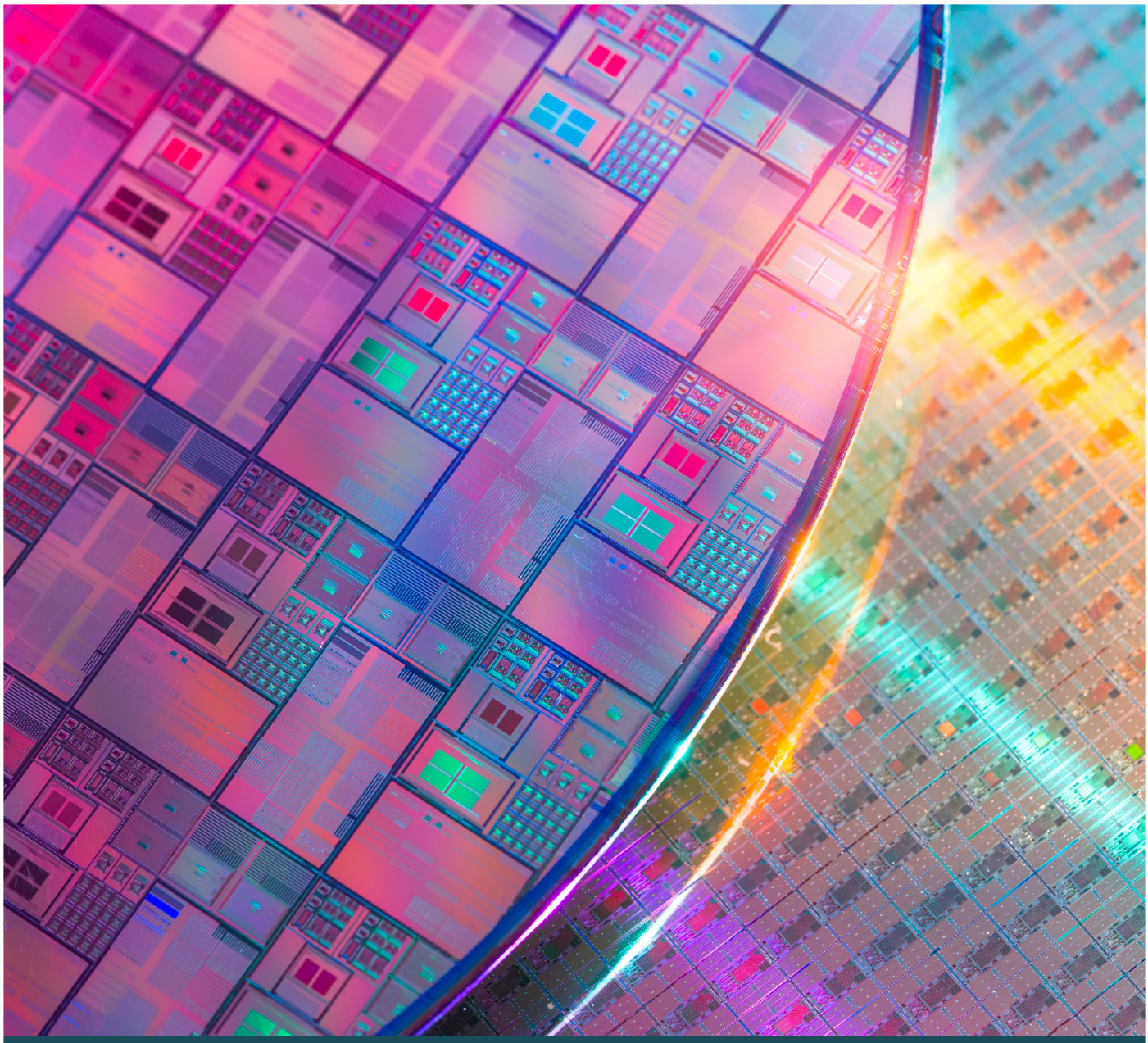


Overview

Technology:

Priority actions towards a nature-positive future

December 2025

In collaboration with Oliver Wyman

Introduction

The technology sector has a critical role to play in the transition to a nature-positive world – both through its direct impacts and dependencies on nature, and through those of consumers and businesses in other sectors. With products and services underpinning nearly every aspect of modern life, the sector is a key driver of innovation, productivity and connectivity. Demand for semiconductors, data centers and hardware is accelerating globally, with the semiconductor and hardware industries expected to grow by 6 to 8% annually[1,2] and data center demand rising by 19 to 22% per year through 2030[3]. This growth is driven by artificial intelligence (AI), cloud computing and digital transformation.

