Chapter VI

Towards environmentally sustainable digitalization that works for inclusive development

This chapter turns to the policy challenge of fostering environmentally sustainable digitalization that works for inclusive development. It stresses that policy responses at the national, regional and international levels are more likely to prove successful if they reflect the involvement of all stakeholders and address digital, socioeconomic and environmental goals holistically, across the entire life cycle of digital devices and ICT infrastructure.

Government strategies to mitigate GHG emissions, conserve water resources and reduce waste generation should also pay adequate attention to the environmental footprint of digitalization, as well as to how digital technologies can offer solutions to environmental concerns. Given the asymmetrical distribution of capabilities and resources, development partners are called upon to offer adequate support to low-income countries to strengthen their ability to participate effectively in a more circular global digital economy that is also environmentally sustainable.

A. The need for a new policy mindset

This report has explored the relationship between digitalization and environmental sustainability, from the perspective of trade and development, with a view to moving towards a digital economy that leads to both environmental sustainability and inclusive development. The relationship between digitalization and environmental impact is bidirectional, in that digitalization has a significant and growing environmental footprint, yet digital solutions can also play a role in addressing environmental challenges. The report has mainly focused on the direct impacts of digitalization on environmental sustainability. Achieving environmentally sustainable digitalization requires government policies and consumer and business decisions that help to reduce unsustainable practices along the life cycle of digitalization, including production, use and end-of-life.

Digital and data divides are still widening, and various environmental costs associated with digitalization continue to rise. The new and complex interplay between digitalization, development and environmental sustainability points to the need for integrated policy responses that can help to bridge digital divides and ensure that technological progress contributes to socioeconomic equity while respecting planetary boundaries. At present, the world is not on track for achieving either inclusivity or sustainability.

For change to become a reality, a shift in mindset is needed. Business as usual is not an option. Exponential growth in digitalization and the associated demand for transition minerals cannot be sustained, as the reality of a finite planet is increasingly evident. The current linear economy model, based on extract-make-use-dispose, is exhausting its resources. This calls for a move towards a circular economy model based on the principles of reducing, reusing and recycling – approaches that favour reduced consumption and greater material recovery. Such a shift could also stimulate new economic activities and job opportunities, supporting inclusive development. Moving towards a circular digital economy would require changes in consumer behaviour and business models, as envisaged in Sustainable Development Goal 12.

This chapter explores actions by relevant stakeholders and options for policymaking to foster environmentally sustainable digitalization that works for inclusive development. Section B discusses the case for the integrated treatment of digitalization, environmental sustainability and inclusive development, as a key objective. Section C argues that this can be achieved through sustainable consumption and production, as well as moving towards a circular approach, which will require proactive policy support. Preconditions and fundamentals for better policymaking are discussed in section D, notably with regard to improving the understanding and evidence base of how to achieve environmentally sustainable digitalization that works for inclusive development. Section E summarizes policy options at different levels and stages of the digitalization life cycle. The final section discusses the role of international cooperation for collective action.

> The new and **complex interplay** between **digitalization, development and environmental sustainability** points to the need for integrated policy responses

B. Aligning digitalization, environmental sustainability and inclusive development

1. Complex and interconnected global challenges

The world is undergoing a deep transformation driven by many global forces, notably the rapid progress in digital technologies and the need to move towards environmental sustainability and low-carbon technologies. These two interrelated drivers are mutually reinforcing, with key implications for inclusive development. In light of the strong interface between digitalization and environmental sustainability, associated challenges therefore need to be assessed and addressed in an integrated manner.

A continuation of the current trajectories is not consistent with the need to comply with the **"planetary guardrails"**

The growing urgency to tackle these challenges has not yet been matched by a sufficiently integrated and overarching aim towards an inclusive and environmentally sustainable digital future. In fact, trends reviewed in this report leave little room for optimism:

- Many digital and data-related divides keep widening;
- Concentration of market power continues to grow in the digital economy and is expected to be further accentuated by increased reliance on AI;
- More digital devices are sold globally, and new digital networks and data centres are being built, increasing the demand and competition for raw materials, including minerals and metals, some of which are in scarce supply and environmentally and socially unsustainable practices persist in mining, processing and manufacturing for digitalization;
- The ICT sector is consuming increasing amounts of energy and water, contributing to GHG emissions and threatening water availability, including in locations where water resources are under significant stress;
- Digitalization-related waste is growing in volume, while levels of reuse, repair and recycling remain insufficient, contributing to pollution and environmental degradation, especially in developing countries;
- Major applications of digital innovations, such as e-commerce, while adding convenience for consumers and businesses, also contribute to unsustainable levels of consumption and negative environmental impacts.

A continuation of the current trajectories is not consistent with the need to comply with the "planetary guardrails" related to climate, biodiversity, soils and oceans. Many more people around the world are expected to come online, adding demand for digital devices and services. Furthermore, AI, IoT and augmented and virtual reality, among other emerging technologies, are only in their infancy. This makes it all the more important to consider how to reduce the direct environmental footprint of the ICT sector.

2. Towards a holistic, whole of life cycle and multi-stakeholder approach

Achieving environmentally sustainable digitalization that works for inclusive development requires international cooperation, with the engagement of many stakeholders. Digital transformation and environmental sustainability need to

be considered jointly and holistically, to move humanity towards the sustainable development future envisaged by the United Nations Conference on Environment and Development in 1992, also known as the "Earth Summit", and in the 2030 Agenda for Sustainable Development. The transformation that the world is undergoing affects many spheres and is driven by several interconnected global forces.

Shaping an environmentally sustainable digital economy that is also inclusive is complex and requires the consideration of a range of dimensions, as follows:

- Digitalization can have positive and negative impacts on the environment. Environmentally sustainable digitalization involves direct effects from the production and use of digital technologies and indirect effects from changes enabled by digitalization in economic and social behaviour (complicated by rebound effects). Indirect effects also include societal impacts resulting from the ways in which those changes affect underlying economic and social structures. To date, measures to assess the net effect have not been available;
- Impacts occur at all stages in the life cycle of digital devices and infrastructure;
- Several environmental challenges emerge from digitalization, including in relation to the extraction and processing of natural resources, energy and water use and waste generation;
- Addressing these challenges requires the involvement and collaboration of diverse stakeholders, such as academia and civil society organizations that contribute research and insights into the effects of digitalization on environmental sustainability; Governments and international organizations that can set policies, standards and regulations in order to ensure the environmental and social sustainability of the digital economy; scientists and developers who can design products and services with the purpose of sustainability in mind; businesses throughout the digital life cycle that can produce goods and provide services on the basis of sustainability criteria; and consumers, whose choices both create and respond to market signals that affect the environment;
- Policy responses need to reflect the perspectives and priorities of countries at all levels of development.

Multi-stakeholder engagement for the necessary actions and policymaking has become increasingly important in both the environmental and digital domains in recent years. Enabling relevant actions and policies along the life cycle of digitalization is a joint responsibility for all stakeholders and all countries.

Enabling relevant actions and policies along the life cycle of digitalization is a joint responsibility for all stakeholders

The objective of any action taken should be to maximize the positive contribution of digitalization to sustainability and minimize its negative impacts, while ensuring inclusive development outcomes. Achieving this will require a new culture of sustainable digitalization and a change in mindsets and behaviours. It should be built on shared principles of sustainable consumption and production, and based on a circular economy approach. Uncertainties related to the severity of environmental challenges (including raw materials depletion, climate change and water scarcity), as well as the rapid evolution of digital technologies, will require all stakeholders to adjust to evolving circumstances. There is no time to waste. Decisions taken in the next few years will profoundly affect the digital economy and its environmental impact long into the future.

3. Harnessing the principle of common but differentiated responsibilities in the digital economy

The 2030 Agenda for Sustainable Development committed the global community to ensuring that no one, and no country, is left behind in the pursuit of sustainable development. Currently, benefits and costs from digitalization are

Policy responses will have to take into account the unequal ecological exchange and the situation of countries that are only at an early stage of digitalization

asymmetrically distributed. Developed countries have gained much more from industrial development, including digitalization, than most developing countries. Most of the added value created in the digital economy is captured by developed and digitally advanced developing countries. They have also contributed far more to its environmental footprint. Conversely, many of the costs related to this footprint are incurred in lower-income countries. Developing countries are often locations of mining operations and the destination for digitalization-related waste and are particularly vulnerable to the impacts of climate change. There are risks that LDCs, in particular, will fall further behind in terms of inclusive digital development and environmental welfare. Policy responses will have to take into account the unequal ecological exchange and the situation of countries that are only at an early stage of digitalization.

For the digital economy to be inclusive and environmentally sustainable, it must provide opportunities for Governments, businesses and citizens in developing countries to participate effectively in increasingly digitalized domestic markets, global value chains and trade. While there is a need at the global level to reduce the overconsumption of ICT goods and services, especially in developed countries and higher-income parts of society, bridging the digital divide and raising digitalization levels above the social floor remain critical preconditions for achieving equitable growth and prosperity.

Efforts to foster environmentally sustainable digitalization need to recognize that economies differ in their characteristics and abilities to engage in and benefit from the digital economy. Countries at different levels of development do not have the same capacities to address the challenges of digitalization and environmental sustainability. They also have specific needs to fulfil in order to meet their development objectives.

Worldwide, the digital economy is dominated by large digital corporations based in developed countries and in some developing countries in Asia. While the extraction of many essential minerals is concentrated in developing countries, including several LDCs, processing activities and manufacturing of ICT goods with higher value addition are overwhelmingly performed elsewhere. Similarly, global corporations that dominate the entire global data value chain, including data collection, storage and analysis, and related digital intelligence, are mainly concentrated in China and the United States (UNCTAD, 2021a).

Some developing countries have succeeded in nurturing dynamic digital sectors, generating growth and jobs by leveraging local expertise and lower costs. However, many developing countries may lack the resources and capabilities to compete directly with global manufacturers, network providers and platforms, and are vulnerable to international competitors that harness global reach and scale. Most developing countries remain involved in lower value addition activities and experience the related environmental consequences.

This situation raises concerns for developing countries, including the following:

- Developing countries rich in natural resources are often suppliers of unprocessed raw materials needed for digitalization, generating little domestic value addition while having to pay for imported digital equipment and services to meet digitalization needs;
- As connectivity and the use of digital technologies grow in developing countries, the digital data that are generated domestically provide opportunities for international digital platforms to produce digital intelligence that can be monetized, rather than for local businesses (UNCTAD, 2021a);
- Policies, regulations and standards adopted for the digital economy are often being shaped by and for developed countries. Norms and standards, which may become global in spite of the marginal participation of low-income countries in their development, risk being ill-adapted to their needs and capabilities;

- The digital divide between low-income and more advanced countries continues to widen.

Requirements related to more environmentally sustainable digitalization should not favour international corporations or businesses that may find it easier to finance or demonstrate environmental responsibility than businesses in developing countries. A more level playing field needs to be established for developing-country businesses to engage in global markets. This would imply improving the value they derive from low-value sectors, such as mining and digitalization-related waste management, as well as increasing their engagement in higher-value domestic and regional markets for digital products and services.

The principle of "common but differentiated responsibilities" is highly relevant in this context. It acknowledges that while all countries share a responsibility to address global environmental challenges, the extent and nature of that responsibility vary according to each country's past responsibilities, capabilities and level of development. Some international environmental agreements recognize that, while all countries have a common interest and responsibility to address environmental problems, the historic contribution of developing countries is significantly lower.[1] Regulatory powers and policy institutions are frequently much stronger in countries with large markets compared to those with smaller markets; this reduces the bargaining power of the latter in negotiations with global companies, reinforcing existing asymmetries.

Actions by relevant stakeholders and policymaking at all levels should be founded on the basis of this principle. The steps taken should factor in digitalization needs in less advanced economies and ways to achieve economic development and social welfare within the framework of the Sustainable Development Goals, while considering the constraints that Governments may face in implementing environmental sustainability policies.

The principle of **"common but differentiated responsibilities"** is highly relevant

C. Fostering sustainable consumption and production in the digital economy

1. Applying the concept of sustainable consumption and production

Rapid digitalization has led to growing concerns about its environmental impacts, suggesting an urgent need to move towards more sustainable consumption and production. As stressed in *Global Resources Outlook 2024*, "it is no longer whether a transformation towards global sustainable resource consumption and production is necessary, but how to urgently make it happen" (UNEP and IRP, 2024).

The second United Nations Conference on Sustainable Development (Rio+20) in 2012 adopted a framework for sustainable consumption and production,[2] which was referred to in the 2030 Agenda for

[1] See, for instance, principle 7 of the Rio Declaration on Environment and Development and article 3 of the United Nations Framework Convention on Climate Change.

[2] See https://sustainabledevelopment.un.org/content/documents/944brochure10yfp.pdf.

