Guide

greenly

Greenly for Tech

The Hidden Emissions of Tech

A Sustainability Guide for Businesses in the Tech Industry

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The Technology Industry's Environmental Impact and Decarbonization Efforts

The technology sector has become a cornerstone of modern life, powering everything from global communications to artificial intelligence and the burgeoning Internet of Things (IoT). However, this growth comes at a cost: the tech industry contributes significantly to global greenhouse gas (GHG) emissions, consumes vast amounts of energy, and generates substantial waste. In the face of climate change, the industry must address its environmental impact through ambitious decarbonization strategies, innovative solutions, and adherence to robust regulatory frameworks. This report explores the technology sector's contribution to global emissions, current decarbonization efforts, and the challenges and opportunities it faces on the road to sustainability.

Global Emissions Contribution

The Scale and Sources of Emissions

The technology industry contributes approximately 2-4% of global GHG emissions, a figure that rivals aviation and could triple by 2050 without intervention (Allianz, 2023). As the demand for digitalization rises, this sector is under increasing scrutiny (International Energy Agency, 2021).

Scope 3 Dominance: Scope 3 emissions, which encompass upstream supply chain activities and downstream product use, dominate the tech sector's carbon footprint (Bain & Company, 2023). These emissions are particularly significant in hardware and semiconductor manufacturing, accounting for up to

90% of total emissions in these subsectors (McKinsey & Company, 2022).

Semiconductors: Approximately 61% of emissions in this industry stem from downstream product use, with an additional 17% from upstream supply chains and 17% from energy use (Scope 2) (McKinsey & Company, 2022).

Software and IT Services: The software industry sees 57% of emissions from downstream Scope 3, while IT services experience 55% downstream Scope 3 emissions, largely due to energy-intensive operations and consumer product usage (BCG, 2023).

Data Centers and Energy Use

Data centers - the backbone of the internet and cloud computing - contribute approximately 1% of global emissions (International Energy Agency, 2021). They consume vast amounts of energy, projected to surpass 1,000 terawatt-hours annually by 2026. This accounts for roughly

4% of global electricity consumption, driven by the growing demands of artificial intelligence, machine learning, and global data traffic (Reuters, 2024).

01

Power Usage Effectiveness (PUE):

The average annual PUE for data centers, a measure of energy efficiency, has improved from 2.5 in 2007 to 1.56 in 2024, signaling significant progress while still underscoring the sector's considerable energy demands (Statista, 2024).

Cooling Needs:

Innovative solutions, such as immersion cooling fluids, are being adopted to meet these growing energy requirements. According to manufacturers, these systems can reduce cooling energy by over 30%, offering a promising pathway to enhanced efficiency (McKinsey & Company, 2022).

Data Centers and Energy Use

Corporate Emissions Profiles Big Tech companies dominate emissions rankings:

SAMSUNG

It is the largest emitter in the tech industry, producing 3.73 million metric tons of Scope 1 emissions, 9.5 million metric tons of Scope 2 emissions, and a staggering 120 million metric tons of Scope 3 emissions (Financial Times, 2024). These numbers are self-disclosed, and it is unclear if they have been independently audited (World Economic Forum, 2023).

amazon

Despite their efforts to purchase renewable energy certificates to match their electricity consumption in 2023, Amazon emitted 16.2 million metric tons of CO2e in 2021. This was primarily due to its expansive logistics operations, underscoring the challenge of decarbonizing complex supply chains (ITIF, 2020).

tsmc

Taiwan Semiconductor Manufacturing Company, responsible for 92% of global semiconductor production, is heavily reliant on fossil fuels for electricity, contributing 10.2 million metric tons of Scope 2 emissions annually (McKinsey & Company). These figures are self-reported, and verification through third-party auditing has not been specified.

02

Decarbonization and Key Statistics

While the tech industry's emissions are significant, it is also uniquely positioned to lead in decarbonization, leveraging its innovative capacity to drive sustainable practices.

Reducing Scope 1 and 2

Emissions Many companies are investing in renewable energy and operational efficiency to reduce direct (Scope 1) and indirect (Scope 2) emissions:

Microsoft

Committed to 100% renewable electricity by 2025, Microsoft reduced its Scope 2 emissions by 30% between 2021 and 2022 through investments in solar, wind, and energy storage solutions (McKinsey & Company, 2025). However, these reductions are based on market-based emissions accounting, which includes the purchase of renewable energy certificates (RECs). This approach does not directly lead to new renewable capacity, raising questions about the long-term impact of such claims (BCG, 2023).