However, this rapid expansion comes with significant nature impacts and dependencies. The sector is a major direct consumer of natural resources. Semiconductors and data centers together draw over 1.5 trillion liters of water annually[4] - more than the entire country of Denmark[5] - and the technology sector accounts for around 4% of global energy use, a share projected to rise as AI adoption increases[6]. The sector is also dependent on critical minerals such as silicon and copper, deepening its upstream environmental footprint[7]. Over 62 billion kilograms of electronic waste (e-waste) were produced worldwide in 2022, while only 22% was formally recycled[8].

Many leading technology companies – such as Microsoft, Google, Meta and AWS – have already made high-profile commitments to embed sustainability in their operations, with some organizations setting targets to purchase 100% renewable energy and replenish 100% or more of water consumption by 2030[9,10]. Efforts are also underway to address the challenge of e-waste through circular solutions and responsible lifecycle management. Meanwhile, governments and regulators are becoming more involved. The European Union's (EU) 2023 Energy Efficiency Directive mandates energy and water monitoring for data centers[11], and major economies have invested in sustainable semiconductor manufacturing through initiatives such as the European Chips Act[12] and the U.S. CHIPS Act[13]. Additionally, tech companies are in a unique position to enable other sectors through innovative technologies, accelerating nature-positive transitions beyond their operational boundaries.

While these efforts are welcome, more needs to be done. The technology sector continues to contribute to key drivers of biodiversity loss across its value chain, notably through extensive use of water and other resources, pollution and waste, greenhouse gas (GHG) emissions and land use. Like other sectors, technology is also dependent on nature services to function and grow, making nature loss a key risk for the sector.

In addition, the technology sector plays a huge role in shaping society well beyond its own operations and value chain – enabling and supporting behaviors and actions by businesses and individuals that can be more, or less, sustainable. While not the subject of this overview and the larger report, this role is vital to consider and will be one subject of a future body of work by the World Economic Forum.

To complement ongoing sustainability initiatives, businesses across the sector should use the Nature Strategy Handbook – which draws on the **A**ssess, **C**ommit, **T**ransform, and **D**isclose framework (ACT-D high-level business actions on nature) – to help them understand their relationship with nature and embed nature in their business strategy. The Handbook forms the basis of It's Now for Nature, a global campaign to rally all businesses to act on nature. It helps companies acknowledge the value of nature to their business; identify, assess and measure their impacts and dependencies on nature; set transparent, time-bound, science-based targets; take actions to address their key impacts and dependencies and transform their businesses; and publicly disclose performance and other relevant nature-related information.

This overview provides a non-exhaustive, sector-level summary of the technology sector's key impacts and dependencies on nature. Importantly, it also sets out the priority actions that all businesses can take now to transform their own value chain.

