy. The growing demand for these materials is greatly driven by the shift to low-carbon and digital technologies.

According to an assessment by the World Bank, production of minerals such as graphite, lithium and cobalt could see an increase of 500 per cent by 2050 to meet growing demand. The global energy and climate model of the International Energy Agency (IEA) revealed that consumption of platinum group minerals could be 120 times higher in 2050 than in 2022. Such trends risk meeting the limits of the availability of minerals on a planet with finite resources.

Geopolitical concerns could exacerbate digitalization's environmental footprint

The global minerals and metals market is highly concentrated geographically in terms of reserves, extraction and processing activities. For example, concerning extraction, in 2022, the Democratic Republic of the Congo produced 68 per cent of the world's cobalt. Australia and Chile produced 77 per cent of the world's lithium, and Gabon and South Africa produced 59 per cent of the world's manganese.

For China, shares of world production stood at 65 per cent for natural graphite, 78 per cent for silicon metal and 70 per cent for rare earth elements. China also plays a major role in terms of mineral processing, accounting for more than half of global mineral processing for aluminium, cobalt and lithium, about 90 per cent for manganese and rare earth elements, and close to 100 per cent for natural graphite.

Securing access to the supply of critical minerals has become a strategic priority, particularly for developed and developing countries that are important producers of goods needed for the transition towards a low-carbon and digital world. In some countries, efforts to secure mineral and metal supplies may inadvertently encourage hoarding and lead to overcapacity in production facilities. This may result in less efficient processes and an unnecessarily large environmental footprint for the digital economy.

Changing industrial policies reflect the strategic importance of critical minerals

The strategic importance of certain raw materials has triggered new policymaking.

As Asia, particularly China, emerged as the global electronics manufacturing hub, proximity to markets of intermediary products and components has bolstered burgeoning mineral processing activities. As China strives to improve its performance in strategic technology sectors, such as AI and low-carbon technology, there is an increased demand for minerals that are essential to these industries. Recent years have also seen a revival of industrial policies in some developed countries related to transition minerals and associated industries (including electronics). The focus in some global supply chains has shifted from "just in time" to "just in case" approaches.

In the United States of America, for example, the President has called for securing a made in America supply chain for critical minerals, and the 2022 Inflation Reduction Act in the country establishes percentages of critical minerals that must be mined, processed or recycled domestically.

The European Union, in its Critical Raw Materials Act of 2023, sets 2030 benchmarks for the strategic raw materials value chain and for diversifying its supplies. Both the United States and the European Union have also taken measures to support domestic production of semiconductors.

Resource-rich developing countries should benefit

If resource-rich developing countries can add more value to the minerals extracted, make effective use of proceeds from the raw materials and diversify into other parts of the value chain and other sectors, the increased demand for minerals and metals required for digitalization can be leveraged as an opportunity for development.

There is a fundamental need to reverse the ecologically unequal exchange

In this context, there is a fundamental need to reverse trade imbalances, wherein developing countries export raw minerals and import higher value added manufactures, which contributes to an ecologically unequal exchange.

It is also imperative to minimize negative environmental and social impacts, including human rights concerns. To achieve a more inclusive and environmentally sustainable digital economy, a balanced global policy response is needed that seeks to achieve responsible and sustainable consumption and production, and reflects the interests of both exporters and importers of raw materials.

Digital use is boosting energy and water consumption

As more people, businesses, Governments and organizations around the world make use of digital services, consumption of energy and water related to devices and ICT infrastructure has increased significantly.

When considering the life cycle of data transmission networks and data centres, the bulk of energy and GHG emissions stem from the use phase. For devices, on the other hand, the proportion of such emissions generated during the use phase is smaller, although this can vary depending on the device and the energy mix used. Emissions related to desktop computers and televisions occur largely during the use phase, while for smartphones, tablets and laptops, the production phase generates most of the emissions.

Data centres exert a significant environmental impact during the use phase. The expanding data-driven digital economy increasingly relies on data centres with huge storage and computing capacity, and these consume large amounts of both energy and water.

The estimated electricity consumption by 13 of the largest data centre operators more than doubled between 2018 and 2022; consumption was led by Amazon, Alphabet, Microsoft and Meta. And there is more to come. According to IEA, worldwide, electricity for data centres amounted to about 460 TWh in 2022, a figure that could more than double to 1,000 TWh by 2026. By way of comparison, total electricity consumption in France was about 459 TWh in 2022.

