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TESS Forum on Trade, Environment, & the SDGs

Digital Transformation
Trade, Climate, and Net Zero Pathways: Scenarios and Implications for Developing Countries and Climate-Resilient Development

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TESS Forum on Trade, Environment, & the SDGs

About TESS

The Forum on Trade, Environment, & the SDGs (TESS) works to support a global trading system that effectively addresses global environmental crises and advances the sustainable development goals. To foster inclusive international cooperation and action on trade and sustainability, our activities seek to catalyse inclusive, evidence-based, and solutions-oriented dialogue and policymaking, connect the dots between policy communities, provide thought leadership on priorities and policy options, and inspire governments and stakeholders to take meaningful action. TESS is housed at the Geneva Graduate Institute.

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Contents

About This Series of Sectoral Briefing Notes

This briefing note is part of a series of sectoral notes commissioned by TESS intended to inform a final report on *Trade and climate scenarios on the road to 2050: Implications for developing countries and climate-resilient development.*

The series and the report aim to provide an overview of current and anticipated transformations in trade on the road to 2050 in the context of the unfolding climate crisis and the international community's climate action agenda and to discuss potential scenarios and implications for developing countries.

A wider objective of the series is to contribute to a better understanding of emerging trade and trade policy trends and dynamics and their implications within the various sectors, with a focus on supporting developing countries in identifying and advancing their climate change trade-related interests and priorities in international discussions.

The sectors covered in the series include agriculture, carbon markets, critical minerals, digital transformation, fisheries, energy transition, heavy industries, shipping, and textiles, each authored by experts in these respective fields.

Abbreviations

AI	Artificial Intelligence
COP	United Nations Climate Change Conference
ESG	Environmental, Social, and Governance
EU	European Union
GHG	Greenhouse Gas
GSMA	Global System for Mobile Communications Association
ICT	Information and Communication Technology
IEA	International Energy Agency
IMF	International Monetary Fund
IoT	Internet of Things
ITU	International Telecommunication Union
MSMEs	Micro, Small, and Medium-Sized Enterprises
OECD	Organisation for Economic Co-operation and Development
UN	United Nations
UNCTAD	UN Trade and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WTO	World Trade Organization

1. The "Twin Transition": A Simultaneous Pursuit of Digital and Green Transformations

The digital transformation is reshaping the architecture of economies, societies, and trade systems. It is driven by two interrelated processes: digitization—the conversion of analogue data and processes into a machine-readable format—and digitalization—the use of digital technologies and data as well as interconnection that result in new or changes to existing activities (OECD, 2019). Collectively, the changes produced by different forms of digitization and digitalization on economic and social activities constitute the digital transformation (IMF et al., 2023). This shift is propelled by a wave of "frontier technologies"—including artificial intelligence (AI), generative AI, the Internet of Things (IoT), blockchain, big data, cloud computing, 3D printing, robotics, and drones—that are fundamentally changing how goods and services are produced, exchanged, and delivered (UNCTAD, 2025).

The widespread adoption of digital technologies is reshaping value chains, creating new business models, and accelerating the transition towards digitally enabled economies. At the same time, the urgency of addressing climate change and transitioning to a net-zero economy demands a fundamental transformation of production and consumption across manufacturing, transport, agriculture, and services. This transformation requires cutting greenhouse gas (GHG) emissions, accelerating the production and use of clean and renewable energy, and deploying low-carbon and carbon-free technologies. The "twin transition" captures this dual dynamic, with the green and digital transformations interconnected and unfolding simultaneously. The world is increasingly reliant on digital tools and innovations to accelerate the transition to low-carbon economies and mitigate and adapt to climate change (World Bank, 2023).

While digital technologies are central to climate action, their potential to accelerate progress towards net-zero goals is neither automatic nor assured. Realizing this potential depends on deliberate policy choices, effective governance, and adequate institutional, technical, and financial capacity. The convergence of digital transformation and climate priorities offers new opportunities to advance sustainable development, but it also raises concerns about environmental impacts, equity, and the ability of developing countries to participate meaningfully and capture the benefits of the twin transition.

2. The Digital Transformation, Climate Change, and Trade Nexus

Digital technologies are opening new pathways to cut emissions, improve energy efficiency and resource use, and build resilience to climate impacts. One important pathway is through dematerialization: replacing physical goods and services with low-emission digital alternatives such as virtual meetings, cloud computing, and digital financial services, which reduce the need for travel and paper-based transactions (Calvino, et al., 2025). At the same time, technologies such as cloud computing, AI, the IoT and big data carry environmental costs, including rising energy demand and growing volumes of electronic waste (UNTAD, 2024). Digitalization does not automatically reduce sectoral carbon footprints. Some solutions may lower emissions per unit of activity but drive greater overall consumption, creating rebound effects (World Bank, 2023).