Scope of this overview

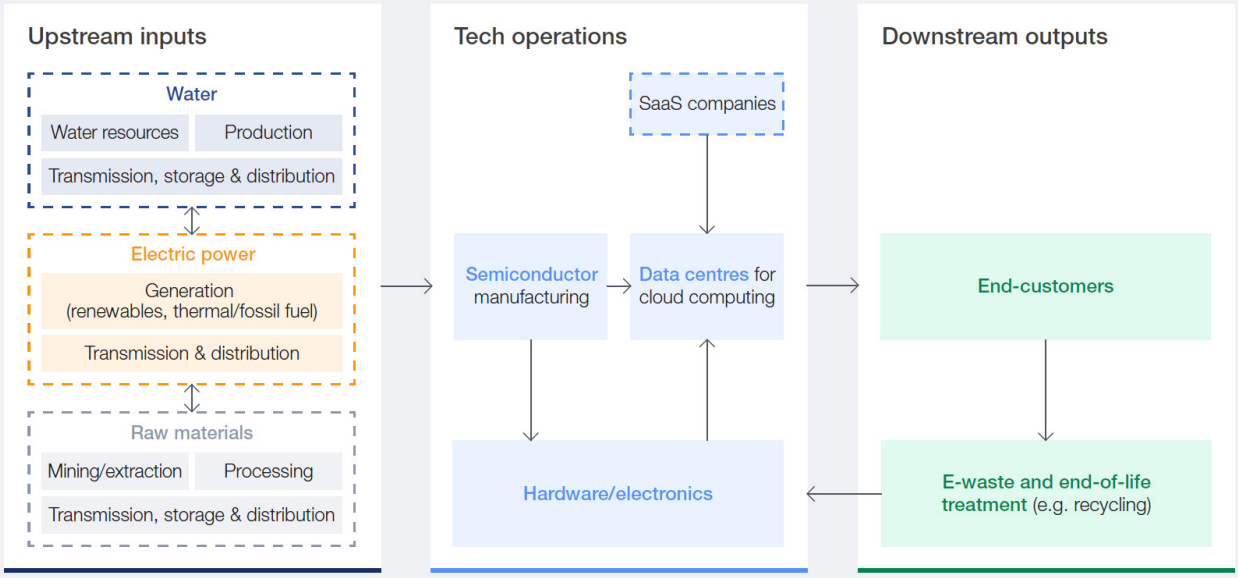
This overview focuses on semiconductors, data centers and hardware and e-waste (SICS codes: TC-SC, TC-IM, TC-SI, TC-ES, TC-HW) in the technology sector value chain. This focus includes businesses involved in the design, fabrication and assembly of semiconductors and electronic components, the construction and operation of data centers, and hardware and its end-of-life infrastructure. These subsectors were selected as areas of focus due to their rapid growth resulting from AI and the overall magnitude of their impact, but other aspects of technology (such as telecommunications infrastructure) are also important.

Given the sector's upstream reliance on critical mineral supply chains and water and electric utilities, and due to its downstream impacts from end-of-life management, technology's nature impacts and dependencies are deeply interconnected with other sectors such as mining, utilities and waste management. This overview therefore considers these elements of the broader value chain for technology products, but does not directly assess the influence of these products on customer behavior.

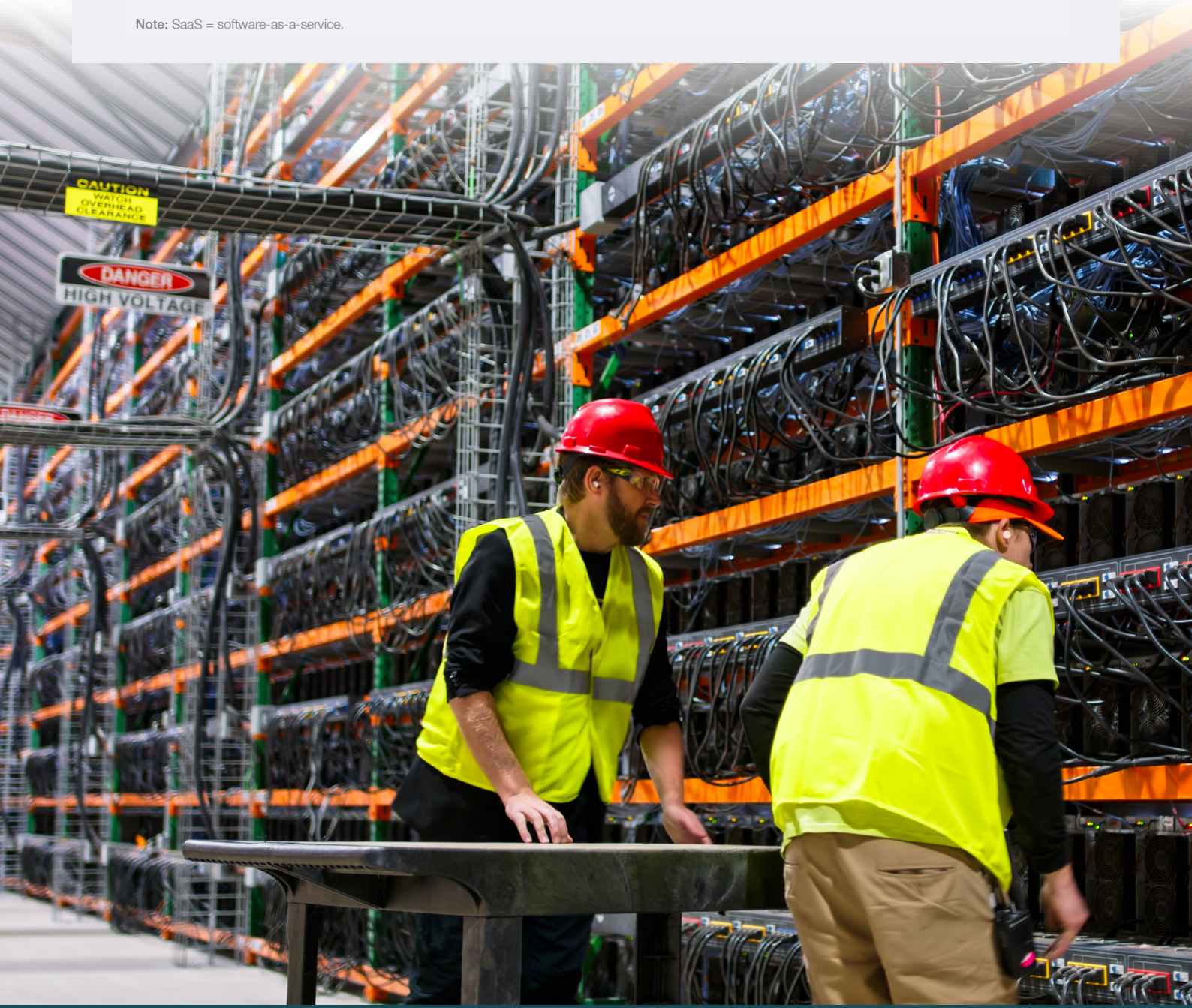
For additional information on the mining sector as a whole, please see the Mining and Metals summary report.