Google

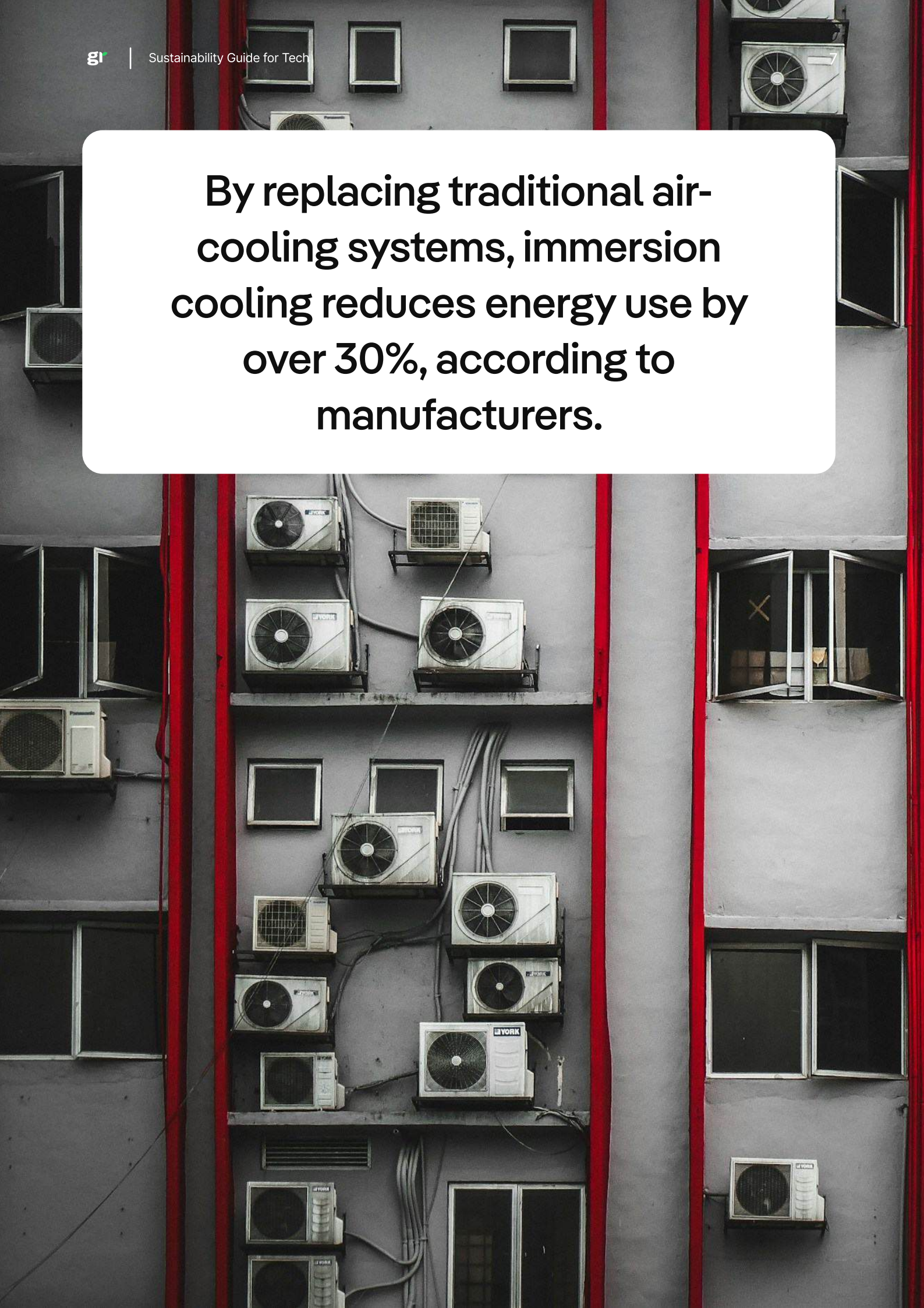
Pioneering "carbon-aware computing," Google shifts workloads to times and locations with the lowest carbon intensity, achieving emissions reductions of up to 90% for certain operations. This strategy leverages existing grid variations to optimize energy use, showcasing the potential for operational flexibility to drive significant sustainability gains.