Environmental considerations have to date been given insufficient attention in relation to the consumption and production of digital products

Consumers and businesses are the principal actors in the growing digital economy and, consequently, play an important role in influencing sustainability

Sustainable Development.[3] Accordingly, targets for sustainable consumption and production under Goal 12 link these to economic prosperity, social welfare and human rights, but there is no explicit link within that context to digitalization.[4] However, the targets can usefully be applied in the digital context (box VI.1).

Sustainable digitalization and sustainability by design should be at the core of any emerging global governance framework for digital technologies (UNEP, 2023b). Sustainable consumption and production are inherent in this approach. Governments and the wider stakeholder community should be encouraged to proactively shape the digital future, integrating digital and non-digital ways of achieving digital sufficiency and circularity rather than merely maximizing the reach of digital innovation (Digitalization for Sustainability, 2022).

The impacts of the digital economy depend significantly on the relationship between the consumers and producers of digital products and infrastructure, i.e. the individuals and organizations that buy goods and services and the businesses that design, make, sell and, ultimately, dispose of them. Governments can enable, promote, incentivize and regulate their behaviours to encourage environmentally sustainable practices and discourage those that are unsustainable. This can also be supported by actions by civil society.

Consumers and businesses, including digital platforms, are the principal actors in the growing digital economy and, consequently, play an important role in influencing sustainability. Consumers have embraced new digital technologies, driven by the potential for improvements in their quality of life, leading to evolving lifestyles in response to digitalization. Businesses have prioritized the development of new digital products and services, and have sometimes made use of regulatory grey areas, to create new business models and markets to seize profit-making opportunities. Technology experts and developers have focused on innovations in response to such priorities. Governments, especially in digitally advanced economies, aim to maximize potential gains for national economies that can benefit their citizens and business communities.

In this context, environmental considerations have to date been given insufficient attention. Sustainable consumption and production should be placed at the centre of efforts to foster a sustainable digital economy. This will imply modifying modes of consumption and production, as well as adapting existing economic models. Discussions in this context are increasingly focusing on the need to achieve a more circular digital economy, moving away from the linear economy model of extract-make-use-dispose or the throw-away economy.

2. Fostering more sustainable consumption of digital products

Consumers of ICT goods and services are diverse, with different needs and priorities. Growing prosperity over many decades has led to increased consumption, and digitalization has exacerbated trends towards consumerism through digital advertising, e-commerce and digital delivery channels. Digitalization has increased the choice, convenience and availability of goods and services, often at reduced prices. Meanwhile, unsustainable practices by consumers relate, for example, to the frequent replacement of digital devices, although they may remain functional.

Consumer choices are driven by a number of factors, including cost, value for money, longevity, efficiency, convenience, capability and performance, as well as personal skills. Beyond these more objective factors, consumers may also be swayed by "perception", related to what ownership and use of a digital product represents and how

[3] See https://www.un.org/sustainabledevelopment/sustainable-consumption-production/.

[4] See https://sdgs.un.org/2030agenda.

the consumer may be perceived in terms of status, fashion or identity. These drivers are primarily associated with cost and perceived enhancements in quality of life. While ethical and environmental considerations have resonance with some consumers, they do not yet substantially affect most individuals' consumption patterns. In order to increase the incentives for consumers to make more environmentally responsible choices, it will be important to ensure that such choices are attractive on the basis of affordability, efficiency convenience and style.

There appears to be new interest among some consumers in products that are environmentally friendly. As discussed in this report, a few recent surveys point to growing demand for more sustainable electronic products, especially among younger people. Consumers can and should be encouraged to take more responsibility for the environmental footprint of their own behaviour and lifestyles, but to do so they need awareness of the environmental impact of their consumption and its implications. Consumers also need information that enables them to make

Ethical and environmental considerations do not yet substantially affect most individuals' consumption patterns

Box VI.1
Relevant targets of Sustainable Development Goal 12 on sustainable consumption and production for digitalization

Sustainable Development Goal 12 is particularly relevant to minimizing the environmental footprint of the digital economy. It points to the importance of utilizing the planet's scarce natural resources more responsibly, producing more sustainably and keeping consumption within the limits of planetary guardrails. Seven of its 11 targets are highly pertinent in relation to digitalization, as follows:

Achieve the sustainable management and efficient use of natural resources (target 12.2). For the digital economy, this requires measures to mitigate overconsumption and for sustainable mining, responsible production, effective waste management and a more circular digital economy.

Achieve the environmentally sound management of chemicals and all wastes (target 12.4). This concerns the management of waste related to digitalization.

Substantially reduce waste generation (target 12.5). This involves preventing, reducing, reusing and recycling digital devices and infrastructure, but can also extend to digitally enabled services that promote waste reduction.

Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle (target 12.6). This target relates to the need to develop a stronger evidence base on which to inform policymaking. Throughout the life cycle of digital products, there is a need for more standardized reporting, especially by the largest corporate players in the digital economy.

Promote public procurement practices that are sustainable (target 12.7). Governments can lead by example to ensure that the procurement of ICT goods and services takes into account their environmental footprints.

Ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles (target 12.8). This target underscores the importance of raising awareness about the environmental implications of the choices of consumers and of enabling a more circular digital economy. It could involve measures such as digital product passports.

Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production (target 12.a). This target involves strengthening international cooperation in areas that can enable developing countries to achieve more sustainable production of ICT goods and services.

Source: UNCTAD.

environmentally responsible decisions, and increased availability of environmentally sustainable goods and services.

One aim of sustainable consumption is to mitigate overconsumption and move away from an instinctive or compulsive use of digital technologies to a more controlled use that factors in both associated risks and opportunities. The concept of "digital sufficiency" includes the following four dimensions (Santarius et al., 2023): *hardware sufficiency*, aiming for lower demand and production of fewer devices, and keeping energy demand as low as possible to perform the desired task; *software sufficiency*, keeping data traffic and hardware utilization as low as possible; *user sufficiency*, with users applying digital devices frugally and using ICTs in a way that promotes sustainable lifestyles; and *economic sufficiency*, with digitalization supporting a transition to an economy characterized not by economic growth as the primary goal but by sufficient consumption and production within planetary boundaries. Changes of consumer behaviour in this direction may relate to the availability of, among others:

- Environmentally sustainable digital devices and services;
- Easier ways to acquire digital products responsibly and sustainably, aligning environmental sustainability with consumer preferences in terms of cost, convenience, capacity and image;
- Information that helps consumers understand environmental impacts regarding how different digital products are used, and how their environmental footprint could be reduced. This could lead to a more frugal use of connectivity, fewer connected IoT devices and less use of standby mode. In some contexts, it could involve using less sophisticated devices, such as those with smaller screens, or favouring standard telephone calls over video calls (Bordage, 2019);
- Possibilities for consumers to extend the lifespan of devices rather than frequently replacing them with newer, only marginally upgraded, models. This would require more opportunities to upgrade device components, replace batteries and reuse, repair, refurbish, resell and recycle devices. It would need to be supported by well-developed second-hand markets, the ability to obtain digital products as a service, convenient channels for collecting devices at end of use and appropriate information on how to dispose of them in an environmentally sound manner;
- More environmentally friendly online shopping practices, for example through ecofriendly delivery options and limiting free returns.
- Extending the lifetime of digital products can allow consumers to make monetary savings, restore efficiency and possibly add value. Consumers can also be empowered by their ability to contribute directly to environmental sustainability.[5]

Businesses and business associations are more likely to move towards more environmentally responsible digitalization business models if consumers demand more sustainable digital product options. Meanwhile, consumers may be interested in maintaining and protecting their devices, giving items a second life, valuing used items, engaging with reverse logistics (whereby a product is returned from the point of sale to the manufacturer or distributor for recovery, repair, recycling or disposal), valuing easy-to-repair products, repairing products and replacing batteries. Renting or sharing options could give users access to items, when necessary, without owning them.[6]

It is important for consumers to understand potential environmental impacts before

[5] See https://www.oneplanetnetwork.org/sites/default/files/2023-02/23_02_02_PLE_Infographic_One%20Way.pdf.

[6] See https://www.oneplanetnetwork.org/sites/default/files/2023-02/23_02_02_PLE_Infographic_Players.pdf and https://www.oneplanetnetwork.org/sites/default/files/2023-02/23_02_02_PLE_Infographic_Eletronic.pdf.

buying, be informed about proper recycling and disposal at end of use and be aware of the environmental and human rights impacts of products over an entire supply chain. Consumers should also have the necessary information on how to opt for more rational, productive and environmentally sustainable ways of using the Internet, for example in terms of data storage involving pictures, streaming videos and sending messages.[7]

Individual consumers may think that their contribution to environmental impacts through digitalization is relatively small, and that individual actions or behaviours in this context do not matter, particularly if others do not act. Therefore, actions towards environmentally sustainable digitalization need to be a joint responsibility between Governments, producers and consumers, as discussed in the rest of this section.

3. Fostering sustainable production in the digital economy

In general, businesses in the ICT sector, as elsewhere, are mainly driven by the maximization of profits. In most cases this leads to a focus on market growth and innovations that will lead to creation of new products and improve economic efficiency and productivity in meeting consumer demand, encouraging the rapid roll-out of innovations without a detailed scrutiny of potential impacts on society or the environment. In the digital economy, network effects, which intensify value to users when networks are used by large numbers of people, have added pressure to bring new products and services to market early and helped to concentrate market power (UNCTAD, 2019a).

Some business models in the digital economy are distinct from those in other sectors in that they are modelled on the following two trends that actively work against sustainable consumption and production:

- Rapid technological change, which requires the frequent upgrading of infrastructure for digitalization and has sometimes encouraged obsolescence in digital products. The average lifetime of digital devices is often very short. This is of concern, as most of the environmental footprint of such devices is generated at the production stage;
- The revenue model for many digital platforms, particularly social media, is based on advertising revenue and on exploiting data gathered from customer interactions. This incentivizes platforms to maximize such interactions and, thereby, maximize exposure to advertising, which encourages excess consumption. Recommendation algorithms on e-commerce platforms can exacerbate this trend.

These business models lack strong incentives to economize on scarce resources and energy consumption or to facilitate environmental sustainability. There is, however, an alternative to this model. The Coalition for Digital Environmental Sustainability (CODES) Action Plan calls for the "mindset of maximizing shareholder value [to] evolve to a new set of values focusing on transparency, accountability and inclusive stakeholder engagement", in which a "shared set of sustainability values and standards [is] encoded into the design, development and deployment of digital products, services, practices and business models" (CODES, 2022: 13). As argued by some scholars, there is a need to go even further in considering the social and environmental context, as "business models must profoundly change to foster the common good and overcome the existing growth fixation of the fossil and linear economy" (Digitalization for Sustainability, 2022: 82).

> Actions towards environmentally sustainable digitalization need to be a joint responsibility between Governments, producers and consumers

[7] For more detailed discussions on actions for sustainable consumption in the digitalization context see, for instance, Zibell et al. (2021) and Green IT (2022).

A new culture that recognizes the significance of environmental outcomes during the design phase of digital products could have a substantial impact over the entire digitalization life cycle. Platform service providers, for instance, could refocus algorithms and data management to optimize through efficient use of (environmental) resources rather than maximize potential business opportunities. Devices could be designed on the basis of environmental sustainability considerations. The modularization of devices would allow for their repair, reuse and refurbishment and make it easier, and more economically attractive, to recover components and scarce resources through recycling.

Most digital devices are not designed with environmental sustainability in mind

Most digital devices are not designed with environmental sustainability in mind. Standard-setting bodies in the digital sector have generally prioritized technical and economic efficiency, paying less attention to environmental impacts and externalities. This has stimulated innovation and benefited businesses developing new markets, but has led to outcomes that are often environmentally suboptimal. The digital economy encourages programmed obsolescence, as businesses upgrade digital products frequently rather than extending their lifespans. For much hardware, business models prioritize replacement rather than software upgrades or refurbishment, which would be more environmentally sustainable.

Similar issues relate to the design of online services, both those that are entirely digital and those that use digital resources to deliver non-digital goods and services. The ways in which these are configured and interface with customers affect the kinds of devices that end users require, the amount of energy they use and the environmental costs of delivering consumer goods that have been ordered. In addition, digital ecosystems that tend to lock in users not only stifle competition (Jacobides and Lianos, 2021; UNCTAD, 2021h), but can also limit consumer choices for more sustainable hardware and software solutions.

With encouragement or requirements from Governments, digital businesses could contribute towards a more environmentally sustainable digital economy by:

- Undertaking impact assessments of existing and new digital products with a view to optimizing environmental efficiency in their design, deployment and disposal. These should pay attention to the entire supply chain, from the sourcing of components through to marketing and data management and disposal;
- Collecting detailed information on environmental performance and impacts, and reporting them transparently. Ideally, technologies would include detailed manufacturing information, enabling an independent evaluation of the environmental footprint based on the provided input data. Independent scrutiny should ensure that data are not selected in such a way as to present companies in a more favourable light; ensure that greenwashing does not take place; and ensure a fair reflection of reality;
- Partnering with other businesses in supply chains and, where necessary with competitors, to minimize the use of scarce resources and optimize the use of data centres and of networks. For instance, in the case of the roll out of 5G mobile networks, competing network and service providers could be required to share the use of base stations (Pohl and Hinterholzer, 2023);
- Developing better systems for reuse and recycling, including collection and handling of waste, as well as separating different types of material, particularly plastics and transition minerals (Handke et al., 2019);
- Developing software with energy and resource efficiency in mind. This includes optimizing software applications for reduced power consumption and minimizing the computational resources required, thereby extending the life span of devices and lowering the overall environmental footprint (Atadoga et al., 2024).