These risks are real, but the gains are also significant: digital technologies can drive process efficiency and resource optimization. This includes through enabling predictive maintenance in manufacturing, optimizing transport networks, and supporting real-time energy management in smart grids (UN DESA, 2018). Digital agriculture is transforming farming by harnessing new technologies, platforms, and analytics to deliver more precise, productive, and sustainable practices. In developing countries, these innovations are making precision agriculture increasingly affordable and accessible for smallholder farmers. Tools such as satellite- and unmanned-aerial-vehicle-based remote sensing, field sensors, and IoT systems allow farmers to monitor crop health, optimize input use, and raise yields, thereby advancing climate-resilient agricultural practices (UNDP, 2021). Digital technologies are also central to disaster preparedness. Digital risk mapping and early warning systems powered by cell broadcast and messaging provide timely alerts that save lives and protect vulnerable communities (ITU, 2023).

In addition, digital technologies contribute to circular economy models by facilitating sharing, repair, and reuse. For example, the rise of IoT-enabled products with self-diagnostic capabilities allows consumers to receive targeted, timely advice on optimal use and maintenance, helping to enhance product lifetime and reduce the need for costly repairs. These systems also make repair instructions more accessible and can connect consumers directly with quality-certified repair services, thereby supporting more sustainable consumption (OECD, 2025).

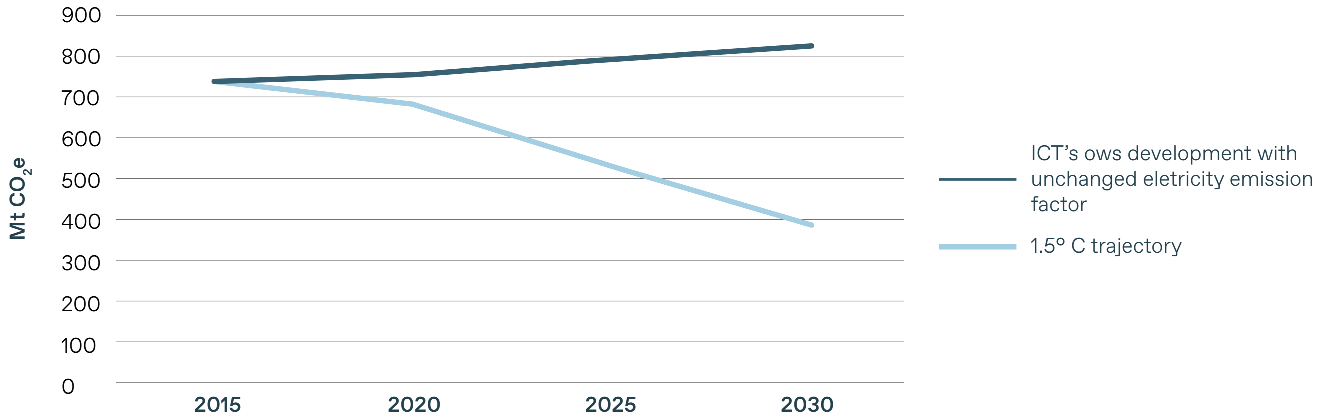
Climate-related digital opportunities are unfolding rapidly, but persistent inequalities and a widening digital divide have far-reaching implications for the ability of developing countries to realize this potential. As of 2024, an estimated 2.6 billion people—around 32% of the world's population—remained offline, with internet penetration in low-income countries at only 27% (ITU, 2024). This exclusion limits access to technologies that are critical for climate adaptation, emissions reduction, and participation in emerging green markets. Moreover, the ability to harness the digital transformation varies widely, with disparities in access to and use of digital infrastructure, tools, and platforms across gender, age, and geography (Chauvet, 2020). Bridging these divides is essential for inclusive and climate-resilient development, enabling developing countries to participate fully in the green transition and advance along net zero pathways. At the same time, expanding connectivity requires significant investment in infrastructure and greater access to devices, which must be carefully managed to avoid escalating energy demand and emissions (ITU & World Bank, 2024).

The environmental costs of digital transformation are increasingly evident. World Bank (2023) research finds that while technology-based solutions advance climate progress they also contribute between 1.4% and 4% of global GHG emissions—comparable to the emissions of the airline industry. To help reach the 1.5°C target of the Paris Agreement, emissions from the digital sector will need to be slashed by at least half by 2030. Rising energy demand compounds this challenge. Data infrastructure—particularly data centres and cloud services—is highly energy- and resource-intensive, with heavy reliance on refrigerants and water for cooling (World Bank, 2023). The International Energy Agency (2024) projects that total electricity consumption by data centres (including cryptocurrency operations) could more than double from 460TWh in 2022 to over 1,000TWh by 2026.

Figure 1 shows two trajectories under different scenarios of the overall carbon footprint of the information and communication technology (ICT) sector—the backbone of the digital transformation involving mobile and fixed networks, data centres, user devices, and cloud or enterprise networks.