Technology value chain



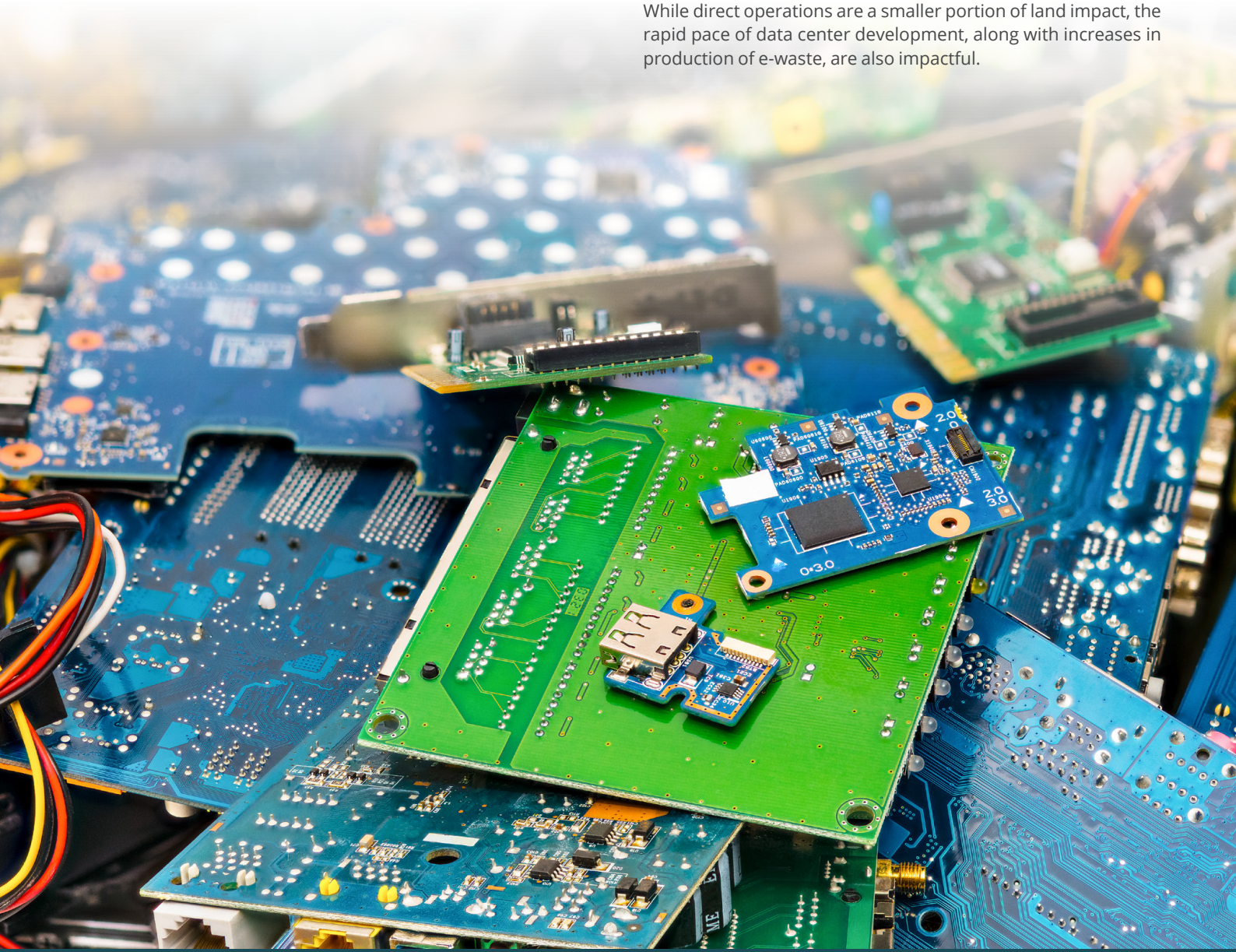
Note: SaaS = software-as-a-service.