In some countries, growing data centre activity has put a strain on the local electricity grid. In Ireland, electricity use by data centres more than quadrupled between 2015 and 2022, representing 18 per cent of total electricity consumption in 2022. Projections indicate that this could reach 28 per cent by 2031.

In Singapore, where data centres were responsible for around 7 per cent of all electricity demand in 2020, the Government imposed a moratorium on new data centres and later replaced it with stricter conditions on the use by data centres of electricity, water and land.

Digital technologies have a significant water footprint which comprises a substantial part of their overall environmental impact. However, information on the impacts on water consumption is limited. Data centres not only have considerable electricity needs but also require water for cooling. Water usage and the impact of data centres on local water resources needs to be assessed in a location-specific context, as the choice of cooling technology is influenced by the local climate and resource availability; comparisons between regions with plentiful water supplies and those facing severe water shortages require vastly different considerations. While some cooling technologies can operate with less water, these technologies may consume more electricity instead. Therefore, water and electricity use by data centres should be considered holistically.

Energy consumption is accentuated by compute-intensive technologies

The environmental impacts of digitalization also vary depending on the activities and technologies involved. New digital services and their increasingly sophisticated technologies, such as blockchain, AI, 5G mobile networks and IoT, are poised to greatly increase the demand for data processing and storage and significantly affect the environmental footprint of the ICT sector. Some technologies, such as AI and blockchain, will primarily impact data centres. Others, such as 5G networks and IoT, will largely affect networks and devices. Managing and reducing the related environmental impacts will require concerted efforts from technology companies and policymakers.

Artificial intelligence and machine learning in particular require extensive computing resources and dedicated hardware. Understanding their energy and water use will become critical as mainstream applications, such as Gemini (formerly Bard), ChatGPT and Ernie, become more widely adopted.

For example, Meta's computing demand for machine-learning training and application has increased annually by more than 100 per cent in recent years. In the case of Microsoft, training of GPT-3 (a large language model on which ChatGPT is based) in its data centres in the United States has been estimated to have directly consumed 700,000 litres of potable water for cooling.

Cryptocurrency mining is another energy-intensive activity, especially when relying on a "proof-of-work" blockchain consensus mechanism, a process that requires significant computational power. According to the Cambridge Centre for Alternative Finance, the global energy consumption of bitcoin mining, the most prominent cryptocurrency, rose about 34 times between 2015 and 2023 to reach an estimated 121 TWh.

Understanding the energy and water footprints of AI and cryptocurrencies is crucial when assessing the environmental impacts of such technologies. Such operations should, to the greatest extent possible, be powered by low-carbon electricity. Operators also need to continue to improve the energy and water efficiency of data centres, while limiting the waste generated from frequent equipment replacements. At the same time, the scope for further efficiency improvements in these areas remains uncertain, partly due to the physical limits of transistors, which are fundamental building blocks of electronic devices.

SECTION 4

Waste related to digitalization is expanding, with uneven regional implications

An average person generates 3.25 kg of waste in developed countries, under 1 kg in developing countries, and 0.21 kg in LDCs

Waste from digitalization is a growing environmental concern. Between 2010 and 2022, the volume of waste from screens and monitors as well as small IT and telecommunications equipment expanded by 30 per cent globally, from 8.1 million to 10.5 million tons (not including waste from various IoT devices, batteries and communications satellites).

In 2022, the largest contributors of such waste were China, the United States and the European Union. In per capita terms, developed countries generated on average 3.25 kg of waste compared with less than 1 kg in developing countries and 0.21 kg in the least developed countries (LDCs). In the United States, an average citizen generated 25 times more waste than an average citizen in LDCs. These significant disparities reflect the digital divide between countries in terms of access, affordability and use of digital devices and equipment.

While it is important to address the considerable overconsumption in high-income countries and be mindful of the waste generated, it is also important to recognize that many developing countries still need to digitalize further in order to participate effectively in the global economy and society. This digitalization process will inevitably involve consumption, highlighting the complex balance between sustainability and economic development.