In developing countries, rising digital energy demand risks exacerbating grid instability, straining scarce power supplies, and deepening energy access inequalities. Climate change amplifies these risks, exposing digital infrastructure to a growing range of natural hazards, including riverine and coastal flooding, cyclones, landslides, water scarcity, and extreme heat (World Bank, 2023). These shocks can overwhelm cooling

Figure 1. ICT Sector Carbon Footprint Trajectories, With and Without Decarbonization of Electricity by 2030



Notes: MtCO2e stands for metric tonnes of CO2 equivalent. The green line shows the projected carbon footprint trajectory of the ICT sector with the decarbonization of electricity in alignment with the 1.5 °C objective of the Paris Agreement. The blue line shows the trajectory with unchanged electricity emission factor.

Source: ITU (2020b).

systems, damage submarine and terrestrial cables, and disrupt mobile and satellite networks. They can also disrupt digital tools and services dependent on data centres and cloud computing, with cascading impacts across communities, communications, financial services, energy grids, and other critical public infrastructure.

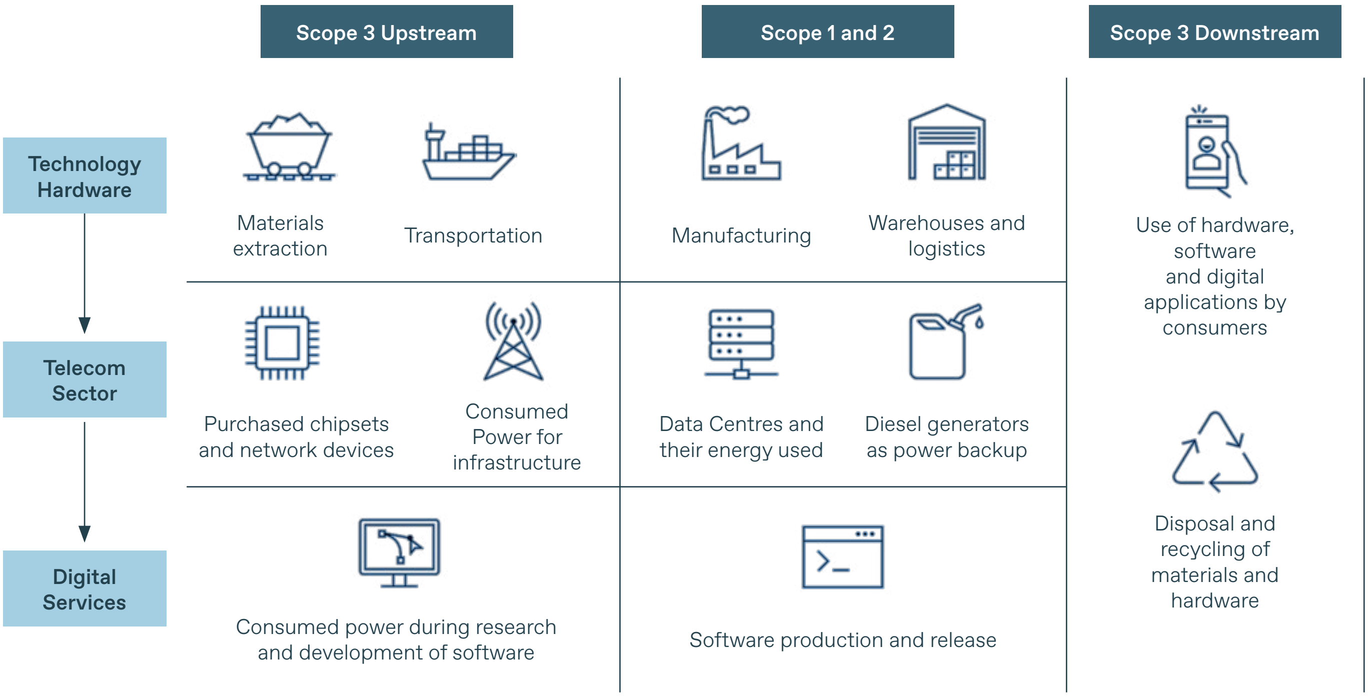
Digital trade or e-commerce—the cross-border exchange of digitally ordered, delivered, or enabled goods and services—is amplifying opportunities and risks at the intersection of digital and green transitions.[1] According to UN Trade and Development (UNCTAD, 2024), e-commerce and digital platforms offer new prospects for sustainability through low-emission delivery, eco-friendly packaging, sustainable returns, and efficient logistics. These models lower market entry barriers for micro, small, and medium-sized enterprises (MSMEs), facilitating participation in global and green value chains and accelerating the uptake of climate-smart technologies. At the same time, the rapid expansion of digital trade and digital services innovations are intensifying environmental pressures. E-commerce activity contributes to packaging waste, emissions from last-mile delivery, increased product returns, and risks fuelling overconsumption. Moreover, the digital backbone powering these electronic transactions is expanding to meet rising demand, while remaining energy-intensive and carbon-reliant, risking to deepen fossil fuel dependency (IEA, 2024; UNCTAD, 2024).