Addressing Scope 3 Emissions

Scope 3 emissions, encompassing the entire supply chain and product lifecycle, are the most challenging to address but also the most impactful (Bain & Company, 2023):

1. **Eco-Design Principles:** Companies like EDF Group are redesigning their digital products, cutting emissions by 3.5 times compared to their initial design by optimizing website code and server efficiency (McKinsey & Company).
2. **Circular Economy:** The global market for refurbished electronics is expanding rapidly:

- The used smartphone market is projected to grow from $64.7 billion in 2023 to $110 billion by 2027. This represents approximately 10-15% of the total global smartphone market, highlighting growing consumer demand for sustainable alternatives. 2
- The refurbished PC market is expected to reach $11.8 billion by 2031, growing at a compound annual growth rate (CAGR) of 10.8% (World Economic Forum, 2023).



By replacing traditional air-cooling systems, immersion cooling reduces energy use by over 30%, according to manufacturers.

Challenges and opportunities for sustainability in tech

Immersion Cooling: By replacing traditional air-cooling systems, immersion cooling reduces energy use by over 30%, according to manufacturers. However, independent studies on this technology's performance remain limited. Cooling systems account for approximately 30-40% of a data center's total electricity consumption, making advancements in this area critical to overall energy efficiency.

Renewable Energy Integration: Companies like Amazon and Google are exploring the potential use of small modular nuclear reactors (SMRs) to supplement their renewable energy portfolios and meet surging energy demands. While promising, SMRs remain an emerging technology that has not yet reached commercial maturity or regulatory approval needed for widespread deployment.

Challenges

01 Dominance of Scope 3 Emissions:

- Up to 90% of emissions in the tech sector are Scope 3, encompassing supply chains, product use, and end-of-life disposal.
- Tracking these emissions is inherently complex due to fragmented supply chains and varying regional regulations.

02 Regional Energy Dependencies:

- Regions like Taiwan, which rely on 81% fossil fuel energy, pose significant barriers to reducing emissions from energy-intensive industries like semiconductor manufacturing.

03

03 High Initial Costs:

- Adopting advanced technologies such as modular nuclear reactors or immersion cooling systems requires substantial upfront investment, making it a challenge for smaller firms to participate.

04 Regulatory Complexity:

- Emerging regulations, including the EU's Corporate Sustainability Reporting Directive (CSRD) and Carbon Border Adjustment Mechanism (CBAM), mandate comprehensive emissions tracking and reporting. These frameworks encourage greater transparency and accountability but require companies to invest in new systems and processes to ensure compliance, which can be resource-intensive.

05 Consumer Expectations:

- Although there is growing interest in sustainable products, consumer willingness to pay a "green premium" remains inconsistent. Companies must balance affordability and sustainability while educating customers on the value of environmentally responsible options.

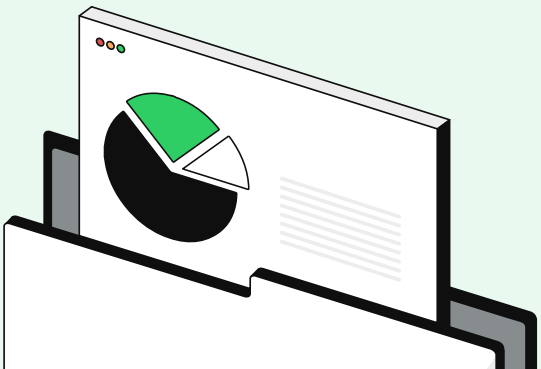
Decarbonization and Business Opportunities

01 Carbon-Aware Computing:

- Innovations such as time- and location-shifting workloads reduce emissions by 15–90%, particularly for cloud-based operations.
- Microsoft's leadership in carbon-aware computing highlights the potential for industry-wide adoption.

02 Localized Supply Chains:

Instead of relocating production, companies are increasingly lobbying for renewable energy adoption in existing manufacturing regions. Aligning operations with cleaner energy grids through such advocacy offers a more practical pathway to reducing emissions while maintaining economic viability.



03 Circular Economy Models:

Expanding "hardware-as-a-service" and modular product designs allows companies to extend product life cycles, reducing the need for new manufacturing and cutting emissions. These concepts known as “reparable design,” “modularity,” and “refurbishment” align with key circular economy practices and have potential to significantly reduce emissions related to technologies’ manufacturing process.

04 Workforce Training in Green IT:

Companies such as Microsoft and SAP are training their IT teams in eco-design and green coding practices, embedding sustainability into core operations. This ensures that environmental considerations are integrated into technology development and deployment processes.