High market concentration in the context of digitalization, for example, in the manufacturing of semiconductors and digital devices, the ownership of social media and e-commerce platforms and the provision of infrastructure networks and hyperscale data centres, give a small number of large companies huge influence over the options available to businesses throughout the supply chain. Changes in business models significantly affect their direct environmental footprints, as well as those of their suppliers, customers and other businesses dependent on the infrastructure, hardware and services that they provide. Improvements in the carbon efficiency of data centres, for instance, would have knock-on effects on the carbon efficiency of all businesses that rely on them.

Businesses may pay more attention to environmental impacts and adopt more sustainable business models if environmental issues become a more decisive consumer preference, and if consumers seek to influence choices in ways that are both commercially and environmentally sustainable. Business associations can encourage collaboration on more sustainable innovation and production by building consensus and establishing self-regulatory mechanisms, for instance concerning advertising.[8]

More broadly, sustainable innovation in the digital economy requires integrating environmental considerations into the development of new technologies. These include standard setting and the design, development and deployment of infrastructure, products and services by digital businesses, from the largest manufacturers and data corporations to start-up enterprises entering niche markets. Standards-setting bodies and product and service designers should consider and seek to mitigate potential negative environmental impacts. In particular, developers should be encouraged to apply designs that help economize on scarce resources, optimize energy and data storage or reduce the power requirements of consumer devices. Design for environmental sustainability should also help minimize the use of hazardous substances, enable more substantial recycling (for example, through more modular design) and the greater use of recycled materials and to the greatest extent allow digital products to be disassembled into their initial components.[9]

Producers can benefit from extending the lifetime of digital products, for example, in terms of reduced production costs and a smaller environmental footprint; increasing their product portfolio to include both new products and services such as repairing or remanufacturing; developing new business models; identifying ways to improve the design of future products; seizing opportunities to increase profitability by offering higher value added materials and products; contributing to corporate social responsibility and generating more job opportunities; and achieving customer loyalty.[10]

Businesses may pay more attention to environmental impacts and sustainable business models if environmental issues become a more decisive consumer preference

4. Moving towards circularity

Circular economy activities can offer a sustainable foundation for business models aimed at enhancing the longevity, utilization and overall lifetime of products, particularly in the context of digitalization and electronic devices. By prioritizing product life extension strategies, such as maintenance, repair, refurbishing and recycling, they reduce the need for new products and the corresponding extraction of raw materials, thereby cutting down

[8] Examples of business initiatives in the context of environmentally sustainable digitalization include the Global Enabling Sustainability Initiative, the European Green Digital Coalition, the Global Electronics Council and the Circular Electronics Partnership.

[9] For a more detailed discussion of the role of businesses in moving from linear to circular economies, including in the electronics value chain, see UNEP (2021b).

[10] See footnotes 5 and 6.

on waste. They can also create valuable opportunities for economic growth and job creation within these areas. Thus, there is a business case for the move towards circularity,[11] which can contribute to inclusive development. Entrepreneurs can play a catalytical role in such a transition (UNCTAD, 2024b). The economic potential is reflected in the expected expansion of circular economy practices related to the electronics industry (see chapter IV).

Circularity needs to be already factored in at the innovation and design stage

In order to enable a more environmentally sustainable digital economy, circularity needs to be already factored in at the innovation and design stage. Progress towards a more circular digital economy could lead to the optimization of economic and environmental impacts of digitalization by:

- Reducing waste and pollution in extraction and processing;
- Encouraging the more frugal use of scarce resources in manufacturing;
- Increasing the use of renewable energy and reducing water use by data centres and network operators;
- Ensuring sufficient, adaptive and resilient infrastructure without excess capacity;
- Ensuring the repair, reuse, refurbishment and recycling of devices;
- Maximizing the recovery of material resources from digitalization-related waste.

While no economic process can be entirely circular, approaching business and digital product design in this way can embed more sustainable processes that encourage positive impacts and reduce adverse environmental effects. Circular economic thinking needs to be approached holistically, as reductions in environmental impacts at one stage of the digital life cycle may generate increased impacts at other stages. Attention must be paid to both the direct and indirect impacts of products and services.

Achieving greater circularity will require concerted action at all levels by Governments, businesses and consumers throughout the digital life cycle, including in designing digital platforms, products and services in ways that foster sustainable consumption by default and by encouraging sufficiency in the use of resources, promoting behavioural change among consumers and facilitating the recovery and reuse of resources to maximize their value.

All of this requires a reconsideration of how digital products make use of hardware and software and how to manage these components at the end of their life. Such an approach could provide new environmental, social and economic benefits. Value retention processes that can be adopted in this context could offer win-win opportunities for relevant stakeholders. Governments could benefit from having to deal with less waste while generating new environmentally sustainable jobs and stimulating economic growth. Producers could lower production costs, avoid resource constraints on business growth and open new markets, while customers could benefit from lower prices for refurbished products (UNEP, 2017).

5. The growing need for integrated policymaking

Self-regulation through corporate governance and voluntary agreements between digital businesses can contribute to a culture of environmentally sustainable digitalization among producers. However, relying solely on the free play of market forces is unlikely to be enough to prompt shifts in consumer or producer behaviour towards sustainability in the digital economy.

Significant policymaking efforts are needed to enable collective action, align with circular economy goals and promote the transition towards sustainability among consumers and producers. This will require a combination of policies, legislation, regulations, licences, mandatory requirements and fiscal incentives. Environmentally responsible behaviour can

[11] The case for circular business models in the electronics industry is discussed in PwC Sweden (2023).

be encouraged through incentives and information campaigns, and unsustainable behaviours should be discouraged or halted.

Many Governments have adopted national strategies for digital development. These relate to national goals such as digital inclusion, promotion of digital sectors, digital trade that contributes to economic development and regulatory oversight of data protection and cybersecurity. In parallel, most Governments have also established strategies for environmental sustainability, in response to the Sustainable Development Goals, including multilateral agreements related to climate change, water, pollution and biodiversity, such as the nationally determined contributions under the Paris Agreement,[12] as well as various national priorities. These play a similar role in focusing government and stakeholder attention on environmental goals and how these relate to economic and social development.

To date, however, Governments have tended to address digitalization and environmental sustainability in silos. Digital strategies, where they have been adopted, typically focus on leveraging the digital economy to benefit national competitiveness, export markets and employment, and pay little attention to the environmental dimension. Environmental strategies, meanwhile, generally underestimate and fail to address the negative effects of digitalization. This needs to change.

Developing a stronger understanding of the relationship between the two areas, as discussed in the next section, and integrating policies for the transition to digital and low-carbon technologies, is critical to building environmentally sustainable digitalization that works for inclusive development. Digitalization and environmental sustainability strategies should be coherently considered as part of national development strategies.

Governments are responsible for overseeing and shaping economic relations, including digitalization and environmental sustainability developments, in the general interest of the societies they govern. This includes translating international and regional agreements and standards into national regulation. Policymakers can provide strategic leadership and shape public opinion. They can build environmental awareness within the business community and among consumers to encourage the adoption of environmentally responsible digital business models and consumer behaviour. Moreover, as major purchasers of digital products, Governments can set an example through public procurement. Governments and public service providers are high-volume consumers of digital products, wielding considerable procurement power as they seek value for money (box VI.2).

Several policy enablers could promote the objective of inclusive and environmentally sustainable digitalization in practice through the following:

- Broad-based and stronger understanding and awareness of the complex and varied impact of digitalization on the development of different countries, industries and communities, as well as on environmental sustainability;
- An underlying commitment from relevant stakeholders to the objectives of environmental sustainability, including a more circular economy;
- Willingness on the part of Governments, in close collaboration with the business community and civil society, to develop legal and regulatory frameworks that facilitate sustainable innovation and business development and promote sustainable consumption; and
- Institutional arrangements that embed a culture of environmentally sustainable digitalization into policymaking, design standards and business decision-making at a time of rapid technological and economic change.

> To date, Governments have tended to address digitalization and environmental sustainability in silos

[12] See https://www.un.org/en/climatechange/all-about-ndcs.

Box VI.2
Towards environmentally sustainable procurement of digital products

The promotion of sustainable public procurement practices is one of the targets under Goal 12. Governments are increasingly moving public services online as complements to, or substitutes for, offline services. Digital products are also procured in large quantities in the private sector. Digitally enabled businesses (such as e-commerce retailers) would be unviable without digital devices and services. Other businesses that are highly dependent on digital transactions and data management, such as banks, acquire high-quality equipment in bulk and require reliable infrastructure, while all large businesses rely on digital resources to undertake transactions, manage operations and serve clients. A growing number of office workplaces make extensive use of telecommuting, teleconferencing and cloud storage.

Governments, as well as corporate consumers, should consider the environmental impacts of their activities. For example, they could undertake environmental audits of the ways in which they interact with suppliers and clients, with the aim of reducing environmental footprints. In particular, they should include environmental impacts in procurement policies and strategies along the same lines as public services and foster a culture of sustainability among employees throughout business operations.

Procurement practices can promote sustainability both directly, by including environmental goals within procurement decisions, and indirectly, by acting as an example to other decision makers. Environmentally sustainable procurement can have economic benefits if equipment with a longer active life proves cheaper over its life cycle than alternatives.

Procurement policies should favour products and services that minimize impacts related to energy and water use, and waste across the digital life cycle. For example, in Argentina, the National Information Technology Office and the National Procurement Office work jointly to promote circular and sustainable ICT procurement by public administrations. In India, the Government e-market place for digital procurement promotes sustainable procurement by targeting and prioritizing the listing and availability of environmentally sustainable products and services, with filters to help government buyers identify sustainable options (ITU, 2023b). In Spain, the Barcelona City Council is working towards minimizing the environmental impact of the use of ICT equipment needed for municipal services.[a]

Tender requirements that prioritize or incentivize environmental responsibility can have a significant impact on businesses seeking public sector contracts, particularly if these require compliance with internationally agreed norms, as well as national priorities. Governments should include environmental impact assessments in tender criteria and evaluation, encourage contracted suppliers to include similar assessments in their procurement processes and require them to report regularly on the environmental impacts of their public service work.

United Nations agencies should adopt similar criteria in order that their procurement efforts integrate sustainability across the board (UNEP, 2023b). Criteria and good practices for sustainable procurement should be consolidated and shared among Member States and United Nations agencies. The CODES Action Plan calls for the establishment of an international framework to enable standardization and harmonization of sustainable procurement principles and green digital infrastructure across Governments and corporations (CODES, 2022).

To this end, ITU, in a circular on the sustainable procurement of ICT equipment, offers comprehensive guidance on embedding sustainability and circular economy principles into public sector procurement practices, emphasizing the importance of developing policies and strategies that not only align with international sustainability standards but actively promote innovation and sustainability in the ICT sector (ITU, 2023b). This approach is important for reducing environmental footprints and fostering a culture of sustainability within public procurement processes. UNEP has also launched the Circular and Fair ICT Pact, a procurement-led partnership to accelerate the transition to a sustainable ICT sector.[b]

Source: UNCTAD, based on sources cited.

[a] See https://www.ajsosteniblebcn.cat/ins_eng_c_ict_maq_68272.pdf.
[b] For more information, see van Geet et al. (2022).

Proactive policy frameworks are needed to achieve significant and sustainable changes in consumer behaviour, particularly where lifestyle choices are affected (UNEP, 2023b). Governments have the capacity to influence, or nudge, consumer behaviour towards more environmentally responsible practices. Importantly, they are also uniquely positioned to address collective action problems and facilitate coordinated efforts that individual actions alone cannot achieve. This can be done through a variety of mechanisms, including those that are designed to make environmentally responsible behaviour more attractive (Digitalization for Sustainability, 2022). Choices available to consumers in the digital economy are greatly influenced by businesses. The most powerful levers that Governments and international organizations can apply towards an environmentally sustainable digital economy that works for development are therefore those aimed at shaping and, when necessary, regulating business models towards sustainability.[13]

Governments have the capacity to influence consumer behaviour towards more environmentally responsible practices

D. Preconditions for policymaking

The challenges at the digitalization and environmental sustainability nexus are complex and interdependent. Overall, actions by stakeholders and policymaking at all levels in pursuit of the common goal of an environmentally sustainable digital future that works for inclusive development should be based on various fundamentals, as presented in box VI.3. These fundamentals should inform the work of all stakeholders concerned. Two enabling factors can be seen as preconditions for the effective implementation of actions in this area: first, an enhanced understanding of the impacts of digitalization on the environment, founded on a robust evidence base, to inform policymaking and decisions by other stakeholders; and second, broad-based awareness of the critical issues.