These trends underscore the need to advance digital trade and the economy more generally within a low-carbon framework, ensuring that the digital transformation accelerates the net-zero transition and supports climate-resilient development. Figure 2 illustrates key sources of GHG emissions across the digital economy, from technology hardware and the telecom (or ICT) sector to digital services, structured along three scopes of emissions. Scope 1 and 2 emissions cover direct and indirect energy use from core operations, including consumed power for infrastructure, software production, data centres, and diesel generators for backup power. Scope 3 upstream emissions capture impacts from materials extraction, purchased chipsets, and network devices, consumed power for infrastructure, and transportation or logistics. Scope 3 downstream emissions reflect emissions from consumer use of hardware, software, and digital applications, as well as the disposal and recycling of devices and materials.

1. The OECD notes that, while there is no single recognized and accepted definition of digital trade, there is a growing consensus that it encompasses digitally-enabled transactions of trade in goods and services that can either be digitally or physically delivered (López González & Jouanjean, 2017).

The framework in Figure 2 distinguishes between the technology hardware sector, the telecom sector, and digital services. It illustrates how each stage of the digital economy life cycle—from materials extraction and production to use and end-of-life—contributes to the sector's overall carbon footprint.

Figure 2. Main Sources of GHG Emissions Across the Digital Economy by Sector and Scope



Source: Authors' elaboration based on ITU (2020b), KPMG (2024), Jose (2014), and Microsoft (2021).

3. The Digital Transformation on the Road to Net Zero: A Patchwork of Initiatives

In the multilateral deliberations of the United Nations Framework Convention on Climate Change (UNFCCC), digital technologies are recognized as a means for facilitating and enabling climate action, yet their environmental footprint remains largely unaddressed. The 2015 Paris Agreement emphasized technologies primarily as enablers of climate action through: facilitating the exchange of information, knowledge, and best practices among countries and stakeholders; promoting the development of low carbon energy solutions; enhancing energy efficiency; and supporting adaptation efforts (UNFCCC, 2016; UNCTAD, 2024). Building on this, the 2023 UN Climate Change Conference (COP28) outcome on the first global stocktake under the Paris Agreement specifically referenced "digital transformation" and the accelerated deployment of existing clean technologies and accelerated innovation as essential for achieving the agreement's long-term emission reduction goals (UNFCCC, n.d.; UNCTAD, 2024).

The International Telecommunication Union (ITU), the UN specialized agency for information and communication technologies, has been active in providing analysis and producing non-binding standards and recommendations (ITU-T products) to policymakers and stakeholders addressing the adverse effects of the ICT sector on climate and the environment. Notably, ITU Recommendation L.1470 outlines GHG emissions trajectories for ICT sub-sectors compatible with a 1.5°C scenario, establishing a long-term ambition to halve emissions by 2030 and achieve net zero by 2050. It identifies key levers, including increased energy efficiency, renewable energy sourcing, and circular economy models for devices and networks and proposes examples of supporting actions (ITU, 2020b). Other ITU-T recommendations cover, among others, requirements on energy efficiency in the ICT sector and the role of AI and the optimization of 5G wireless networks' energy consumption.[2] However, there is limited information available on the level of adoption and implementation of these recommendations across jurisdictions and stakeholders.

Multistakeholder initiatives are increasingly emerging to support emissions reduction in the digital sector. At COP29, a broad coalition of state and non-state actors issued a Declaration on Green Digital Action, expressing concern over the carbon footprint and climate impacts of digital technologies and related tools along their value chains and full life cycle, and highlighting the need for more data and analysis of the sector's emissions (COP29 Azerbaijan, 2024). The declaration recognized that digital divides can impede equitable transitions and set a common objective to mitigate the climate impacts of the digital sector, with national governments and other stakeholders—including international organizations, financial institutions, philanthropies, private sector entities, academia, and civil society organizations—committing to develop policies and collaborate to achieve this goal.

Alongside global and multistakeholder action, governments are introducing measures to promote environmental responsibility in the digital sector. For example, the European Union's (EU) Corporate Sustainability Reporting Directive obliges companies, including those operating digital infrastructure and ICT services, to report sustainability information in line with mandatory European Sustainability Reporting Standards. The directive expands the number of companies covered and the range of information to be disclosed across environmental and social indicators, including climate (European Commission, n.d; Pitre et al., 2023).

The private sector is also taking steps to advance digital net zero pathways. In 2019, the board of the Global System for Mobile Communications Association (GSMA), representing almost half of global mobile connections, set an industry-wide goal for the mobile sector to achieve net zero by 2050 (GSMA, 2024). The GSMA-led Mobile Net Zero Initiative now includes 70 operators that have committed to reducing emissions in line with science-based targets, signalling growing momentum for industry-driven climate action. The GSMA publishes annual reports on progress towards its net zero targets, with the 2025 report finding that there has been progress in addressing scope 1 and 2 emissions (operational emissions), yet the initiative continues to face challenges in tackling scope 3 emissions, which account for 70% of overall mobile industry carbon emissions (GSMA, 2025).[3]

The 2025 report highlights regional disparities, with more progress in scope 1 and 2 emissions reductions between 2019–2023 achieved in developed economies—i.e. Europe (-56%) followed by North America (-44%)—compared to other regions—i.e. Latin America (-36%), Sub-Saharan Africa (-25%), Middle East and North Africa (-13%), Asia Pacific (-5%), and Eurasia (-1%). Greater China reported an increase in operational emissions of 8%. In general, circularity in

2. For other relevant ITU-T recommendations see ITU (n.d).
3. Scope 3 emissions include purchased goods and services, capital goods, fuel and energy-related activities, and product use.

mobile and network equipment remains a significant challenge for the industry.