Nature-related impacts

To protect and enhance the ecosystems on which they depend, businesses in the technology sector should direct their efforts towards addressing the most significant impacts on nature in their operations and value chains, namely:

- **Water use** – High levels of water abstraction in the tech sector can lead to a range of nature impacts, such as contributing to the effects of drought due to overconsumption or introducing pollutants when wastewater is expelled, harming biodiversity in water bodies.
- **Pollution and waste** – Semiconductor production by the world's top 12 manufacturers generated an estimated 2.7 million tons of waste in 2023, with 40 to 60% of this waste classified as hazardous due to the use of metals, acids and chemicals[14,15]. The sector also remains a significant user of per- and polyfluoroalkyl substances, also known as PFASs or "forever chemicals," whose resistance to degradation leads to accumulation within the environment and poses long-term risks to ecosystems and human health. E-waste exacerbates this picture with over 62 billion kilograms generated globally in 2022 and volumes expected to climb to 82 billion kilograms by 2030. Current systems capture only 22% for formal recycling, and leave substantial quantities to degrade in landfills, releasing toxic elements such as lead, arsenic and mercury into natural environments[16,17].
- **Greenhouse gas (GHG) emissions** – Across the technology value chain, substantial energy demand results in significant GHG emissions, as do the production and processing of materials (steel, concrete, copper etc.) for activities such as data center construction. Semiconductor manufacturing generates direct emissions, with the trend toward ever-smaller chips driving both energy and carbon intensity upwards. Wafer fabrication at 2 nanometers requires over twice the energy of chips manufactured a decade ago[18]. Of particular concern are the high global-warming-potential gases such as certain PFASs for which no viable substitutes currently exist[19]. At the product's end of life, burning or improper decomposition of e-waste releases additional GHG emissions, with e-waste emissions rising 53% from 2014 to 2020 to reach 580 million tons of CO_2e[20]. This number could rise to 852 million tons by 2030 in a business-as-usual scenario[21].
- **Land use** – Most land impact comes from upstream input industries such as energy generation or mining for critical minerals and metals like cobalt, nickel and lithium. These industries, especially mining via open-pit techniques, result in extensive land disturbance, erosion, runoff and forest loss. These activities are particularly impactful in biodiversity-rich but weakly regulated regions. While direct operations are a smaller portion of land impact, the rapid pace of data center development, along with increases in production of e-waste, are also impactful.



Nature-related dependencies

Like many sectors, the technology sector is highly dependent on a number of environmental assets and ecosystem services to function and thrive. While increasingly characterized by its digital reach, the sector's material footprint and business continuity needs remain closely linked to natural systems, particularly in semiconductor fabrication, the expansion of data center infrastructure, and the global manufacture and turnover of electronic hardware.