1. Improving the understanding of how digitalization impacts the environment

Understanding of the impacts of digitalization on environmental sustainability remains limited. More research and analysis are needed to build the evidence base. Extensive, reliable and timely information is required to raise awareness and enable Governments, businesses and consumers to gain confidence that their actions will bring economic, social and environmental gains.

As shown in this report, while there is a considerable amount of data gathering and modelling of digitalization and environmental impacts, this evidence base has several weaknesses:

- Some environmental concerns (notably related to carbon emissions) are more extensively researched than others (such as water use and digitalization-related waste) and this risks that processes are optimized only in these domains, potentially leading to “greenwashing”;
- In certain areas, such as digitalization-related waste, data-related challenges include incomplete reporting, ambiguous definitions, incorrect categorizations and inaccuracies; lack of data is particularly acute in the case of waste because a significant part is managed in informal settings and through illegal channels, particularly in transboundary flows;
- Much of the information available draws on data predominantly from developed countries;
- Some oft-cited results have been derived using models of data collection and

[13] For a detailed discussion of how sustainability is governed throughout the electronics value chain, see Evans and Vermeulen (2021).

Box VI.3
Fundamentals for informed policymaking

Establishing a commonly agreed understanding of the need for new policies is vital to ensure that the development of the digital economy aligns with broader goals of environmental sustainability, inclusivity and equity. Public policy to bolster development gains from the growth of a national digital economy is more likely to succeed if it is part of an overarching strategy designed with economic inclusion and environmental sustainability in mind.

Drawing on the analysis in this report, eight broad fundamentals are proposed that could serve as the basis of an inclusive and environmentally sustainable digital economy that contributes both to prosperity for all and to improved environmental outcomes.

Policies and practices to promote the digital economy should:

1. Integrate economic, environmental and other goals related to sustainable development, including principles of geographical and social inclusion, intergenerational equity and the protection of planetary boundaries, which were established as global priorities at the United Nations Conference on Environment and Development in 1992 and reinforced in the 2030 Agenda for Sustainable Development;
2. Recognize disparities in living standards and resource use within and between countries at different levels of development and the need to expand opportunities for disadvantaged groups, including women, youth and marginalized communities, in line with the pledge in the 2030 Agenda that no one will be left behind;
3. Understand that economic development that is not environmentally sustainable will be economically unsustainable, that responsible innovation and the deployment of technology should optimize rather than maximize the use of digital devices and services and that environmental considerations should be incorporated into national strategies for digital development and in the design, development and delivery of products and services, as part of national development strategies;
4. Consider the whole life cycle of digital equipment and infrastructure, including the extraction and processing of material resources and the manufacturing, distribution, use and disposal of devices, identifying ways to minimize and mitigate negative environmental impacts at each stage and facilitate a more circular digital economy;
5. Consider the full range of environmental impacts, including direct, indirect, rebound and societal effects, identify ways to optimize beneficial applications and minimize those that are inequitable or environmentally harmful and pay attention to the interface between policies concerned directly with the digital economy and those concerned with other social and economic domains affected by it (such as transport, energy, housing and urban development);
6. Involve all stakeholders in the shared endeavour to achieve a sustainable digital economy, reflecting the views and needs of consumers alongside those of policymakers, businesses and civil society in general, and building environmental expertise into the development of policies, standards and business models from the outset and develop relevant statistics to inform policymaking;
7. Be consistent with relevant United Nations and international goals, including those concerned with human rights, gender equity, poverty reduction and consumer welfare, particularly the targets under the Sustainable Development Goals and relevant international digital and environmental agreements;
8. Be agile, capable of responding and adapting to changes in the context of the digital economy, including technological developments (such as new opportunities to address environmental problems emerging through the use of AI) and trade-related, environmental and social developments.

Source: UNCTAD.

analysis that reflect the interests of those funding and publishing the research; and

- Methodology and models are frequently inconsistent in terms of assumptions, scope and definitions, leading to widely different estimates of impacts and potential outcomes (see assessments of GHG emissions and energy consumption in previous chapters).

Reliable and comparable information on the environmental impacts of digital products can be provided by both Governments and businesses, for example, through product labels and in marketing literature. Independent information and trustworthy, consumer-friendly digital product reviews and ratings are desirable, as well as search filters that make it easier for consumers to identify environmentally positive options.

Addressing information and research deficits will help focus efforts towards building a more reliable, comprehensive picture of the environmental impacts of the digital economy. There are important responsibilities for Governments, businesses and the research community. Major objectives in this context include:

- *Developing standardized assessment methodologies and indicators* that enable comparisons between different companies and countries, as well as aggregation at the business sector, national and global levels. It is important to incorporate multiple criteria into these methodologies, to consider the broad spectrum of environmental indicators across the life cycle of digital products. Such an approach can help ensure a holistic assessment of the digitalization footprint, encompassing not only energy consumption and GHG emissions but also factors such as water use, resource depletion and pollution. This is crucial for developing targeted, effective policies that address the multifaceted environmental implications of digitalization and for preventing greenwashing. The life-cycle assessment standards developed by the International Organization for Standardization (ISO), such as ISO 14040 and ISO 14044, can be particularly useful in this context as they provide a comprehensive framework for evaluating multiple direct environmental impacts of digital products throughout their life cycles.

Similarly, increased standardization in assessing indirect environmental impacts from digitalization in other sectors will be necessary. An initial, single-criteria framework has been proposed by ITU in a recommendation on assessing the impacts of ICT on GHG emissions in other sectors (ITU, 2022). Digital standard-setting agencies and environmental organizations, including those concerned with sectors that are particularly affected by digitalization such as energy and transport, should be strengthened. This would enable more environmentally sustainable frameworks to arise for the design of networks and infrastructure, especially where standards are likely to become universal (as, for example, with the next generation of infrastructure for mobile communications and those concerned with innovations in AI).

The CODES Action Plan proposes an impact initiative aimed at developing a new, multi-stakeholder and globally representative platform to co-define key standards for sustainable digitalization and economic circularity. This "clearing house" would seek to create an up-to-date, authoritative overview of global digital standards, to address key gaps, and conduct outreach to enable effective implementation by all concerned parties (CODES, 2022). While it will take time to reach agreement on relevant methodologies in all areas, Governments, researchers and businesses can work with international agencies, including ISO, the International Electrotechnical Commission, the Institute of Electrical and Electronics Engineers and the ITU Telecommunication Standardization Sector to agree on assessment approaches for particular aspects of environmental sustainability in the digital economy, including under-researched areas such as water use

and waste.[14] International organizations should work with business associations and consumer bodies to develop standardized data sets and indicators that are consistent with relevant global goals, to establish norms for data transparency applicable to global corporations, promote the use of internationally comparable data and support enhanced analytical capacity in national statistical networks.

- *Promoting effective data collection in all jurisdictions*. At present, data collection on the digital economy and its environmental impacts is concentrated in developed countries. Their experiences often differ substantially from those of the majority of developing countries, especially low-income countries. Effective policymaking requires more data and analysis in developing countries, reflecting local circumstances and priorities;
- *Fostering greater transparency among businesses* throughout the life cycle of digital devices and infrastructure, particularly corporations whose activities have a global reach (such as those that manufacture semiconductors and end-user digital devices, manage hyperscale data centres or develop AI applications). Their environmental performance should be reported transparently and comprehensively, in ways that enhance understanding and policy development rather than seeking to manage public opinion or regulatory outcomes. Transparency requirements can be established through normative agreements between government and business or mandated through legislation and regulation. This would be valuable for policymakers and consumers, as well as for businesses, and help to identify improvements to business models that would be commercially as well as environmentally beneficial. Another way to enhance the global evidence base on the interface between digitalization and climate change would be for the UNFCCC to extend its emissions monitoring to encompass the ICT sector. Monitoring is focused on the energy sector, industrial processes and products, agriculture and waste (UNFCCC, 2018); the inclusion of the ICT sector in monitoring efforts would provide valuable data, to inform sustainable practices within the sector. However, this would require a sufficiently wide definition of the ICT sector and systematic tracking of the carbon footprint;
- *Improving data collection and assessment methodologies* with regard to emerging technologies and services, including AI and cryptocurrencies. In the case of AI, recent research points to the need for more granular data to assess the environmental impacts of different stages of the life cycle of machine learning (Kneese, 2024; Luccioni et al., 2023). In addition, developers of AI could be obliged to report on the energy demand and carbon emissions of their models. There are already software tools and metrics available for reporting on model accuracy (Anthony et al., 2020). In the case of cryptocurrencies, the United States Energy Information Administration aims to estimate and manage the electricity consumption of cryptocurrency mining operations more accurately. This research involves both top-down and bottom-up methodologies for estimating energy use, with data sourced from the Cambridge Centre for Alternative Finance and directly from mining facilities (United States, Energy Information Administration, 2024). While such innovations can greatly influence the development of the digital economy during the next decade, they can also substantially contribute to its environmental footprint. Associated environmental impacts need to be carefully monitored so that businesses can identify ways of maximizing energy efficiency at an early stage and Governments can take necessary

[14] For example, the 2022 Harmonized System amendments by the World Customs Organization (WCO) include classification provisions for e-waste, which simplify identification (WCO, 2019).

action to manage energy and water markets in the face of rising demand;

- *Increasing independent research and data analysis* by institutions concerned primarily with public interest outcomes. Much of the current data analysis comes from businesses and business associations that have privileged access to data and may wish to emphasize positive outcomes. Independent data analysis is essential if policymaking is to avoid capture by vested interests. It should include consumer bodies, academia, independent research institutions and think tanks, and should draw on both environmental and digital expertise. Findings should be widely publicized in order to build awareness, inform policymaking and facilitate consumer choice.

Governments should enforce transparency and accountability to combat greenwashing, ensuring that businesses substantiate environmental claims, to support informed and sustainable consumer choices (box VI.4).

The need to improve the evidence base should not be used as an excuse for inaction today. The underlying evidence that is currently available is sufficiently clear to establish the need for urgent action to reduce the environmental impacts of digital technology, build awareness and put policies in place to enhance sustainability.

2. Raising awareness of the environmental footprint of digitalization

Only recently has increasing attention been given to the environmental footprint of digitalization. As a result, there is limited awareness among most stakeholders of how different digital products and their use may impact the environment. Greater awareness is needed to foster more sustainable consumption and production in this area.

As noted, stakeholders in the digital economy are primarily driven by priorities other than environmental considerations. Addressing the goal of environmentally sustainable digitalization that works for inclusive development requires shared awareness and understanding by all stakeholders. In an ideal scenario, improved consumer awareness of the implications of their choices leads to changes in buying behaviour as well as foster greater political awareness and action, creating a virtuous circle through which increased public pressure encourages businesses to adopt more sustainable practices. Civil society plays a significant role in raising awareness and influencing public opinion on these issues, providing the necessary impetus for businesses and policymakers to take action.[15]

While understanding has been growing in recent years, achieving greater comprehension and appreciation of the importance of the environmental footprint of digitalization is not straightforward, for several reasons:

- Some of the impacts that threaten future generations (such as those related to climate change) include gradual, long-term processes that can be easily sidelined by short-term economic or political objectives. It is important to ensure a long-term recognition that economic and environmental goals are interdependent and central to policymaking. Over time, gains in economic value can become economically unsustainable if they are not also environmentally sustainable;
- The relationship between positive and negative environmental impacts is often presented as a trade-off, that is, increased energy consumption for digitalization can be tolerated, for instance, if it enables decreased energy consumption through energy efficiency in other sectors. While such trade-offs are valid, there may be rebound effects, as greater

There is limited awareness among most stakeholders of how digital products and their use may impact the environment

[15] For example, civil society organizations such as Stop Planned Obsolescence and the Right to Repair Movement are important in raising awareness about unsustainable business practices with regard to digital products.

efficiency tends to induce consumption. Environmental impacts are also complex and interrelated. Relevant impacts for society arise from the production, distribution, consumption and disposal of digital devices and infrastructure. They also include broader impacts on the future of urban centres, public transport, workplaces, employment, taxation and overall national economic development. Thinking about trade-offs may encourage complacency. Potential environmental

Box VI.4
Protecting consumers against greenwashing

The rapid expansion of digital retail has drawn attention to the issue of "greenwashing", where businesses inaccurately claim that their products are environmentally sustainable, exploiting consumer interest in "green outcomes" (United Nations, 2023c). This practice not only misleads eco-conscious consumers but adds to traditional consumer protection concerns regarding data privacy, misleading marketing and fraud. To mitigate greenwashing and promote genuinely sustainable consumer choices requires a multifaceted approach, combining government regulation, industry standards and consumer education.