At the request of the EU Council, the European Green Digital Coalition was established in 2021. Coalition members (37 companies at the time of writing) together are committing to support the EU's green and digital transformation by investing in the creation and implementation of green digital solutions, collaborating with expert organizations to develop tools and methodologies for assessing the climate impact of digital technologies, and working jointly with stakeholders from other sectors to design recommendations and guidelines that promote a green digital transition (European Green Digital Coalition, n.d.).

Private sector initiatives are also taking place in the area of digital trade. A number of e-commerce platforms have been declaring, individually, their pledges to achieve net zero. Amazon (n.d.), for example, announced in 2019 its target to reach net-zero emissions across its operations by 2040 and investing in carbon-free energy to achieve this goal. The Chinese platform Alibaba (2021) has committed to achieving carbon neutrality in its operations and to halving scope 3 emissions by 2030 compared to 2020 levels. The e-commerce platforms Mercado Libre (2024) in Latin America and Jumia (2021) in Africa have also reported measures and progress towards emissions reductions from their operations . However, the accuracy, frequency, and level of detail in sustainability reporting by digital platforms vary considerably, reflecting disparities in data availability and reporting capacity across regions and business size. Reliance on voluntary disclosure frameworks, which differ widely in scope and methodology, makes meaningful comparison across firms and countries difficult. This fragmented landscape increases the risk of selective reporting and greenwashing, weakening the credibility of disclosures. Limited regulatory oversight compounds these challenges, leaving stakeholders uncertain about the reliability and comparability of sustainability information (UNCTAD, 2024).

While the growing number of initiatives, commitments, and declarations across international fora, multistakeholder and industry coalitions, and private sector actors reflect increasing awareness of the need to address the digital sector's climate footprint, these efforts remain fragmented and largely uncoordinated. Divergent methodologies for measuring GHG emissions and differences in reporting capacities across these initiatives, among other factors, further complicate efforts to compare outcomes or track the sector's collective progress. World Bank and ITU (2024) research finds that reliable country-level data collection and analysis of the ICT sector's GHG emissions and energy consumption remain scarce. Assessments of the sector's climate impact remain largely based on aggregate global estimates, constraining the evidence base for informed policymaking on reducing ICT emissions and managing energy demand. In addition, methodologies remain inconsistent, and no harmonized global framework exists to support transparent, comparable reporting.

4. Decarbonization Pathways in the Digital Sector, Impacts on Trade, and Opportunities and Challenges for Developing Countries

The rapid expansion of the digital sector is driving exponential growth in data traffic, creating unprecedented demand for transmission capacity. This demand is being met through advances in network technologies, rising investment in infrastructure, and a corresponding surge in electricity consumption. Data centres—at the core of data storage and processing—are especially energy intensive, relying heavily on electricity, refrigerants, and often large quantities of water for cooling (World Bank, 2023). Given the digital sector's fast-paced innovation cycles and structural complexity, achieving net-zero targets will require integrated pathways that address scope 1, 2, and 3 emissions across value chains. These pathways should embed ambitious mitigation strategies, with priority given to the rapid decarbonization of electricity use through the integration of renewable and other low-carbon sources, complemented by the systematic implementation of energy efficiency measures across operations (KPMG, 2024; ITU, 2020a). Equally important is the promotion of responsible and sustainable sourcing and supply chains, adopting circular economy approaches to extend product life cycles and minimize e-waste, and favouring the deployment of climate-resilient digital infrastructure to sustain the sector's efficiency and decarbonization momentum.[4]

Table 1 synthesizes five priority pathways (levers) to guide decarbonization across the digital sector. It highlights their expected impacts on emissions and trade, and assesses the trade-related opportunities and challenges they present for developing countries.

Table 1. Levers of Decarbonization and Climate Resilience in the Digital Sector: Emission and Trade Impacts and Implications for Developing Countries

Lever	Description	Impact on Emissions	Impact on Trade	Trade-Related Opportunities	Trade-Related Challenges
Green and energy-efficient infrastructure and data centres	Deployment of low-power, climate-optimized data centres and network infrastructure using efficient cooling and increasingly powered by renewable electricity.	**HIGH** Data centres contribute up to 45% of ICT sector emissions.	Shift in data hosting and cloud service production to countries with low-carbon infrastructure and renewable energy production abundance.	Developing countries with renewable energy and established connectivity (e.g. Kenya, Morocco, and South Africa) are well positioned to attract investment in green data centres. Kenya is leveraging its green electricity mix to become East Africa's data-centre hub (Microsoft and G42 are developing a 100 MW geothermal-powered facility, with plans to expand to 1 GW.) The exponential growth of AI is amplifying demand for data processing. African countries with access to renewable energy are well placed to capture this market by hosting AI workloads in low-carbon data centres.	High capital and operational costs, unreliable electricity grids, and limited access to green finance constrain the deployment of energy-efficient infrastructure and data centres. These challenges are compounded by the sector's energy and water demands that strain already weak infrastructure. Regulatory gaps, a lack of targeted incentives, and fragmented policy frameworks further slow the transition to green data centres.