The growth in digitalization-related waste is due to several factors that include increased consumption of electronic devices and ICT equipment with shorter life spans; insufficient awareness among consumers about the waste implications of their devices; a linear model of production; and limited options for repairing or upgrading existing devices.

New models with higher performance quickly replace existing models or make them redundant. Planned obsolescence by producers, for example by making smartphones work more slowly over time or phasing out support for older versions of software, adds to the growing waste problem.

Encouragingly, concerns about planned obsolescence and limits to the right to repair have led to strong reactions from civil society. This is helping to raise awareness and spark calls for appropriate policy responses.

Digitalization-related waste collection needs to expand

Current rates of formal collection of digitalization-related waste remain low, especially in developing countries. While the global average for formal collection of digitalization-related waste amounted to 24 per cent of all waste in 2022, this figure dropped to just 7.5 per cent in developing countries. Even in developed countries, despite generally better formal collection systems, an average collection rate of 47 per cent is not high enough.

Only 24 per cent of digital waste was formally collected globally in 2022, with just 7.5 per cent in developing countries

Waste management brings significant challenges. In developing countries, formal collection systems to manage digitalization-related waste in an environmentally sound manner are often lacking, and much of the waste is handled by the informal sector. Moreover, only one in four developing countries has adopted relevant legislation for managing waste from digitalization.

Available data and research indicate a pattern of unequal ecological exchange in the international trade of waste related to digitalization. This is due to the largely uncontrolled trade in used digital equipment, which typically moves from developed to developing economies.

In contrast, the higher-value parts of this waste for processing or treatment (such as printed circuit boards) are mostly exported from developing to developed countries. As a result, developing countries remain locked in the low value part of the waste value chain (e.g. uncontrolled trade in used electronic equipment), yet bear the burden of various related environmental and social costs.

E-commerce should become more environmentally sustainable

Business e-commerce sales rose from \$17 trillion in 2016 to \$27 trillion in 2022 in 43 countries

People and businesses are increasingly going online to buy goods and services. E-commerce represents an important application of digital technologies, with implications for both domestic and international trade.

Since the beginning of this century, the number of people shopping online has surged from less than 100 million to some 2.3 billion in 2021. The value of sales across the world's top 35 e-commerce platforms has boomed in recent years, from \$2.6 trillion in 2019 to more than \$4 trillion in 2021, led by Alibaba, Amazon, JD.com and Pinduoduo.

UNCTAD estimates that the total value of e-commerce sales by businesses, in the 43 developed and developing countries for which data are available, rose from \$17 trillion in 2016 to \$27 trillion in 2022. Most of these sales are domestic, but the share of international e-commerce is growing. At the same time, the shift to e-commerce has only just started in most developing countries, particularly in LDCs.

E-commerce is disrupting economic processes and consumption patterns, with positive and negative implications for environmental sustainability. While precise impact assessments of the environmental impact of e-commerce are hindered by limited data, the net effect depends on how businesses handle warehousing, storage, transportation, logistics, packaging and returns. Consumer behaviour plays a role, too.

E-commerce has boosted consumption due to enhanced accessibility and convenience, lower prices, greater product variety and wider reach of online marketing. More frequent purchases across different platforms and retailers – including more impulse buying – leads to overconsumption, causing increased transportation emissions and waste.

Making e-commerce more environmentally sustainable requires a greater emphasis on circular business models, ethical sourcing and production, energy-efficient logistics and adopting renewable energy and eco-friendly delivery solutions, as well as sustainable packaging and finding ways to promote sustainable consumption.

Policymakers can facilitate these changes through an appropriate mix of legislative, regulatory instruments and tax mechanisms to reduce CO_2 emissions in transportation and minimize waste from e-commerce. This will require a collaborative effort between Governments, businesses, platforms, logistics providers and consumers.

SECTION 6

A new policy mindset is required

There is a need for new business models, policies and strategies that maximize the positive impact of digitalization on sustainability while minimizing the negative impacts.

Digital development should be assessed in light of several critical challenges: the need to reduce overall consumption and optimize the use of scarce resources without jeopardizing the prospects of future generations; the need to curtail carbon emissions and prevent catastrophic climate change; and the need to turn the accumulation of digitalization-related waste into an opportunity for recovery, recycling and reuse in a circular economy.