05 Being a First Mover:

Compliance with frameworks such as France’s RGESN eco-design guidelines can position companies as sustainability leaders, creating a competitive advantage while meeting environmental goals. Early adoption of such guidelines also signals a proactive commitment to industry-wide decarbonization efforts.

Conclusion

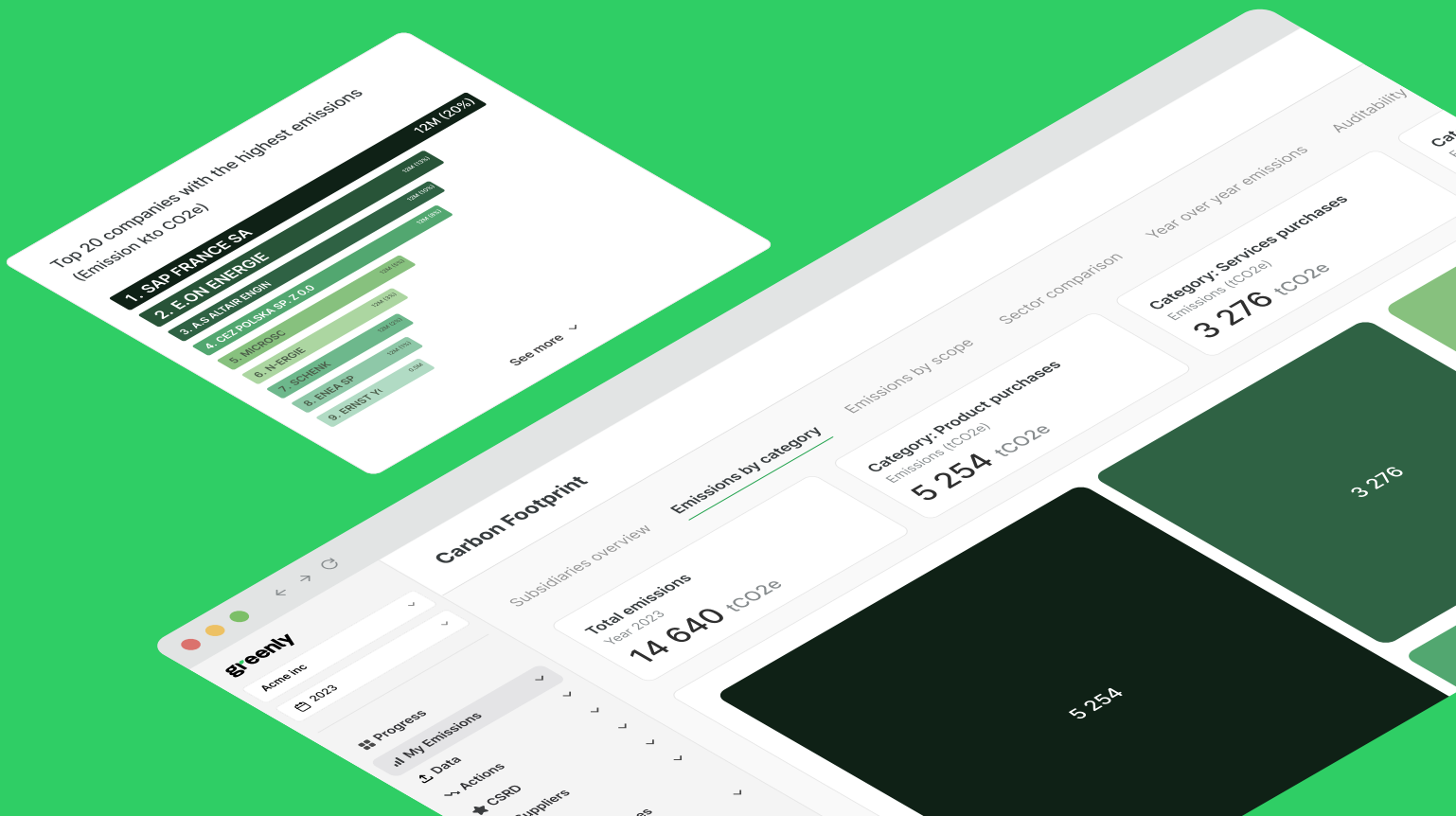
The tech industry is at a pivotal moment in its sustainability journey. While its environmental impact is undeniable, it also holds the potential to lead the charge toward decarbonization. Through renewable energy adoption, circular economy initiatives, and cutting-edge technologies like carbon-aware computing, the sector is already taking steps to mitigate its footprint.