4. Climate-resilient digital infrastructure refers here both to systems that reduce the sector's carbon footprint—through an expanded use of renewable energy, energy efficiency, and decarbonization pathways—and to infrastructure able to withstand the impacts of climate change.

Table 1. (continued)

Lever	Description	Impact on Emissions	Impact on Trade	Trade-Related Opportunities	Trade-Related Challenges
Green and energy-efficient ICT operations and digital trade logistics	Decarbonization of ICT operations and trade logistics through electrification powered by renewable energy, smart routing, and low-emission data transmission networks. Also use of AI for emissions monitoring and energy optimization.	**HIGH** ICT operations rely heavily on electricity.	Increased demand for low-carbon ICT services, digital exports, and e-commerce logistics and transport services.	Countries with solar/wind potential can export clean digital services and low-carbon logistics solutions. Rising demand for low-emission logistics and digitally optimized delivery creates entry points for green entrepreneurship and digital services. Smart logistics, AI-enabled monitoring, and real-time data systems expand opportunities for efficient transport, cleaner trade flows, and competitive participation in sustainable value chains.	Grid unreliability, low renewable penetration, and high capital and operating costs of clean energy technologies limit competitiveness. Carbon-intensive last-mile delivery models and slow uptake of sustainable transport solutions drive higher emissions from e-commerce expansion. Regulatory and institutional gaps, including weak carbon pricing signals, fragmented logistics policies, and lack of incentives, hinder investment in sustainable logistics.
Sustainable and transparent digital supply chains	Integration of AI, blockchain, IoT, and digital measurement, reporting, and verification systems to enhance traceability, responsible sourcing of raw materials, and critical minerals, and compliance with environmental, social, and governance (ESG) standards across digital value chains.	**MEDIUM** Emission reductions come from upstream supply chain improvements and lower risk of environmental harm from mining.	Differentiation based on traceability. Firms with robust ESG practices gain better market access.	Compliance with international ESG and due diligence standards enables developing countries to shift from exporting raw, low-value materials to becoming verified, sustainable suppliers in global electronics and ICT value chains. Projected global demand for critical minerals is expected to rise by up to 500% by 2050, creating new trade opportunities for resource-rich countries to move up value chains through local processing to higher value-added activities. Opportunities include producing intermediate goods such as precursors and batteries, and developing regional value chains for final products like electric vehicles and smartphones.	Digital and institutional capacity gaps limit compliance with complex ESG and traceability rules. Extraction of critical minerals—e.g. cobalt, lithium, and rare earth elements—intensifies ecological pressure and undermines sustainable development. Weak safeguards and unsustainable mining practices heighten risks of biodiversity loss, environmental harm, and community conflict. Continued dependence on unprocessed raw material exports exposes economies to commodity price volatility and missed value addition opportunities. Limited domestic processing capacity prevents many developing countries from capturing greater value from digitalization, leaving them reliant on imports of high-value digital equipment and services.

Table 1. (continued)

Lever	Description	Impact on Emissions	Impact on Trade	Trade-Related Opportunities	Trade-Related Challenges
Digital circular economy and e-waste management	Designing devices for reuse and recyclability, scaling e-waste recycling infrastructure, and formalizing cross-border trade in secondary raw materials.	**HIGH** Formal recycling and circularity reduce demand for virgin materials and energy-intensive production.	Reduced import demand for raw and processed materials. Increased import demand for secondary materials. Emphasis on durability, modularity, and recyclability in product design standards.	Establishing regional hubs for repair, refurbishment, and recycling can generate trade opportunities through the export of recycled materials and components. Rising demand for sustainable packaging, reverse logistics, and modern recycling systems can generate green jobs and expand participation in circular value chains. Scaling refurbishment and recycling industries allows countries to capture more value locally while advancing resource-efficient and low-carbon development pathways. Circular e-commerce and digital tools for e-waste recovery can create pathways for green jobs, regional recycling hubs, and higher value addition in digital value chains.	Informal sector dominance, regulatory gaps, and lack of circular design ecosystems constrain scaling-up. Weak waste management infrastructure and hazardous informal practices expose communities to severe health and environmental risks. Limited formal collection and recovery mechanisms leave most e-waste unmanaged.
Resilient and climate-compatible digital infrastructure	Adapting infrastructure to withstand climate risks (e.g. floods, heatwaves) and expanding decentralized models (e.g. satellite, mesh, and solar-powered networks.	**LOW** Ensures continuity of low-impact digital services (e.g. e-health, digital finance, smart energy) and reduces reliance on carbon-intensive alternatives like paper systems or in-person logistics at climate hazard times.	Trade continuity during climate shocks. Enhanced cross-border service reliability and resilience.	Rising demand for resilient digital infrastructure generates new opportunities for trade diversification and sustained economic activity, particularly in landlocked and climate-vulnerable countries. Investment in climate-proofed networks and decentralized models can secure service continuity, reduce economic disruptions, and strengthen the resilience of regional trade systems. Green industrialization, underpinned by clean energy and low-carbon manufacturing, enables developing countries to move up digital and green value chains and capture broader economic gains from net-zero transitions.	Adaptation to climate risks is often under-prioritized in national adaptation and ICT strategies, leaving digital infrastructure exposed to floods, heatwaves, and other shocks. Limited access to concessional and blended finance—including climate finance, private–public–philanthropic sources, and debt-for-climate instruments—further constrains investment in climate-proofed infrastructure and decentralized models, exacerbating exposure in climate-vulnerable regions.