Achieving an inclusive and environmentally sustainable digital economy requires a shift towards circularity

According to the Circle Economy Foundation, the global economy is still only 7.2 per cent circular, showing a declining trend driven by rising material extraction and use.

A shift towards a more circular digital economy would optimize the economic and environmental impacts of digitalization, including supporting business opportunities and job creation. This means using renewable energy and adaptive and resilient infrastructure;

reducing wasteful use of digital networks, products and services; increasing repair, reuse, refurbishment and recycling of devices; and significantly improving the recovery of material resources from digitalization-related waste.

Achieving greater circularity requires change at all stages of the digital life cycle: designing platforms, products and services in ways that foster sustainable consumption by default; encouraging sufficiency and frugality in the use of resources where overconsumption is currently prevalent; and facilitating the recovery and reuse of resources to maximize their value.

Many developing countries are in a double bind, experiencing limited benefits of digitalization and suffering high exposure to its negative environmental impacts

Currently, the distribution of benefits and costs from digitalization is skewed. Most of the value added in the digital economy is captured by developed and some digitally advanced developing countries, while many of the costs are most harshly felt in other developing countries.

Countries at different levels of development are unevenly affected by environmental impacts related to the various stages of the digitalization life cycle. Many developing countries are providers of key raw materials, and some are the destination for significant digitalization-related waste. At the same time, developing regions are often at the tail end of global trade, where opportunities for value addition and economic growth are limited.

Moreover, developing countries tend to be more affected by climate change, which can limit their options for socioeconomic development. Finally, developing countries often lack the resources and capacity to use digital technologies for mitigating negative environmental impacts (box).

There are risks that LDCs in particular will fall further behind in terms of both digital development and environmental sustainability. Achieving environmentally sustainable digitalization that fosters inclusive development will require a reversal of the unequal ecological exchange and vulnerabilities faced by developing countries.

Against this backdrop, and in line with the principle of common but differentiated responsibilities, the extent and nature of responsibility for environmental protection varies according to each country's capabilities, historical responsibilities and level of development.

Economies that are more digitally developed have a particular responsibility to ensure a global transition towards an inclusive and sustainable digital future by devising and implementing policies to reduce digitalization's environmental footprint and to enhance the capacity of developing countries to benefit from digitalization.

Balancing climate needs with digital transformation in developing countries

Digital divides remain a significant barrier to socioeconomic development. While there is great potential for most developing countries to benefit from digital transformation, many countries have seen relatively limited benefits to date. A lack of financial and human resources often hampers the ability to harness digital infrastructure for sustainable development. At the same time, many countries struggle to use digital solutions for dealing with climate change and other environmental risks.

As historic responsibilities for environmental challenges lie predominantly with today's developed countries, which have also reaped the greatest gains from digitalization, tailored and nuanced solutions are needed to advance digital transformation in developing regions and balance environmental impacts. Policy responses should reflect the disproportionate role that developed countries have played in both technological progress and environmental degradation. Integrating policies on digitalization and environmental stewardship is essential. More international cooperation will be vital for low-income countries to participate in a global and environmentally sustainable digital transformation. Developed and digitally advanced countries can do more to support capacity-building for strengthening the digital readiness of countries trailing behind, as well as deploying digital solutions to mitigate climate change.

Source: UNCTAD.

Bold and resolute action at national and international levels is imperative

Policy efforts at the national level are more likely to prove successful if implemented as part of digital strategies developed with economic inclusion and environmental sustainability in mind. Similarly, government strategies to mitigate GHG emissions, conserve water resources and reduce waste generation should pay adequate attention to the environmental footprint of digitalization and to how digital technologies can offer solutions to environmental concerns.

Policies and strategies at the international level should acknowledge the needs and priorities of all countries and highlight opportunities for developing countries to benefit from the potential that digitalization offers. Development partners should offer adequate support to low-income countries to strengthen their capabilities for digitalization and environmental sustainability and to ensure that they can participate effectively in a more circular global digital economy. Several international developments provide opportunities for further advancement.

The World Summit on the Information Society (WSIS), which first established global goals for digital development in the early 2000s, will be reviewed by the United Nations General Assembly in 2025.