Governments can address greenwashing by mandating standardized environmental reporting by businesses, including for product comparison, exposing false claims through published data and holding non-compliant companies accountable. This requires establishing clear regulations and guidance to limit and verify green marketing claims, possibly through a pre-market control mechanism, to ensure claims are substantiated (Consumers International and International Institute for Sustainable Development, 2023).

Industry self-regulation, guided by advertising standards set by organizations such as the International Chamber of Commerce and the World Federation of Advertisers, can also play a crucial role in curbing false claims and facilitating consumer complaint resolution (ICC, 2021; World Federation of Advertisers, 2022). The United Nations Guidelines for Consumer Protection do not explicitly mention greenwashing, but recommend updating consumer protection policies for the digital marketplace (United Nations, 2016). The United Nations High-Level Expert Group on the Net-Zero Emissions Commitments of Non-State Entities (2022) has called for an end to greenwashing and for regulation starting with large corporate emitters, including assurance on their net zero pledges and mandatory annual progress reporting.

Despite such efforts, dedicated legislation targeting environmental claims in e-commerce remains limited. In 2022, over 80 per cent of respondents to a questionnaire on green claims reported a lack of specific laws or regulations for addressing environmental claims in e-commerce. These respondents were from consumer protection agencies in countries that are members of a working group on consumer protection in e-commerce, under the UNCTAD Intergovernmental Group of Experts on Consumer Protection Law and Policy. However, almost two thirds said that educational materials to raise awareness among consumers and businesses in this area had been or were being developed (UNCTAD and Superintendence of Industry and Commerce of Colombia, 2022).

Notable efforts to address greenwashing include UNEP guidelines on regulatory frameworks (UNEP, 2023c) and proposed rules by the European Commission for substantiating green claims (European Commission, 2023b). On the national level, for example, the United Kingdom and the United States introduced the green claims code in the former (United Kingdom, Competition and Markets Authority, 2021) and the guides for environmental marketing claims in the latter (United States, Federal Trade Commission, 2012). In Asia, important steps to mitigate greenwashing have been taken by China, India, Malaysia and Singapore.[a]

Source: UNCTAD, based on sources cited.

[a] See, for example, File (2023).

benefits from digitalization should not undermine the need to minimize its environmental costs, for example, by designing more energy-efficient devices and services. On the contrary, policies should be complementary, focusing innovation on approaches that optimize both digital and environmental outcomes;

- Some Governments, businesses and individuals may see their contributions to global environmental impacts as marginal. Individual consumers, in particular, may feel that adjusting their behaviour (at a personal cost) will have little or no effect unless everyone else does likewise. This suggests that awareness and exhortation alone are unlikely to change the behaviour of most businesses or consumers on their own. Incentives and regulations will also be required;
- Governments should take steps to build knowledge and understanding of environmental impacts, and of the role that individuals and businesses can play in mitigation. This can be achieved through public education and information campaigns, and by requiring businesses to be transparent about their impacts in marketing and packaging. For example, digital applications embedded in social media and e-commerce platforms, which involve product comparability, ethical nudging, gamification, carbon footprint calculators and positive feedback loops, can be used to raise awareness (CODES, 2022). One example is providing information that allows for the circularity of a product to be traced, which would also enable consumers to be aware of the composition of products (box VI.5).

Box VI.5
Towards better tracing of the circularity of digital products

Currently there is no international agreement on the product information needed to facilitate digital circularity, but steps in this direction are being taken. A variety of approaches exist or are in development, to introduce digital product passports in corporate, policy and research activities, as reviewed by Jansen et al. (2022).

The European Commission is consulting on proposals to trace digital products throughout their life cycle in order to facilitate decarbonization, recycling and a more circular economy. The proposed digital product passport will bring together information about the components, materials and chemical substances, repairability, spare parts and professional disposal requirements of a product with the aim of improving durability, repairability and upgradability. The legislation will be introduced as part of the European Commission Circular Economy Action Plan, adopted in 2020, and will require companies to create passports for certain products (European Commission, 2022b; University of Cambridge Institute for Sustainability Leadership and Wuppertal Institute, 2022).

Similar principles can be applied to software. In Germany, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2020) has initiated the “blue angel” label for software with the aim of encouraging applications that are more power- and resource-efficient during use.

ITU is also working on developing standards to describe the information that should be contained in a sustainability passport for digital products (ITU, 2021b). Measures such as these offer a potential way for Governments with sufficient regulatory capacity to improve the circularity of digital product markets.

Source: UNCTAD, based on sources cited.

E. Policy options

The need for a holistic, whole of life cycle, multi-stakeholder and interdisciplinary approach to environmentally sustainable digitalization implies that multiple policy areas need to be considered in an integrated manner. Many of them have been discussed in this report. This section provides a summary of such policy options, then delves into some relevant aspects of policies in the three main phases of the digitalization life cycle.

1. Overview of policy options

The appropriate balance between different legislative, regulatory and collaborative instruments depends on the scale and nature of digitalization in each national economy, the extent to which policymakers can influence the behaviour of international businesses and the institutional capacity for data gathering, analysis and policy enforcement. Mandatory requirements, through legislation, licencing or regulation, are particularly important where service providers are virtual monopolies. These are also needed when competition between businesses acts as a disincentive to sustainable production, for example, when marketing strategies rely on frequently offering customers new features or service improvements.

Digitalization and environmental sustainability policies should be updated and integrated into national development strategies

Digitalization and environmental sustainability policies should be updated to achieve an integrated treatment of their interdependent goals, as part of coherent national development strategies. For example, with regard to integrating digitalization and environmental sustainability, in 2020, the Government of France created an Interministerial Mission for an Eco-Responsible Digitalization and a policy framework that comprises of various regulations related to eco-responsible public services, digitalization-related waste and the circular economy and reducing the environmental footprint of digitalization. This includes banning programmed obsolescence and reducing energy consumption in data centres.[16] The Government of Germany has been moving in this direction through the Digital Policy Agenda for the Environment (Germany, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2020). These trends have extended to the European Union, which has been integrating various policies in relation to digitalization and environmental sustainability, as discussed in this report. The European Union states that "Europe's digital transition goes hand in hand with the European Green Deal".[17] Outside of Europe, the Republic of Korea is introducing a green agenda for national policy initiatives and aligning its green ICT strategy with national GHG reduction targets.[18]

Coordinated strategies should draw on expertise from policymakers, business and civil society in economic, digital and environmental domains. A holistic, interdisciplinary policy approach is key. Policy options should include realistic and achievable goals with targets and indicators for monitoring progress, mechanisms for data gathering and analysis and clarification of how different instruments of governance can be applied to support sustainable consumption and production, including by promoting a more circular digital economy. Countries have already designed and adopted a number of policy initiatives, which point to progress in this direction, but there are significant

[16] See https://ecoresponsable.numerique.gouv.fr/r%C3%A9glementations/ and https://www.ecologie.gouv.fr/politiques/consommation-et-production-responsables.

[17] See https://digital-strategy.ec.europa.eu/en/policies/green-digital.

[18] See https://www.wbgkggtf.org/node/3560.

challenges when it comes to implementation and enforcement. It is also important to strengthen accountability channels and capacity-building for enforcement.

A summary of policy options discussed in this report, at the national, regional and international levels and in the different phases of the digitalization life cycle, to enable a circular digital economy and to promote the more sustainable consumption and production of digital products and ICT infrastructure, is presented in table VI.1.

There is no one-size-fits-all approach that can be applied, and a plethora of policy options are presented in the table. As countries are at different stages of economic and digital development, the impact of digitalization on the environment varies, as do development priorities. Countries need to prioritize policy options, domestically and internationally, according to their environmental sustainability, digitalization and socioeconomic development needs. Any international approach should be based on the principle of common but differential responsibilities and consider respective capacities and needs. A wide range of instruments is available for policymakers to consider (see table VI.2). The effectiveness of different instruments, and the balance between them, will vary between national contexts, not least because of the different capacities of Governments to influence or enforce other stakeholders' compliance.

2. Managing growing demand for transition minerals sustainably and inclusively

The demand for transition minerals, required for both digitalization and low-carbon technologies, is expected to rise rapidly, regardless of improvements in environmental efficiency. This is due to increased capabilities and deployment of infrastructure, hardware and data analysis. Surging demand puts pressure on the production process, especially as there is a finite supply of transition minerals, and some may be approaching scarcity (see chapter II).

Mining activities can often have direct negative impacts on local environments, including through the exploitation of limited water resources, pollution, deforestation and other adverse ecosystem effects. Poor employment practices and violations of human rights, including child labour, are widespread. This underlines the need to foster sustainable mining practices.

Policies and business practices need improvement at all stages of the digitalization life cycle to maximize the efficiency with which scarce resources are exploited and used. These should aim to strike a better balance between the interests of producing and processing countries and businesses, local communities and the local environment. Mining and processing companies need to apply more sustainable practices. Manufacturers need to develop ways of using resources in smaller quantities and make products that are easier to maintain, disassemble and recycle, thereby reducing consumption and improving the recovery of components at the disposal stage. Greater investment is required in recycling and recovery capacity, including for urban mining, worldwide, notably in developing countries.

> Market forces alone cannot create the conditions for transition mineral to become a source of development and benefit everyone

Market forces alone cannot generate the conditions for transition mineral resources to become a source of development and benefit everyone.While there is no universally applicable approach, Governments in transition mineral-producing countries could pay attention to the following issues.

Ensuring a fair distribution of the rents from mining activities. This implies addressing inequality with foreign investors, reviewing fiscal regimes to improve fiscal linkages and transparency and increasing domestic resource mobilization. Given that other linkages in mineral extraction, for example in terms of job creation, are relatively weak, fiscal linkages are key for development. Developing countries have often not obtained a fair share of the rents from extractive industries, mostly due to limited bargaining power to negotiate mining agreements (UNCTAD, 2010, 2014). Doing so may require efforts to bolster institutional capacity to engage in contract negotiations

Table VI.1
Summary of policy objectives and options at national, regional and international levels, by stage of the digitalization life cycle

Phase of digitalization life cycle		Policy options		
	Objective	National	Regional	International
Production	• Environmentally sustainable and responsible mining and electronics manufacturing, while enabling more domestic value addition for economic development in producing countries	• Improve information on mining resources for exploration • Promote mining contract negotiations for equitable distribution of rents from mining of transition minerals • Develop industrial policies to support value addition of raw materials extracted and move towards manufacturing • Develop technology policy for research on more sustainable substitute materials • Ban use of toxic materials • Incentivize and promote use of recycled materials, supporting development of secondary markets • Require producers to report transparently on their environmental footprints	• Foster regional cooperation to increase negotiating power in mining contracts and regional tax regimes • Develop regional industrial policies for value addition in developing countries	• Develop standards for responsible and sustainable mining and electronics manufacturing • Limit use of minerals that may be a source of conflict • Adopt and apply global transparency standards • Collaborate for improved geological and mining data • Establish sustainable development licences to operate mining activities • Negotiate international tax regime that works for equitable distribution of rents among producers and consumers • Enable international cooperation among consumer and producer countries of transition minerals and metals
Use	• 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	• Raise awareness of environmental implications of different kinds of use (e.g., AI) • Develop policies to counter and ban greenwashing • Require sharing of network infrastructure • Require data centres to report holistically on environmental impacts • Mitigate excessive data storage • Adopt technology policy to foster and meet requirements of energy and water use efficiency in data centres • Require investments by hyperscale data centres in renewable energy to feed local grids • Promote water conservation in data centres, minimizing use of water for cooling	• Consider regional data centres as a more efficient option for the environment • Undertake needs assessment and identification of locations for regional data centres based on potential environmental impact	• Develop global reporting standards on environmental impacts • Foster global data governance, including environmental sustainability considerations • Strengthen international cooperation on bridging digital and data divides and building digital and environmental capabilities in developing countries • Strengthen international cooperation on competition policies to address abuse of market power in the digital economy

Phase of digitalization life cycle	Objective	Policy options		
		National	Regional	International
End-of-life	• Prevent and minimize digitalization-related waste and increase recovery of resources and value from such waste	• Adopt and enforce e-waste policy, legislation and regulations, to improve collection and recycling rates • Improve data and information on digitalization-related waste • Build waste management infrastructure • Apply extended producer responsibility mechanisms • Improve working conditions in waste management sector, moving towards formalization	• 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 • Facilitate collaboration in waste management, sharing technology and best practices	• Improve data and information on digitalization-related waste • Develop global standards for circularity • Ensure compliance with rules of Basel Convention for transboundary flows, to prevent illegal exports of digitalization-related waste • Consider transferring extended producer responsibility in transboundary flows of used equipment and/or extending geographical scope
All phases	• Enable, promote and regulate sustainable consumption and production and the circular digital economy through policies for reducing, reusing and recycling	• Implement circular economy policy approaches throughout digitalization life cycle • Strengthen integration of environmental sustainability and digital development aspects, in a coherent manner, in national development strategies • 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 • Incentivize and promote new sustainable business models (e.g., electronic products as a service) • Develop collaboration and partnerships among relevant stakeholders throughout digitalization cycle • Improve evidence base for policymaking • Raise awareness through targeted campaigns on environmental impacts of digitalization • Regulate advertising in the digital economy to prevent manipulation and control over consumers, including actions that encourage overconsumption	• Consider developing regional approaches to circular digital economy and digital trade • Develop regional approaches to tracing of digital products	• Strengthen international cooperation among relevant stakeholders throughout digitalization life cycle • Adapt policies to ensure that trade works for an inclusive and sustainable global digital economy and digital trade • Develop global standards of design for sustainable ICT products, as well as for reusing, repairing and recycling • Include ICT sector in international frameworks for assessing various environmental impacts

Source: UNCTAD.