- **Freshwater** – Large volumes of ultrapure water are required for semiconductor manufacturing. This makes reliable access to freshwater essential for continued operations and growth as disruption of local watersheds due to drought, over-extraction or pollution can lead to higher operational costs, plant shutdowns or other negative outcomes. A typical plant consumes 18 to 38 million liters per day, equivalent to 7 to 16 Olympic sized swimming pools[22,23]. As an industry, semiconductor manufacturing consumed over 1 billion cubic meters of water in 2023[24]. Drought-prone production hubs, such as Taiwan, have instituted rationing in recent years, highlighting both escalating competition for water resources and the potential for disruption to operations[25]. Data centers are similarly dependent on freshwater for cooling, where one hyperscale data center can require up to 7 million liters per day, and typical data center scale is growing. The industry overall requires over 400 million cubic meters of water annually[26,27].
- **Metal, mineral and energy resources** – The sector relies on a diverse array of mined materials, including copper, silicon, cobalt, gallium, gold, and rare earth elements, many of which are sourced from ecologically sensitive regions. Eight percent of known properties used in global mining operations lie within global International Union for Conservation of Nature (IUCN) Protected Areas, 7% within Key Biodiversity Areas (KBAs), and 16% within Remaining Wilderness[28]. Furthermore, nearly a third of the world's mine tailings are stored within or near protected conservation areas[29]. Stable energy supplies are also critical, as both manufacturing and data center operations are energy intensive. While renewable energy use is increasing, fossil fuels remain a significant part of the sector's energy mix.
- **Climate regulation, soil stability and flood protection** – The sector benefits from ecosystem services such as climate regulation to safeguard production, and from healthy soils and landscapes that provide mass stabilization, erosion control and flood mitigation. These natural systems help protect critical infrastructure - including fabrication plants and data centers - from climate-related risks and natural hazards.
- **Regeneration of natural resources and waste absorption** – The sector relies on the natural environment to re-absorb rapidly rising e-waste volumes, as improper disposal of e-waste can harm ecosystems and reduce the effectiveness of natural waste absorption processes. It also relies on the regeneration of natural resources required for tech construction and operations. Circularity efforts focused on the recovery and recycling of metals from discarded hardware can alleviate pressure, both on waste absorption and on extraction.

These dependencies strengthen the business case for investing in the protection, restoration and sustainable use of nature and its resources.



Priority actions and opportunities

To reduce the negative impacts of the technology sector on nature, mitigate operational risks, and seize emerging commercial opportunities, companies across semiconductors, data centers, and hardware manufacturing must pursue a set of clear and urgent priority actions.

1. **Advance resilient and restorative water use –** Assess potential site locations for water stress levels (current and future) and work with local and regional officials to estimate competition needs across the entire water supply and ensure availability. Prior to construction, aim to design buildings and processes that maximize water efficiency. Implement a standard, such as ISO 46001, to conduct a full accounting of water use in operations and key supply chain components – such as embedded water in energy generation – to identify priority areas. For facilities in operation, update existing processes to reduce inefficiencies and limit water use. To reduce overall impact, use non-potable water where feasible, along with closed-loop systems (at both the server and the facility level) with onsite water purification to minimize net freshwater withdrawals. For residual impacts, champion and support projects to monitor and restore local aquifers and watersheds.

2. **Mitigate pollution and pursue circularity –** Optimize hardware and process design with circularity in mind, such as using recycled materials and designing with a modular focus to support reparability. Prioritize the maintenance and replacement of individual components to extend product lifespan to postpone replacing the whole. Seek to develop the infrastructure (e.g., collection system, repair facilities, consumer awareness etc.) to enable and encourage repair and reuse of consumer electronics. For recycling, explore opportunities to introduce collection programs to streamline recycling processes, encourage proper disposal at authorized end destinations, and harvest working components of unusable devices for reuse. Invest in e-waste recycling infrastructure to expand recovery of valuable metals.

   Beyond e-waste, avoid pollutants and contaminants (e.g., wastewater, waste heat, solid waste) impacting the environment by using advanced waste control systems and setting 'zero waste to landfill' standards (such as UL2799). Invest in land and water restoration efforts to address damage that cannot be avoided or reduced.