Source: Authors' elaboration based on OECD (2022; 2025), Calvino et al. (2025), Energy News Network (2025), UNCTAD (2024), IEA (2024), IMF et al. (2024), World Bank and ITU (2024), McDonald and Ballan (2023), World Bank (2023), and Syamsuri & Pakartipangi (2025).

5. Priorities for Developing Country Policy Engagement and International Cooperation for Digital and Green Transitions

The digital transformation presents developing countries with a strategic opportunity to align trade and trade-related policies with climate action and climate-resilient development. Without deliberate interventions, the digital sector's rapid growth risks reinforcing structural inequalities and generating new environmental pressures. As noted, placing the digital sector on a net zero pathway can be particularly challenging for developing countries. High upfront costs, long investment cycles, weak grids, financing gaps, and limited access to affordable green technologies remain significant barriers to catching up with the digital and green transitions and participating equally in international coordination and policy efforts.

The following priorities identify key areas for policy action, engagement, and international cooperation to support digital and green transitions in developing countries.[5]

Direct Subsidies, Public Procurement, and Finance Towards Greening Digital Infrastructure

In countries where digital infrastructure is expanding rapidly, directing subsidies, public procurement, and financial support towards renewable-powered ICT infrastructure—including data centres, telecom networks, and cloud services—should form part of a wider package for greening digital development. Targeted financial incentives such as tax credits, accelerated depreciation, grants, or VAT relief can lower affordability barriers and reduce the cost of renewable-powered cloud services, efficient data transmission, and low-emission logistics. These instruments not only reduce emissions but also create jobs in renewables and stimulate investment in sustainable digital infrastructure. Redirecting fossil fuel subsidies can form part of this package, alongside green public procurement to stimulate demand for energy-efficient ICT equipment and remanufactured devices. Blended and concessional finance remain essential to de-risk early-stage projects and attract private capital into resilient, low-carbon connectivity.

Use Carbon Tax to Advance Sustainable Digital Infrastructure and Operations

Well-designed carbon tax frameworks can support environmentally sustainable digital transformation by allocating revenues to renewable integration and efficiency upgrades in ICT infrastructure—including data centres, networks, and cloud services. Domestic carbon tax revenues can be allocated to instruments such as grants, concessional loans, or dedicated green infrastructure funds, with eligibility explicitly contingent on verifiable reductions in emissions and energy use. This approach both incentivizes emissions reductions and ensures accountability in the use of public funds.

Carbon taxes also provide a continuous price signal for innovation and R&D, encouraging investment in energy-efficient digital infrastructure, circular economy solutions, and smart grids. Conditioning fiscal incentives and financing on independently verified emissions reductions and energy savings—through transparent measurement, reporting, and verification systems—reinforces accountability and motivates firms to adopt cleaner technologies to qualify for benefits. Digital tools, including AI-enabled analytics and blockchain-based registries, can further enhance transparency, compliance, and public trust in carbon tax systems. While the application of carbon taxes to digital infrastructure remains limited in developing countries, piloting such approaches could help mobilize domestic revenues, reduce investment risks, and align digital expansion with climate goals.

Provide Investment Incentives and Foster Public–Private Partnerships

5. This section draws on analyses by OECD (2022; 2023; 2025), UNCTAD (2024), World Bank (2023; 2024), WTO (2021), ITU (2020b), IEA (2024), McDonald and Ballan (2023), World Bank and ITU (2024), Calvino et al. (2025), and Muench et al. (2022).

For many developing countries, high upfront costs and financing risks remain key constraints to achieving environmentally sustainable digital infrastructure. Targeted investment incentives, such as tax breaks, concessional loans, and streamlined permitting, can help lower barriers to investment and accelerate the deployment of energy-efficient data centres, telecom networks, and digital services. Complementary measures are also needed to strengthen domestic digital ecosystems. Expanding access to venture capital and government-backed financing facilities, including incubation and acceleration programmes, can scale up sustainable digital solutions.