Table VI.2
Policy instruments for environmentally sustainable digitalization that works for inclusive development

Policy instrument	Example
Legislation, enforceable through the courts	Statutory requirements to restrict pollution
Regulations, enforced by statutory regulators	Enforceable rules concerned with competition policy, communications, data protection, consumer rights and environmental outcomes
Mandatory requirements in licencing and other legal instruments	Requirements to provide accurate information on environmental impacts of devices and services; apply standards to enable consumers to repair digital devices and to provide means to recycle devices at the end of life
Encouragement and endorsement of voluntary agreements and self-regulatory mechanisms	Restrictions on advertising or on marketing practices such as free delivery and returns when buying online
Reporting requirements	Regular reporting by businesses that allows Governments to monitor the digital economy and assess impacts on sustainability, and enables consumers to make more environmentally responsible choices
Fiscal and financial incentives and deterrents	Tax incentives to encourage good environmental practices or higher taxes to mitigate negative externalities, such as CO_2 emissions
Other measures to facilitate environmentally positive behaviour by consumers	Provision of recycling facilities to enable better waste management
Public information	Campaigns outlining the benefits of more environmentally sustainable choices by consumers

Source: UNCTAD.

with large mining companies. In this context, Governments need to balance the need to attract foreign investment with the need to appropriate a fair share of rents. Moreover, the fair capture and distribution of rents for domestic development purposes requires avoiding illicit financial flows, corruption and rent-seeking practices.

Fostering local value addition, diversification and structural transformation. Proactive policies are needed to address constraints and build capacities to move up in the mining and related manufacturing value chains and to enhance revenue transparency. There is a need for long-term development policies for domestic value addition among the transition minerals extracted and to enable structural transformation towards higher productivity activities. Increased processing of minerals could boost the proportion of value added to local economies. Industrial policy should support building backward and forward linkages that increase and enhance domestic economic activity and job creation, allowing for progression up value chains (UNCTAD, 2016), including a focus on business regulation, skills development and investment attraction. Overall, there is increasing political awareness among countries of the need to benefit from mineral endowments for domestic resource mobilization, to finance development objectives, which often includes dealing with challenges related to external debt. It will be important to recognize the need for developing countries to use domestic policies to add value to transition minerals for developmental purposes, and for international support in this context (Nature, 2023).

Regional cooperation could enable producer countries to achieve better agreements with mining companies

Regional cooperation could play an important part, not least in enabling producer countries to achieve better agreements with mining companies. In Africa, for example, the Africa Mining Vision,[19] a policy framework created by the African Union, may provide a foundation to enable producer countries on the continent to speak with one voice

[19] See https://unece.org/sed/documents/2023/04/presentations/african-mining-vision-tunde-arisekola-senior-advisor-geological.

to minimize geopolitical risk, strengthen negotiating power and reduce the risk of tax competition. This vision has been complemented more recently by the African Green Minerals Strategy, for countries to harness large deposits of minerals to foster domestic value addition (Kitaw, 2023).

From the perspective of mineral-consuming and importing countries, the surge in demand for minerals is driven by significant processing and manufacturing activities that rely heavily on mineral resources. This has led to increased competition to safeguard supply chains for the future. As highlighted in chapter II, some recent strategies to secure access to transition minerals have included efforts to make relevant value chains more resilient and achieve higher levels of self-sufficiency and sovereignty, as well as more control over production in critical sectors. There is also a trend towards creating alliances or partnerships with countries that may be considered "friends" or "like-minded", to allow for the friendshoring of minerals production.

The implementation of such strategies is not without challenges. First, domestic mining requires having deposits of the desired minerals, and many countries do not have these minerals within their borders. In some cases, local communities may be resistant to the development of domestic mining. Second, decisions about the location of mining and processing activities are influenced not only by Governments but also by multinational mining companies, only some of which are government-owned (Ericsson et al., 2020). Third, domestic support for transition minerals and related sectors could lead to widening development divides. While developed countries can dedicate significant financial resources to support domestic industries, most developing countries, particularly LDCs, have much less fiscal space (Grynspan, 2023). Fourth, with regard to friendshoring, the implications for developing countries depend on whether they qualify as a friend or like-minded country.[20]

Partnerships between developed countries importing transition minerals and exporting developing countries in Africa, Asia or Latin America should seek to foster mutual benefits, allowing for domestic value addition and structural transformation in producing countries (Andreoni and Roberts, 2022; de Brier and Hoex, 2023). Developing countries that export transition minerals should be able to decide on the best agreement for them, based on their development interests.

Current policies focus heavily on the supply side of transition minerals and mainly aim to meet demand through primary production. Although they may also look to the secondary production of minerals from recycling, there is generally less emphasis on the need to reduce overall demand for minerals. Increasing levels of reusing, repairing or remanufacturing of devices and hardware could significantly contribute to reducing mineral consumption, and also reduce demand and supply deficits.

3. Minimizing the environmental footprint in the use phase

Rapidly increasing data traffic is placing growing demand on data transmission infrastructures, in particular on data centres. This trend is expected to persist, especially with the growth in the use of IoT devices and AI, both of which require additional storage and significant computational capacity. Data centres need highly reliable power to run servers, as well as water for cooling. Their operations involve other environmental challenges too, such as with regard to land use. Such impacts on local environments need to be considered in an integrated manner.

[20] For example, the United States refers to countries that are part of a free trade agreement. Concerns were raised in Indonesia about the exclusion of the country's critical minerals from subsidies for green technologies. For more details, see https://www.ft.com/content/814b453c-0001-4d81-a22a-41287e7147f3. In Africa, only Morocco has a free trade agreement with the United States; Schneidman and Songwe (2023) suggest amending the Inflation Reduction Act to include all African countries that participate in the African Growth and Opportunity Act.

Energy consumption represents a high proportion of data centre operating costs. Substantial improvements have been made in energy efficiency in recent years, as operators have sought to curtail costs, offsetting much of the increased energy demand resulting from growing data volumes. However, as the scope for further efficiency gains is likely to decelerate in coming years, while data volumes and computational demand will continue to grow sharply, both Governments and businesses should promote research and development into new technologies that could reduce energy consumption and minimize water stress.

Some hyperscale data centres have been making efforts to increase their use of renewable energy sources. This shift can contribute to overall carbon efficiency, especially if data centres add to the renewable energy capacity of the regions in which they operate. Increased data centre activity has placed considerable burden on energy and water supplies in certain locations, leading some Governments, for example in Ireland, the Kingdom of the Netherlands and Singapore, to restrict future data centre expansion. Corporations can minimize impacts by locating data centres in areas with sufficient renewable energy and water resources and reducing energy use by optimizing rather than maximizing the volumes of data retained.

There are opportunities for Governments to partner with data centre operators to develop power and water infrastructure that could add to local capacity. Data centres that generate their own renewable capacity can support local grids by providing demand-side flexibility, especially if they generate a surplus, while those that buy up local renewable capacity risk doing so at the expense of users in other sectors. Data centres can mitigate some of their local energy-related impacts by developing or investing in local renewable energy projects, participating in demand response programmes and providing waste heat to support local water and electricity infrastructure (IEA, 2023d; Kamiya and Kvarnström, 2019). In terms of infrastructure, one option would be for Governments and utilities in developing countries to co-develop local electricity and water infrastructure jointly with data centres, with the latter serving as "anchor customers" for both the water and electricity utilities, making investments in the infrastructure financially sustainable.

Governments can also encourage data centres to invest in additional renewable energy. For example, the Climate Neutral Data Centre Pact, a self-regulatory initiative, calls for data centre electricity demand in Europe to be matched by 75 per cent renewable energy or hourly carbon-free energy by the end of 2025, rising to 100 per cent by the end of 2030.[21]

However, government subsidies and tax incentives aimed at attracting data centre investment to locations with unsuitable energy and water supplies should be avoided. These may generate significant environmental costs without apparent long-term gains to the local economy in terms of employment or downstream business opportunities. Moreover, the main development opportunity from data does not arise from storing data but from being able to leverage the data for the development of digital intelligence that can be used to create economic or social value (UNCTAD, 2021a).

Data governance also affects the location of data centres. As discussed in *Digital Economy Report 2021*, there has been growing international concern about data privacy, data protection, data security and data sovereignty, which has led to increased willingness on the part of some Governments, businesses and consumers to locate data within national jurisdictions. This points to the need for international governance that can build the necessary trust for Governments and stakeholders to feel comfortable with data that is generated locally being stored outside of their territories, while ensuring access and control over the data, regardless of location.

[21] The pact includes pledges by data centre companies on energy efficiency, clean energy, water, the circular economy, circular energy systems and governance. See https://www.climateneutraldatacentre.net/.

Governments should make use of economy-wide policies, such as carbon and water pricing and renewable electricity mandates, to incentivize investments in renewable electricity and resource-saving technologies. They can use planning controls to ensure that new data centres are located in areas with adequate energy and water resources, and require operators to meet higher standards of operational efficiency (IEA, 2023d). Regulators should ensure that electricity market design provides clear price signals to data centres and other high-volume electricity consumers to participate in programmes to optimize supply and demand. In parallel, these should be balanced with the frequency of server turnover to limit equipment being disposed of earlier than necessary. Progress on demand response has recently been made in Australia, Brazil, the Republic of Korea, Singapore, the United States (in California) and the European Union (IEA, 2023g).

At the same time, switching to renewable energy is not enough to mitigate a negative environmental footprint from the growth of data centre activity. Greater use of AI, machine learning, IoT and cryptocurrency mining, for example, will require more mining and manufacturing to produce servers and specialized chips, and more water. These environmental impacts also have to be factored in when weighing the risks and benefits of using these new technologies. Regulators could consider introducing specific environmental disclosure requirements to enhance transparency across the supply chain of AI (de Vries, 2023). Further, encouraging pricing schemes that take into account the environmental cost of these innovations could contribute to the more informed and sustainable use of these emerging technologies by consumers and businesses.

4. Promoting a circular digital economy

The volume of digitalization-related waste is growing rapidly as the number of digital devices in use worldwide has grown, reinforced by programmed obsolescence in modes of production and limited awareness of waste issues among users. Digital components include materials that are toxic, require special treatment and are in short supply, making recovery and recycling both economically and environmentally desirable. While the volume of waste is rapidly expanding, and is expected to continue to do so, the rates of collection and recycling have not kept up. These rates are insufficient in developed countries and particularly low in developing countries, where recycling activity often takes place in informal settings, with minimal health safeguards and no formal regulation of material recovered. Moreover, large quantities of waste may be dumped in ways that are detrimental to local communities and the environment, with intrinsic resources being lost.

Addressing this situation will require multiple measures which would allow for waste to be transformed into resources and economic value. The potential for circularity, including recycling, needs to be considered throughout the digital life cycle. The main priority is to prevent or minimize the generation of waste.[22] This implies reducing the consumption of digital products and resources used to manufacture them. A major objective of policies in this context is to ensure that digital products are designed in such a way that they can be repaired, reused (in second-hand markets) and recycled, so that resources can be recovered. In this way, the secondary supply of raw materials can be increased, thereby reducing primary supply and its associated environmental impact. Policymakers also

> Regulators could consider introducing specific environmental disclosure requirements to enhance transparency across the supply chain of AI

[22] The United Nations Secretary General announced the establishment of an Advisory Board of Eminent Persons on Zero Waste in 2023 (see http://unzerowaste.org/). The report *Towards Zero Waste: A Catalyst for Delivering the Sustainable Development Goals* sets out how improved resource efficiency and ensuring universal access to waste management services can improve lives worldwide, focussing on actions that Governments and municipalities in the Global South can take to provide cost-effective and inclusive programmes that will contribute to sustainable development, for the benefit of current and future generations (UNEP, 2023d).

need to strengthen the capacity to collect and manage the waste generated. Such efforts in many developing countries can benefit greatly from international support.

More efforts should be made to establish environmentally sound waste management in developing countries. Governments in these regions need to ensure that they have the necessary legislation and regulatory powers in place as well as the skills to implement any policies adopted. Institutional capacities are important, for example, when monitoring is needed to ensure that international flows of digitalization-related waste are not illegal.