The 2030 Agenda for Sustainable Development, which was approved in 2015 and has sought to embed environmental sustainability at the heart of the international agenda, will be reviewed at the end of this decade.

Even before either of these reviews, the United Nations General Assembly will hold a Summit of the Future and agree on a pact for the future with parts emphasizing sustainable development and digital cooperation. The pact is expected to include a global digital compact, which is to set out principles, objectives and actions for digital development that support the Sustainable Development Goals.

More effective global governance is needed

There is currently no inclusive global governance framework in place to help galvanize collective action and facilitate knowledge-sharing among countries, build consensus, set global standards and encourage transparent reporting and monitoring of progress towards shared goals at the interface of digitalization and environmental sustainability. An inclusive and integrated approach is needed to enable policymakers to align their digital and environmental policies at all levels, thereby enhancing the global community's ability to address complex and interdependent global challenges.

Multilateral and cross-sectoral dialogue between digital and low-carbon policy communities should be established at the heart of discussions on sustainable development and embedded in the work of international standard-setting bodies. Multi-stakeholder partnerships (such as the Coalition for Digital Environmental Sustainability) that can draw on the capabilities and strengths of international agencies, Governments, businesses and research organizations are likely to achieve better outcomes than Governments and multilateral agencies acting alone.

International processes and fora focusing on how to leverage digitalization for development, including the World Summit on the Information Society: 20-Year Review (WSIS+20), the Commission on Science and Technology for Development and the global digital compact, should give due attention to the environmental dimensions. There is an equal need for processes related to global environmental challenges – such as the International Resource Panel, the Intergovernmental Panel on Climate Change, the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services – to give more attention to the role of digitalization.

It's time to take bold action on digitalization and track the ICT sector's environmental footprint

To protect the interests and well-being of all, including future generations, urgent and resolute actions have been called for to achieve systemic shifts in the areas of energy, food, mobility and the built environment. It is time to extend the calls for bold action to the entire life cycle of digitalization and to start systematically tracking the environmental footprint of the ICT sector.


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Policy recommendations

Summary of policy objectives and options

at national, regional and international levels, by stage of the digitalization life cycle

PRODUCTION

Objective	Policy options: National	Policy options: Regional	Policy options: International
Environmentally sustainable and responsible mining and electronics manufacturing, while enabling more domestic value addition for development in producing countries	1. Improve information on mining resources for exploration 2. Promote mining contract negotiations for equitable distribution of rents from mining of transition minerals 3. Develop industrial policies to support value addition of raw materials extracted and move towards manufacturing 4. Develop technology policy for research on more sustainable substitute materials 5. Ban use of toxic materials 6. Incentivize and promote use of recycled materials, supporting development of secondary markets 7. Require producers to report transparently on their environmental footprints	1. Foster regional cooperation to increase negotiating power in mining contracts and regional tax regimes 2. Develop regional industrial policies for value addition in developing countries	1. Develop standards for responsible and sustainable mining and electronics manufacturing 2. Limit use of minerals that may be a source of conflict 3. Adopt and apply global transparency standards 4. Collaborate for improved geological and mining data 5. Establish sustainable development licences to operate mining activities 6. Negotiate international tax regime that works for equitable distribution of rents among producers and consumers 7. Enable international cooperation among consumer and producer countries of transition minerals and metals

USE

Objective	Policy options: National	Policy options: Regional	Policy options: International
Optimize data centre performance to minimize impacts on energy and water, as well as on local communities Optimize software to reduce energy use Reduce overconsumption Incentivize and promote meaningful, effective and productive use of digital tools and equipment Bridge digital and data divides	1. Raise awareness of environmental implications of different kinds of use (e.g., AI) 2. Develop policies to counter and ban greenwashing 3. Require sharing of network infrastructure 4. Require data centres to report holistically on environmental impacts 5. Mitigate excessive data storage 6. Adopt technology policy to foster and meet requirements of energy and water use efficiency in data centres 7. Require investments by hyperscale data centres in renewable energy to feed local grids 8. Promote water conservation in data centres, minimizing use of water for cooling	1. Consider regional data centres as a more efficient option for the environment 2. Undertake needs assessment and identification of locations for regional data centres based on potential environmental impact	1. Develop global reporting standards on environmental impacts 2. Foster global data governance, including environmental sustainability considerations 3. Strengthen international cooperation on bridging digital and data divides and building digital and environmental capabilities in developing countries 4. Strengthen international cooperation on competition policies to address abuse of market power in the digital economy