Public–private partnerships can reinforce these efforts by embedding climate performance criteria on emissions, resilience, and circularity, while ensuring that fiscal support is tied to independently verifiable outcomes. Blended finance and green bonds are particularly impactful in higher-risk markets, where they can attract long-term private investment. They help prioritize projects that expand access, create jobs, and strengthen climate resilience in underserved regions. Examples from countries demonstrate how targeted reforms, when aligned with investment incentives, can mobilize private capital for renewable-powered digital infrastructure. In South Africa, for example, energy market liberalization enabled Amazon to power its data centres with renewable energy through one of the country's largest solar farms. Similarly, in Brazil, distributed generation regulation catalysed a shift by telecom operators towards clean energy.

Cooperate On Greening Digital Trade Agreements

Digital trade agreements typically lack environmental provisions or pathways for sustainable digitalization. For developing countries, integrating such provisions should be gradual, voluntary, and non-prescriptive—leveraging pilot initiatives and best-endeavour commitments that reflect national circumstances and preserve policy space. Cooperation can focus on harmonizing measurement, reporting, and verification of ICT emissions and circularity, enabling transparent disclosures across borders. Mutual recognition of green ICT standards can further reduce technical barriers, expand access to circular digital markets, and allow developing economies to benefit without undue burden.

At the same time, it is important to ensure that cooperation does not simply transplant models from advanced economies that may not fit the distinct economic structures, institutional capacities, or national priorities of developing countries. Targeted international support—financial, technical, and institutional—is essential to help developing countries meet global standards, advance circular economy initiatives, and participate effectively in a sustainable digital economy.

Ensure Affordable Access to Green and Circular Technologies and Secure Technology Co-Development or Transfer

Ensuring affordable access to green and circular technologies is essential for developing countries to participate fully in the digital and green transition. Trade policy can help address barriers by lowering tariffs and streamlining customs for renewable energy inputs, efficiency equipment, and ICT repair technologies—reducing costs and encouraging uptake. Open standards and voluntary licensing for climate-smart digital tools can broaden access and allow local providers to adapt solutions to domestic needs. Partnerships with developed economies should be equity-based, supporting domestic value addition through technology transfer, skills development, and knowledge-sharing. Equally important, South–South partnerships can drive technology co-development tailored to regional contexts, while targeted technical assistance can complement these efforts by strengthening skills, infrastructure, and institutional capacity in developing countries. Concessional finance and guarantees remain vital to scale affordable, durable, and repairable ICT products, ensuring that digital transformation is both environmentally sustainable and inclusive.

Upgrade Standards to Meet and Conform With International Practices

Aligning ICT standards with global benchmarks on energy efficiency, eco-design, repairability, and emissions accounting can enhance interoperability and expand market access. This, in turn, facilitates cross-border digital trade, lowers compliance costs, strengthens participation in circular value chains, and supports sustainable investment. To avoid overburdening firms in developing countries, this process should remain gradual and flexible, with transitional pathways that reflect local capacity and cost constraints. Upgrading standards must also be accompanied by robust conformity assessment systems—including accredited laboratories, certification services, and targeted support for MSMEs—to reduce compliance burdens and help firms demonstrate credibility in global markets.

Regional and international cooperation on harmonization and mutual recognition is essential to prevent new trade barriers, lower costs, and ensure that developing economies can fully participate in circular and sustainable digital trade. Developing common standards and classifications for hazardous wastes, non-hazardous wastes, and goods destined for reuse or repair could help to avoid misclassification and facilitate circular trade flows. Compliance with the Basel Convention's 2025 amendments, which require prior informed consent for all e-waste shipments, will be central to ensuring environmentally sound waste management. Capacity development is particularly important to equip governments, regulators, and border agencies to meet these requirements and harmonize technical and environmental standards across borders.

Foster Assistance to Measure and Report Carbon Emissions and Footprint Across Value Chains

Developing robust systems to measure, report, and verify GHG emissions, energy use, and material footprints across digital value chains—data centres, networks, device manufacturing, and cloud services—is essential for greening digital trade. However, in many developing countries compliance with evolving international standards for carbon accounting and environmental measurement is constrained by high costs, weak institutional capacity, and technical skill gaps. Additional challenges stem from uneven levels of development and limited enforcement capacity, as well as the absence of established international standards for emerging technologies.

Targeted capacity development and financial support are therefore essential. Governments, regulators, and firms require digital tools and internationally recognized methodologies for emissions accounting, eco-design, circularity, and conformity assessment. Such measures enhance the credibility, comparability, and cost-effectiveness of reporting. Stronger international cooperation is needed to build local expertise, promote knowledge sharing, and ensure interoperable measurement, reporting, and verification systems across borders, while advancing new standards in areas where gaps remain.

Data-driven decision making must be prioritized. Reliable data on the ICT sector's GHG emissions and energy consumption is essential for governments to set realistic targets, monitor progress, and make informed policy decisions. Strengthening collaboration among ICT, energy, and environmental regulators can optimize joint efforts to address the sector's carbon footprint.

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