At the national level, while most developed countries have adopted an e-waste policy, legislation or regulation, only 36 developing countries have done so (Baldé et al., 2024). National legislation in this area should be clear on the product scope, the stakeholders and their roles and responsibilities. Enforcement measures and penalties for non-compliance also need to be specified. Moreover, there should be clear stipulations on the organizational mechanism for electric and electronic equipment producers, together with clear terminology on who should cover the cost of the management of e-waste (Baldé et al., 2024).

Most developing countries are not yet prepared for circular international trade, as they rely on the informal sector and need to strengthen relevant institutional capacities

Digitalization-related waste management can hold promise for developing countries as it presents opportunities for added value. Some aspects of a circular economy are further along in developing countries, where new devices are less affordable and consumers are more reliant on repair, refurbishment and resale. However, many developing countries remain locked in at the low value part of the digitalization-related waste value chain, in addition to bearing the burden of environmental costs and risks, while developed economies capture the highest value. Most developing countries are not yet prepared to participate effectively in circular international trade, as they rely on the informal sector and often lack relevant legislation and institutional capacity.

Crucially, transitioning from the unregulated and informal treatment of digitalization-related waste to regulated, formal management would help maximize recycling and ensure the safe disposal of toxic materials. It could also help generate income from the sale of recycled materials and allow for the refurbishment and reuse of viable devices that could be resold in domestic markets and help bridge domestic digital divides.

Governments should work together with international organizations to facilitate recycling and regulate the disposal of digitalization-related waste, including related trade between developed and developing countries, in order to reduce risks from toxicity, recover scarce and valuable resources and protect the health and welfare of citizens living close to or working on dumped materials. This collaboration needs to be strengthened, notably to ensure compliance with and the enforcement of relevant legislation.

5. Enabling international trade in a circular digital economy

There is a case for promoting growth through a more circular digital economy. Various estimates suggest considerable economic prospects in second-hand markets for electronic products, as well as in sectors linked to repairing, remanufacturing, refurbishing and recycling (see chapter IV). In this context, there is a need for greater awareness of the nexus between trade and the circular economy. International trade has an important role in enabling more circularity in the digital economy. Different types of goods and services can be part of international trade related to circularity, including used goods that can be reused, repaired, remanufactured or recycled; refurbished and remanufactured goods and parts; secondary raw materials; waste and scrap for recovery and value creation; and goods, services and intellectual property that support the circular trade in goods (figure VI.1).

Despite growing commitment among both Governments and the private sector to facilitate the circular economy and trade

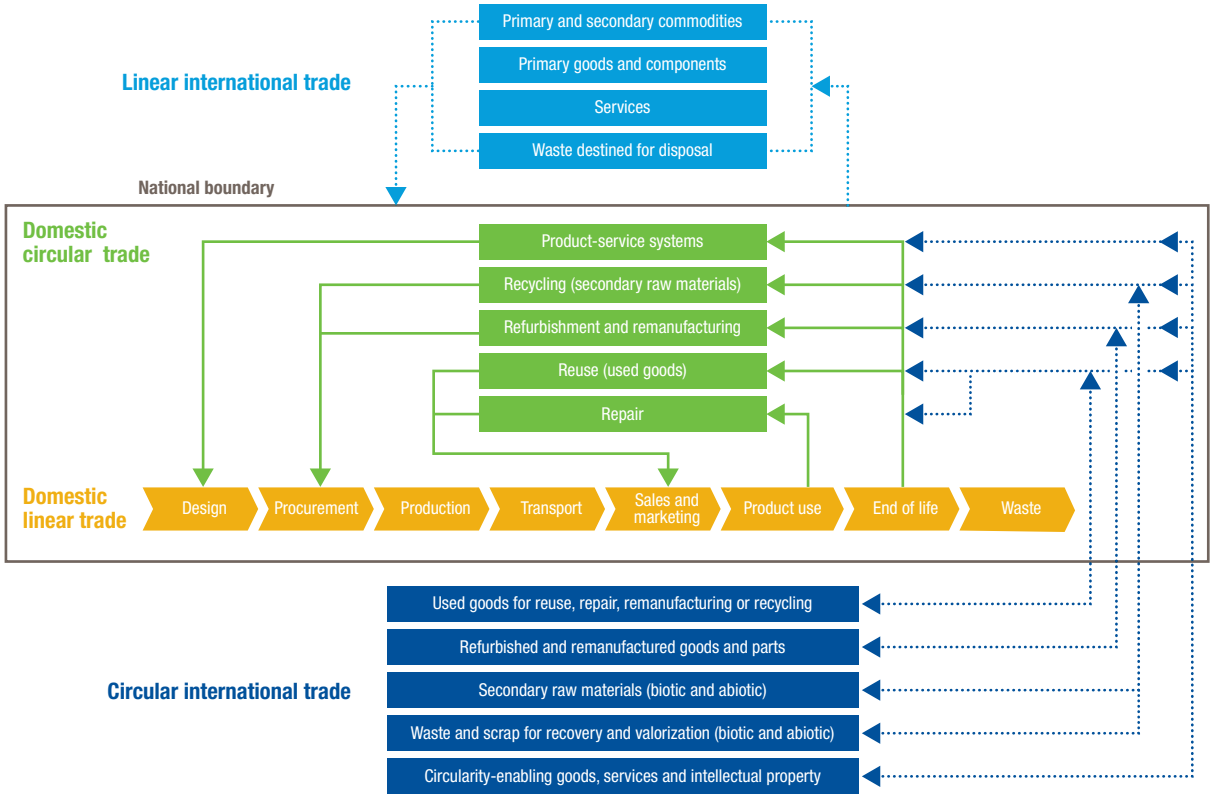
in support of the Paris Agreement and the Sustainable Development Goals, levels of circular trade around the world remain limited. Moreover, achieving inclusive development in the context of circular trade related to digitalization means boosting opportunities for developing countries to move up the e-waste value chain, capturing more value and reducing their exposure to environmental costs and risks.

Circular trade is not always desirable. If poorly regulated, it can result in growing illicit trade, with pollution and negative impacts on people's health and safety (Barrie et al., 2022). In order to secure beneficial circular trade in the digital economy and to achieve more inclusive outcomes, a number of barriers need to be overcome through policy actions, as follows:

- There is a need for common standards, definitions and classifications of what constitutes hazardous waste, non-hazardous waste and non-waste goods destined for reuse, repair and refurbishment (WEF, 2020b). Progress in this area requires globally coordinated efforts to develop a shared language with a view to ensuring that a product traded is classified in the same way in both the exporting and importing countries. This work needs to involve relevant international organizations such as the Basel Convention Secretariat, ISO, WCO and WTO. Public–private dialogue, such as at the World Circular Economy Forum, a global initiative of the Government of Finland and the Finnish Innovation Fund, could play an important role in this process;
- There is a growing need to embrace circularity in trade and economic cooperation agreements. This is in contrast to trade policies of the past

If poorly regulated, circular trade can result in high levels of illicit trade, with pollution and negative impacts on people's health and safety

Figure VI.1
Domestic linear and circular activities and international circular trade flows



Source: UNCTAD, based on Barrie et al. (2022).
Note: Domestic linear trade flows not included, to aid clarity.

that were developed with a linear model in mind (Barrie et al., 2022). Such agreements could include language that emphasizes sustainability, transparency and traceability requirements, as well as relevant provisions on trade facilitation. Comprehensive regional and bilateral trade agreements can support circularity and other environmental goals through binding commitments, mechanisms to stimulate cooperation on infrastructure and border controls. They could improve the efficiency of the supply of raw materials essential for the ICT industry, adding value for commodity producers and improving the security of supply for processors and manufacturers. Partners in agreements would be able to harmonize technical and environmental definitions, standards and regulations. It would also be desirable to integrate trade elements in national strategies aimed at promoting circularity (ECE, 2022b). Several forums are exploring how to make progress in this area and to make circular economy policies and trade policies mutually supportive. At WTO, the trade and environmental sustainability structured discussions have set up an informal working group on the circular economy and circularity. It has identified several areas for trade-related actions on the circular economy, including transparency, standards and regulations, trade facilitation, waste management, technical assistance and technology and other aspects for cooperation (WTO, 2023, 2024). The Global Alliance on Circular Economy and Resource Efficiency, which works on and advocates for a global just circular economy transition and the more sustainable management of natural resources at the political level and in multilateral forums, could give more attention to the trade and digital dimensions of the circular economy;

- Traceability needs to be improved in order to facilitate more circular trade, including by making use of digital solutions. In the context of international circular value chains, it is essential to have granular information on, for example, a product's material composition, methods of production, certification and standards compliance, quality and lifespan (Barrie, 2023). This is needed to mitigate illegal waste shipments while enabling the international distribution of secondary goods and materials. Having transparent access to relevant information also helps build trust among all actors along a supply chain and could prevent import bans and reduce trade frictions. There are currently no comprehensive data on trade in second-hand ICT goods and generally limited data related to circular trade in developing countries (OECD, 2018). Data gaps make it difficult to assess the challenges and opportunities associated with a more circular digital economy and the scope for services development in repair, reuse and recycling (WEF, 2020b). Various solutions have been proposed, including circularity transparency protocols, reporting tools and metrics and business support services (Barrie, 2023; WTO, 2024). Labelling, global trade item number (GTIN) systems and digital product passports are mechanisms that could facilitate the tracking of materials and products (WTO, 2024). As discussed, such digital product passports are being explored in the European Union. Digital technologies, such as digital watermarks, radio frequency identification (RFID) tags and blockchain technology can be leveraged to enable robust verification and certification over a product's life cycle (Barrie, 2023). In July 2023, ECE launched the Critical Minerals Traceability and Sustainability Initiative, which would develop a traceability and sustainability framework for critical raw materials in batteries and IT equipment;[23]
- Another area concerns trade procedures and trade facilitation. One factor delaying more widespread engagement with reverse logistics is that related trade

[23] See https://uncefact.github.io/project-crm/docs/about/.

procedures are typically more costly, require more paperwork and result in border delays (WEF, 2020b). This shows the need for regulatory cooperation to fast track or streamline trade permit systems linked to circular trade. Cross-border cooperation on trade permits, pre-export checks and interoperable standards can facilitate efficient data management. Paperless trading and customs systems, such as UNCTAD's ASYCUDA, and the use of international digital standards can reduce paper waste, enable interoperability and strengthen risk management. In order to avoid waste being dumped in developing countries, under the Basel Convention, all e-waste will be subject to prior informed consent procedures as of 2025. Some concerns have been raised within the e-waste management industry that strict procedures may become cumbersome and discourage exports for legitimate recycling purposes. In this context, it will be important to foster coherent and transparent prior informed consent procedures, automated customs management and clear distinctions between waste and non-waste goods (Barrie, 2023; WTO, 2024). It has also been proposed that the WTO Agreement on Trade Facilitation be amended with a view to facilitating trade in reverse supply chains. The use of trusted "circular trader" schemes and special economic zones for circularity have also been highlighted as worthwhile initiatives to explore further (Barrie and Grooby, 2023);

- In order to achieve inclusive circular trade related to the digital economy, efforts are needed to avoid a worsening of the current unequal ecological exchange. For example, most controlled shipments under the Basel Convention occur either between high-income regions or into high-income regions. Countries are unequally prepared to engage in and benefit from circular transitions. In many developing countries, waste recovery operators are predominantly in the informal sector, with inadequate working conditions and limited capacity to undertake necessary reforms. There is a need for the international community to provide assistance to these countries. Areas where support is needed include investment in recycling and disposal facilities, the transfer of relevant technology, the formalization of circular economy activities and training and capacity-building related to trade facilitation and ensuring compliance with relevant global trade rules. The United Nations, Aid for Trade and international financing institutions will be important in this context.

6. Securing international support for capacity development

The capacities needed to move towards environmentally sustainable digitalization that works for inclusive development are asymmetrically distributed among countries. The required actions and policies involve substantial amounts of financial, human and institutional resources. While the design and implementation of policies are matters for Governments, support from the international community to complement national resources will be indispensable in many developing countries. Finance from multilateral and regional development banks can be helpful in this context.

In terms of human resources, skills need to be developed through education policies and targeted awareness campaigns, for example, by inviting stakeholders to learn how to manage digitalization-related waste in an environmentally sound manner. Moreover, improving the evidence base will require investment in skills and data-gathering capacity, with a focus on indicators that are most relevant for local and national policy and practice.

Low-income countries, in particular, will need adequate support from development partners to strengthen digital and environmental capabilities. At the same time, care must be taken to avoid transferring

There are concerns within the e-waste management industry that strict procedures may discourage exports for legitimate recycling purposes

Low-income countries will need adequate support from development partners to strengthen digital and environmental capabilities

governance models from developed countries that may be inappropriate for developing countries in view of their different economic contexts, regulatory capabilities and national priorities. Countries need policy space to develop digital and environmental business sectors and achieve national development objectives.