However, further path to sustainability requires unprecedented collaboration across stakeholders, from hardware manufacturers to regulators and consumers.

Addressing Scope 3 emissions, transitioning to cleaner energy sources, and integrating sustainability into product design will be critical. The stakes are high: the decisions made today will determine whether the tech sector becomes a leader in global decarbonization - or a barrier to achieving climate goals. As evidenced by companies like Microsoft, Samsung, and Amazon, progress is possible, but scaling these efforts will define the industry's legacy in the fight against climate change.

How Greenly's Solutions Support the Technology Sector

As sustainability becomes a crucial benchmark for corporate responsibility, Greenly offers a set of transformative solutions for the technology industry to address its unique sustainability challenges. These solutions enable the sector to lead in environmental responsibility while optimizing operational efficiency.



01

Automated, Accurate Carbon Management

Greenly's platform enables technology companies to efficiently measure, manage, and reduce their carbon footprints through:

Seamless Data Integration:

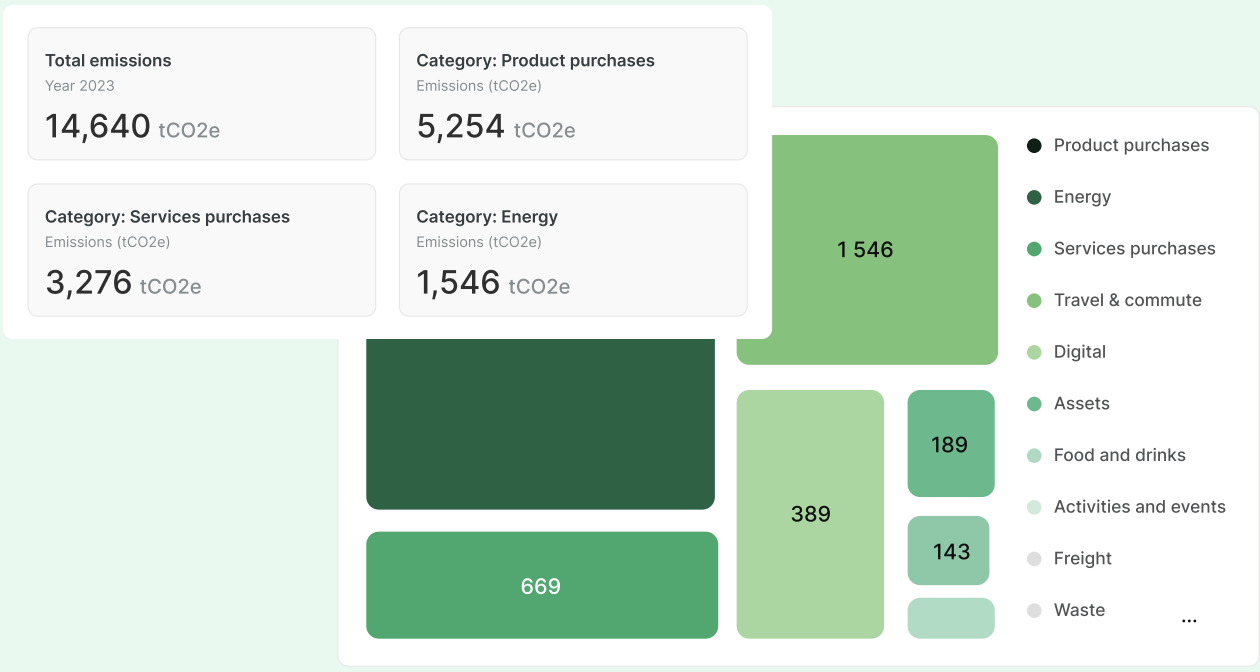
Greenly's platform integrates with API and ETL systems to automate data collection and carbon calculations across cloud services (such as AWS, Azure, and Google Cloud), IT infrastructure, and digital products. Advanced analytics can provide actionable business recommendations to optimize energy use.

Granular Emissions Analysis:

The platform offers comprehensive, ultra-detailed dashboards, allowing businesses to assess emissions at the server level or across specific cloud activities. This helps organisations pinpoint high-emission operations and implement targeted strategies.