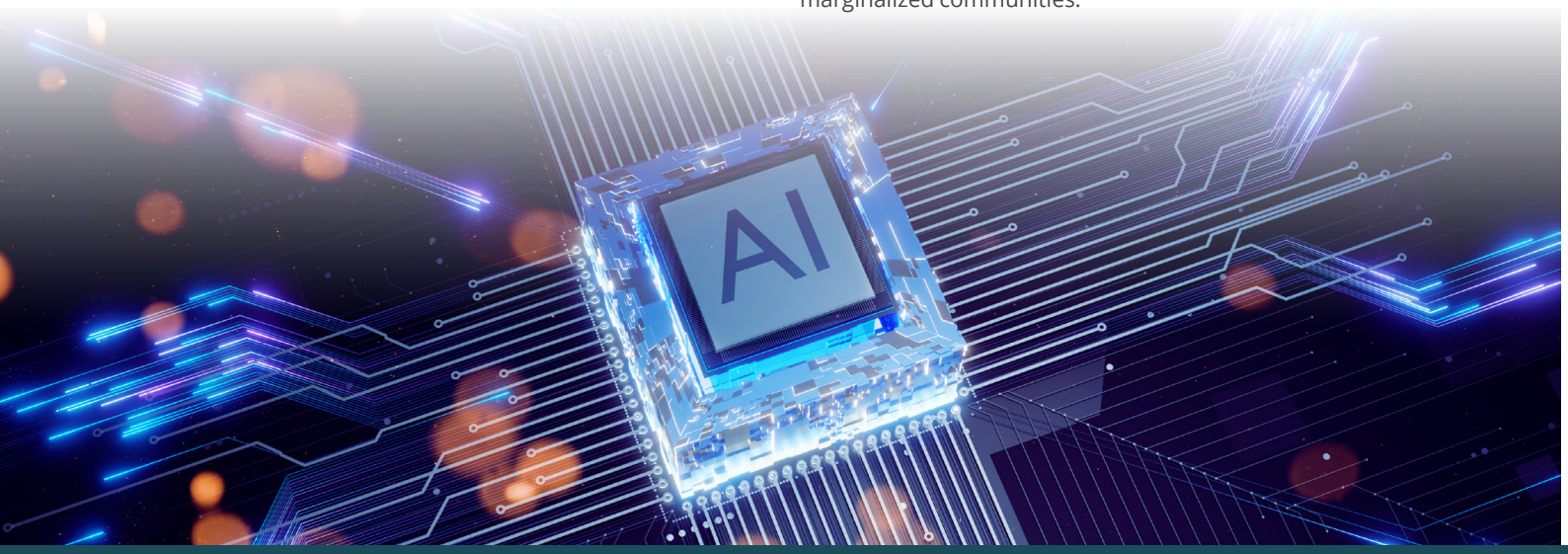
3. **Tackle non-power operational and embodied GHG emissions –** Monitor operations processes to identify and prevent potential for greenhouse gas leaks, transition to lower global warming potential refrigerants, and utilize gas scrubbers to capture waste gases. Design products with lower material input requirements to reduce embodied carbon, such as reducing the quantity of plastic used. Invest in high-quality, verified carbon offset and removal credits to account for residual emissions, considering biodiversity and other co-benefits.

4. **Power operations sustainably –** Minimize nature impacts from electricity generation by utilizing onsite low-carbon power sources and power purchase agreements that drive additional investment in low-carbon power generation. Seek opportunities to directly sponsor the development of additional generation capacity, storage, and transmission and distribution infrastructure to enable additional renewable energy. Before power sourcing, design energy-efficient buildings and operations - considering building envelope; heating, ventilation and air conditioning; lighting and more. This also includes monitoring and optimizing cooling systems for efficiency and conditions (e.g., updating technology, climate monitoring to switch to free air cooling when conditions allow, raising operating temperatures etc.), as well as installing dynamic process management systems to avoid idle energy use and optimize processes.

5. **Engage with your supply chain –** Work with suppliers who hold sustainability certifications (e.g., ISO 14001, Forest Stewardship Council, Rainforest Alliance Certified, the Copper Mark, etc.) and who have conducted impact assessments of their operations to address supply chain impacts. Engage with metal and mineral suppliers for recycled materials, and with mining companies for lower impact materials. Collaborate with suppliers to identify and replace high-impact chemicals and gases, such as those containing PFASs or with high GWP. Seek out low-carbon alternatives for building materials and other material inputs to mitigate embodied impacts in construction. Set nature driver-specific commitments to help improve outcomes throughout the value chain.

Additional important actions around land use and restoration of ecosystems, as well as engaging with policymakers and customers (such as during the use phase for tech products) are included in the full report.

Importantly, efforts to deliver these priority actions and transform the sector must be delivered in alignment with a just and equitable transition, including meaningful dialogue with affected groups, such as employees, local communities, Indigenous People and marginalized communities.



Resources

This summary was derived from the report Nature Positive: Role of the Technology Sector, written by the World Economic Forum in collaboration with Oliver Wyman.