F. Strengthening international cooperation and solidarity for collective action

The global challenges of environmental sustainability and digitalization require urgent action at the global level by all stakeholders. This should be anchored in global debates and agreements that can help to form consensus on how best to address them. To date, there has not been a comprehensive international process or agreement that addresses environmental impacts stemming from the life cycle of digital devices and infrastructure (Santarius et al., 2023). In the coming years, it will be essential to ensure that the digitalization and environmental sustainability nexus becomes fully and coherently addressed in relevant international forums and agreements. Digitalization needs to be as environmentally sustainable as possible to avoid adding to various environmental risks. At the same time, digital tools can make important contributions to support more environmentally sustainable socioeconomic activities so that they can become more efficient and resilient.

There is currently no inclusive, global governance framework in place to help catalyse collective action and facilitate knowledge-sharing among countries, foster consensus-building, set global standards and encourage the transparent reporting and monitoring of progress towards shared goals. An inclusive and integrated approach would be valuable for enabling policymakers to align their digital and environmental policies at all levels, thereby enhancing the ability of the global community to effectively tackle the complex and interdependent global challenges involved.

A number of international agreements include broad principles on the relationship between digitalization and the environment, including the outcome documents from the World Summit on the Information Society (WSIS) and the 2030 Agenda for Sustainable Development. However, most are concerned with particular issues, for example, with digital inclusion or cybersecurity or with climate change, biodiversity or hazardous waste. Dialogue between the digital and low-carbon policy communities should be more firmly established at the centre of discussions on sustainable development and embedded in the work of international standard-setting bodies. Strengthened cooperation between developed and developing countries will be important for successful international dialogue.

Greater coordination and strategic engagement will be required from intergovernmental and international business entities, within and beyond the United Nations, to secure digital development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987, paragraph 27). In this context, there may be a need to create or re-design existing multi-stakeholder forums that can bring the digital and environmental communities together and that also enable countries at different levels of development to participate.

Collaboration for collective action should involve multilateral agencies, as well as civil society and business associations concerned with relevant issues. Partnerships, such as CODES, that can draw on the capabilities and strengths of international agencies, Governments, businesses and research organizations, are likely to achieve better outcomes than Governments or multilateral agencies acting alone. More cross-fertilization between digital, economic and environmental perspectives should be fostered in forums such as those concerned with climate change, mineral extraction, waste disposal and recycling. Experts in the field and those with direct experience of environmental impacts should be at the centre of such cross-sectoral and interdisciplinary dialogues.

International processes and forums focusing on how to leverage digitalization for development, such as the WSIS Forum, the Internet Governance Forum, the Commission on Science and Technology for Development and processes related to the upcoming United Nations Summit of the Future should give adequate consideration to the environmental dimensions. Similarly, there is a need for processes related to global environmental challenges, such as the International Resource Panel, the Intergovernmental Panel on Climate Change and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, to give more attention to the role of digitalization.

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 actions to the entire life cycle of digitalization and to start systematically tracking the environmental footprint of the ICT sector.

International organizations have a critical role to play. United Nations agencies, including DESA, ITU, the Office of the Special Envoy on Technology, UNCTAD and UNEP, coordinate multilateral activity in relevant policy areas and multilateral agreements, such as the United Nations Conference on Environment and Development, WSIS, the 2030 Agenda and the global digital compact. UNFCCC and the Basel Convention have established frameworks and goals for sustainability and digital development. Other multilateral organizations concerned with development and trade, such as the World Bank and WTO, also work towards progress on digital development, environmental sustainability and inclusive development. However, more needs to be done to align these goals with one another and elaborate them in key areas, including managing the trade and exploitation of scarce resources.

Multilateral organizations can also propel the development of a more reliable evidence base for a global understanding of digital sustainability. United Nations regional commissions and other relevant regional organizations could play a useful role by, for example, sharing experiences and expertise within the corresponding regions. At the global level, various entities of the United Nations can facilitate national experience-sharing, recognizing that governance approaches need to be adapted to regional and national circumstances and capacities. Within UNCTAD, the interface between digitalization and environmental sustainability could be a future topic for discussion at sessions of the Intergovernmental Group of Experts on E-commerce and the Digital Economy.

A number of international developments provide timely opportunities for change. WSIS, which first established global goals for digital development in the early years of this century, is to be reviewed by the United Nations General Assembly in 2025. The Sustainable Development Goals, which embedded environmental sustainability at the centre of the international community's agenda in 2015, will be reviewed in 2030. In 2024, the United Nations Summit of the Future is set to agree on an action-oriented

> International processes and forums focusing on how to leverage digitalization for development should give adequate consideration to the environmental dimensions

It is time to extend the calls for bold actions to the entire life cycle of digitalization and to systematically track its environmental footprint

pact for the future, showcasing global solidarity for current and future generations, including by emphasizing sustainable development and digital cooperation. This is expected to include a global digital compact setting out principles, objectives and actions for digital development that supports global development goals (United Nations, 2023d).[24]

As seen in the discussion on policy options, areas for international cooperation can be linked to the life cycle of digitalization.

At the production phase, which concerns the transition minerals and global value chains related to digital devices and ICT infrastructure, international dialogue may be needed to address complex issues related to security, sustainability, efficiency and economic development in a balanced way, taking into account the interests of developing-country producers as well as those of consumers, exporters and importers. Finding solutions will require increased and holistic cooperation that includes developed and developing countries, as well as stakeholders from the producer and consumer sides (Müller, Schulze, et al., 2023).[25]

The Group of Seven five-point plan for critical minerals security requested IEA to establish an internal task force and undertake analysis and verification in collaboration with the IEA working party on critical minerals.[26] This may focus on the perspective of mineral consumers or importing countries, and it is important to achieve a more holistic cooperative approach by, for example, involving global authorities with expertise related to mining activities, such as the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development.[27] International and regional efforts should seek to promote the more equitable sharing of the value derived from transition minerals.

Some steps have already been taken in this direction, as follows:

- At the global level, United Nations Member States have highlighted the need for greater international cooperation on the topic of mineral resource governance. Member States adopted a resolution on Mineral Resource Governance at the fourth session of the United Nations Environment Assembly in 2019.[28] At its sixth session in February 2024, the Assembly adopted a resolution on environmental aspects of minerals and metals, encouraging Member States and inviting relevant stakeholders to align their management practices with the 2030 Agenda for Sustainable Development and to promote sustainable consumption and production;[29]
- A study on mineral resource governance in the twenty-first century by UNEP and IRP (2020b), which maps more than 80 existing international governance frameworks and initiatives, calls for more coordination and integration and proposes building international consensus regarding the normative content and structure of the "sustainable development licence to operate", in a new governance framework for the extractive sector.
- In 2022, the United Nations Working Group on Transforming the Extractive Industries for Sustainable Development was established, to help ensure a more collaborative and impactful services delivery offer in this area. The aim is to coordinate extractives-related work across the United Nations and beyond through joint work, planning and collaboration;

[24] See https://www.un.org/en/common-agenda/summit-of-the-future and https://www.un.org/techenvoy/global-digital-compact.

[25] See also https://www.ft.com/content/394dca37-ac50-4380-9b03-4fdfcef2ff7c.

[26] See Group of Seven (2023b) and https://www.iea.org/news/iea-critical-minerals-and-clean-energy-summit-delivers-six-key-actions-for-secure-sustainable-and-responsible-supply-chains.

[27] See https://www.igfmining.org/.

[28] See UNEP (2019b, 2022b).

[29] See https://www.unep.org/environmentassembly/unea6/outcomes.

providing an information and knowledge hub to scale up and replicate best practices and build synergies with existing initiatives; provide policy advice and technical assistance to stakeholders in the extractives sector; and assist with integrating work on the extractive industries into other initiatives across the United Nations. It highlights the need to address sustainability issues and for producer countries to be able to secure greater value for commodities, improve working conditions and address the challenges of informal mining. Stronger safeguards will be needed to prevent corruption and address illicit trade.[30] Its work offers an opportunity to address issues related to digitalization;

- In December 2023, during the twenty-eighth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, the Secretary-General of the United Nations announced the establishment of the Panel on Critical Energy Transition Minerals.[31] As the Panel is expected to support and enhance the efforts of the Working Group, it should adequately factor in mineral needs resulting from digitalization.

Regarding the use phase of the life cycle of digitalization, given that concerns about the environmental impact of data centres have risen only recently, international cooperation is more limited. Most international cooperation in this area relates to issues of standardization and certification (ITU and World Bank, 2023). In order to enable the optimal geographical distribution of data centres, from an environmental sustainability perspective, an international framework regulating cross-border data flows would be needed.

At the end-of-life phase, dealing with digitalization-related waste is a worldwide concern that requires a globally coordinated approach. The main global governance framework is the Basel Convention, which regulates transboundary flows of electrical and electronic waste. However, significant challenges remain in its implementation and enforcement, which lead to continuous problematic international trade in such waste, mostly illegal, and flowing from developed to developing countries. There is currently no obligation to report on the international trade of used electronic equipment, although several international agreements address such trade. Recent amendments to the Convention may help prevent illegal trade flows of this kind of waste (see chapter IV).

Beyond trade issues, in response to the growing global challenges of e-waste, initiatives by international actors have been increasing, including under the auspices of the United Nations. In 2017, the United Nations Environment Management Group and the Issue Management Group on Tackling E-waste issued *United Nations System-Wide Response to Tackling E-waste*, a report highlighting the need for strengthened collaboration among United Nations organizations. More than 20 organizations are active in tackling e-waste and over 150 initiatives have been undertaken since 2004. The report offered recommendations on maximizing system-wide coherence towards a life-cycle approach to tackling e-waste. Subsequently, seven United Nations system organizations created the E-waste Coalition in 2018.[32] Moreover, the Global E-Waste Statistics Partnership plays a key role in monitoring e-waste developments and helping countries produce related statistics. While initiatives to increase international

[30] See https://www.unep.org/events/working-group/transforming-extractive-industries-sustainable-development, United Nations (2021c) and Baptista (2023). A key output of the Working Group is the Critical Energy Transition Minerals Toolkit, available at https://www.unescap.org/our-work/energy/CETMToolkit.

[31] See https://news.un.org/en/story/2023/12/1144267 and https://www.unep.org/topics/energy/renewable-energy/critical-minerals.

[32] See https://unemg.org/our-work/emerging-issues/innter-agency-issue-management-group-on-tackling-e-waste/.

Stakeholder engagement and flexible policy frameworks are essential to ensure that technological change contributes positively to environmental and socioeconomic well-being

cooperation in this area represent welcome progress, there is a need for more global collaboration and coordination.

Closely linked to digitalization-related waste, and in order to close the loop and address the entire digitalization life cycle, is the need to promote a global circular digital economy. International cooperation is key for moving towards circularity at both the national and global levels. In 2019, a report titled *A New Circular Vision for Electronics: Time for a Global Reboot* was issued as part of a collaboration between the E-waste Coalition, WEF and the World Business Council for Sustainable Development (Platform for Accelerating the Circular Economy and WEF, 2019). The Platform for Accelerating the Circular Economy (2021) has produced a circular economy action agenda for the electronics sector.[33]

At the regional level, policy efforts in the direction of increased circularity are becoming more widespread, including with regard to digital technologies. In 2020, the European Commission (2020) issued a circular economy action plan. ASEAN (2021) has adopted a framework for the circular economy, and the AfDB (2023b) has established a multi-donor Africa Circular Economy Facility. The Economic Commission for Latin America and the Caribbean has commissioned studies towards a circular economy in its region.[34]

Rapid technological change will continue to present significant development challenges and opportunities at all policy levels, necessitating foresight and a proactive governance approach. The evolving nature of digital technologies and environmental risks highlights the importance of continuous research, dialogue and policy adaptation. While policymakers are the primary audience of this report, action is needed by many stakeholders, including consumers, producers and other relevant parties, to enable environmentally sustainable digitalization that works for inclusive development. Stakeholder engagement and flexible policy frameworks are essential for navigating future uncertainties, ensuring that technological advancements contribute positively to environmental and socioeconomic well-being.

Opportunities should arise as a result of more environmentally sustainable digital development. These are more likely to lead to success if they form part of national development strategies that include digitalization policies that have economic inclusion and environmental sustainability in mind. Such strategies should be supported by international agreements that recognize the importance of changing the dynamics of digital trade towards more balanced outcomes. This shows the need for a response that identifies policymaking at the national, regional and global levels and that addresses digital, socioeconomic and environmental goals holistically, across the entire life cycle of digital devices and ICT infrastructure. Solutions need to take into account the context and priorities of all countries, including opportunities for developing countries to benefit from the potential that digitalization offers.

[33] The platform, hosted by the World Resources Institute, is a public–private collaboration platform "made up of global changemakers and their organizations working together to accelerate the transition to a circular economy". See https://www.wri.org/initiatives/platform-accelerating-circular-economy-pace.

[34] See, for example, https://www.cepal.org/en/publications/47604-conceptualizing-circular-economy-caribbean-perspectives-and-possibilities-policy.