END-OF-LIFE

Objective	Policy options: National	Policy options: Regional	Policy options: International
Prevent and minimize digitalization-related waste and increase recovery of resources and value from such waste	1. Adopt and enforce e-waste policy, legislation and regulations, to improve collection rates 2. Improve data and information on digitalization-related waste 3. Build waste management infrastructure 4. Apply extended producer responsibility mechanisms 5. Improve working conditions in waste management sector, moving towards formalization	1. Develop regional recycling facilities, particularly in developing countries, to enable shift to higher value addition in digitalization-related waste value chain and better recovery of valuable resources 2. Facilitate collaboration in waste management, sharing technology and best practices	1. Improve data and information on digitalization-related waste 2. Develop global standards for circularity 3. Ensure compliance with rules of Basel Convention for transboundary flows, to prevent illegal exports of digitalization-related waste 4. Consider transferring extended producer responsibility in transboundary flows of used equipment and/or extending geographical scope

ALL PHASES

Objective	Policy options: National	Policy options: Regional	Policy options: International
Enable, promote and regulate sustainable consumption and production and the circular digital economy through policies for reducing, reusing and recycling	1. Implement circular economy policy approaches throughout digitalization life cycle 2. Strengthen integration of environmental sustainability and digital development aspects, in a coherent manner, in national development strategies 3. Regulate to require the following: ICT products designed for circularity and sustainability; avoidance of programmed obsolescence; extended product durability; right to repair; traceability of products, including components and raw materials (e.g., through digital product/material passports); and higher levels of recycling 4. Incentivize and promote new sustainable business models (e.g., electronic products as a service) 5. Develop collaboration and partnerships among relevant stakeholders throughout digitalization cycle 6. Improve evidence base for policymaking 7. Raise awareness through targeted campaigns on environmental impacts of digitalization 8. Regulate advertising in the digital economy to prevent manipulation and control over consumers, including actions that encourage overconsumption	1. Consider developing regional approaches to circular digital economy and digital trade 2. Develop regional approaches to tracing of digital products	1. Strengthen international cooperation among relevant stakeholders throughout digitalization life cycle 2. Adapt policies to ensure that trade works for an inclusive global digital economy and digital trade 3. Develop global standards of design for sustainable ICT products, as well as for reusing, repairing and recycling 4. Include ICT sector in international frameworks for assessing various environmental impacts

Source: UNCTAD.

Agenda for action for environmentally sustainable e-commerce

1 Promoting better e-commerce practices

- *Government and business collaboration:* Governments should establish regulatory frameworks and provide incentives for sustainable practices, while businesses should innovate and integrate sustainability into their operations.
- *Sustainable warehousing and transportation:* Governments can offer economic incentives for resource-efficient infrastructure and eco-friendly delivery methods, while businesses should invest in energy-efficient solutions and electric delivery vehicles.
- *Packaging and returns management:* Governments should regulate excessive packaging and returns, promoting reusable and biodegradable materials. Businesses should eliminate single-use plastics, avoid unnecessary packaging, and implement fees and technology to reduce returns.

2 Encouraging more environmentally conscious consumer behaviour

- *Regulation and green labels:* Governments should prevent false claims and mandate credible environmental labels on e-commerce platforms.
- *Consumer awareness campaigns:* Governments and businesses should collaborate to raise awareness about the environmental impacts of consumer choices and encourage transparency in disclosing product environmental costs.
- *Incentives for eco-friendly choices:* Businesses should offer discounts for sustainable packaging and shipping options, and clearly present sustainability attributes through recognized eco-labels.

3 Improving the evidence base for informed policymaking

- *Data collection and research:* Governments should establish mechanisms for collecting data on the environmental impact of e-commerce and require companies to disclose sustainability performance.
- *International collaboration:* International organizations should advance research agendas and share data and strategies for sustainability in e-commerce.
- *Partnerships for innovation:* Foster partnerships with financial technology, e-commerce, and digital companies to drive investments in digital innovations prioritizing environmental and social sustainability.

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