The following **sector-specific guidance documents and tools** are currently available to companies in the technology sector:

- Materiality Screening Tool (Science Based Targets Network - SBTN)
- High-Impact Commodity List (Science Based Targets Network - SBTN)
- ENCORE (UN Environment Programme World Conservation Monitoring Centre – UNEP WCMC)

For additional **sector-agnostic resources**, please refer to Business for Nature's High-level Business Actions on Nature and The Nature Strategy Handbook.

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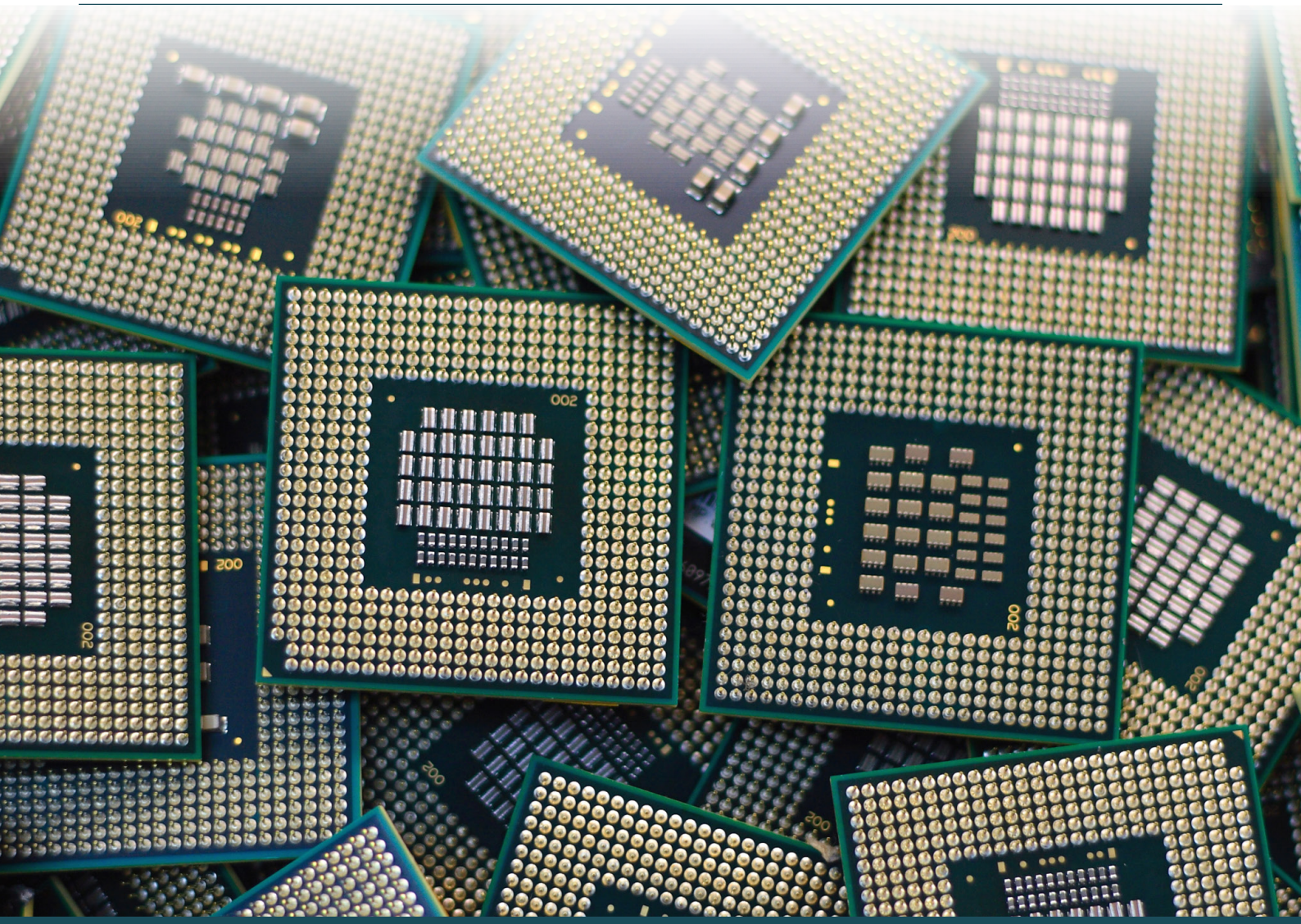
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