Time Efficiency:

Greenly reduces manual effort while ensuring accuracy and scalability for complex infrastructures. By utilizing Greenly's platform, businesses can achieve up to an 80% reduction in time spent on emissions tracking, allowing for greater focus on strategy.

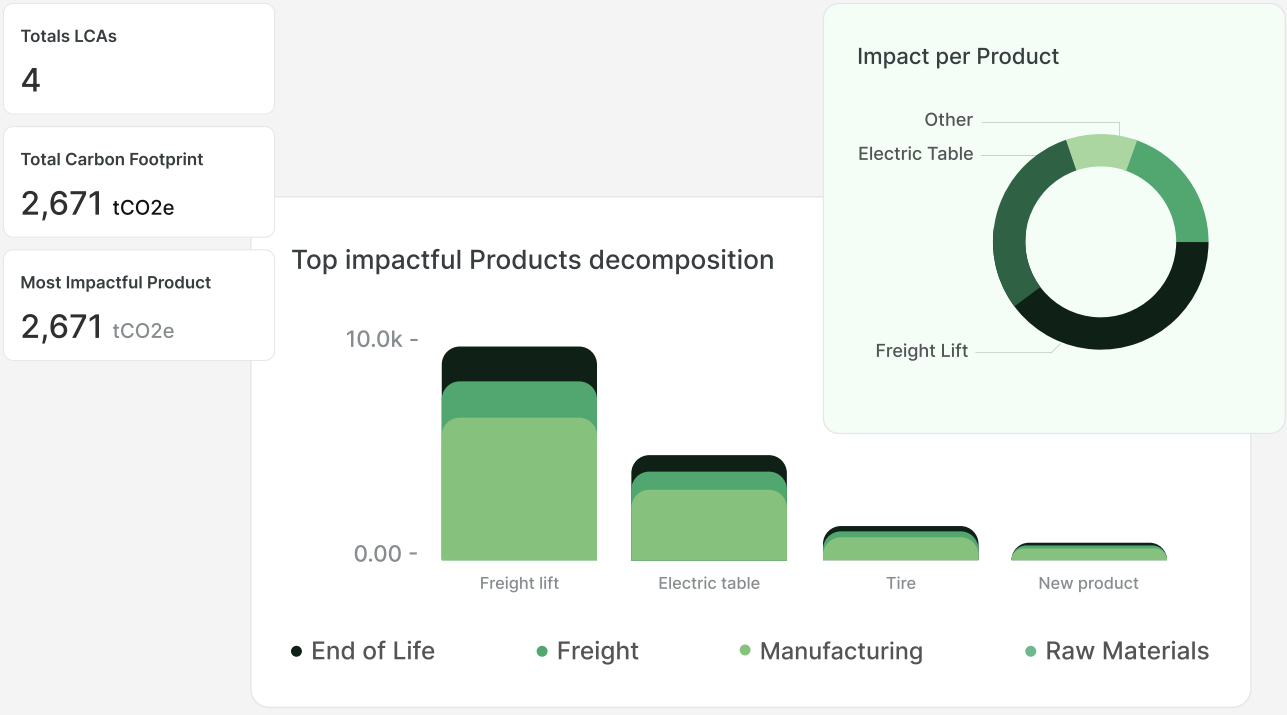


02

Support for Regulatory and Voluntary Compliance

The tech industry faces growing pressure to comply with stringent sustainability standards. Greenly alleviates compliance burdens by:

- **Alignment with Global Frameworks:** Greenly ensures adherence to frameworks such as the Corporate Sustainability Reporting Directive (CSRD), the Science-Based Targets initiative (SBTi), the Carbon Disclosure Project (CDP), and the Carbon Border Adjustment Mechanism (CBAM).
- **Automated Comprehensive Reporting:** Businesses can generate audit-ready, transparent GHG reports that follow GHG Protocol and other regulatory requirements, including the SBTi and International Organization for Standardization (ISO) certifications. This streamlines the often complex and time-consuming reporting process.
- **Customisable dashboards:** Businesses can export data in tailored formats to meet specific compliance needs. Dashboards provide flexible data views at multiple levels and contain scope-specific insights, presenting a holistic view of a company's carbon footprints. Real-time features also enhance monitoring against reduction targets and facilitate compliance with regulatory deadlines.



03

Facilitating Climate Commitments

Meeting ambitious climate goals requires more than measurement - it demands actionable strategies. Greenly supports the technology sector by:

Trajectory Modelling:

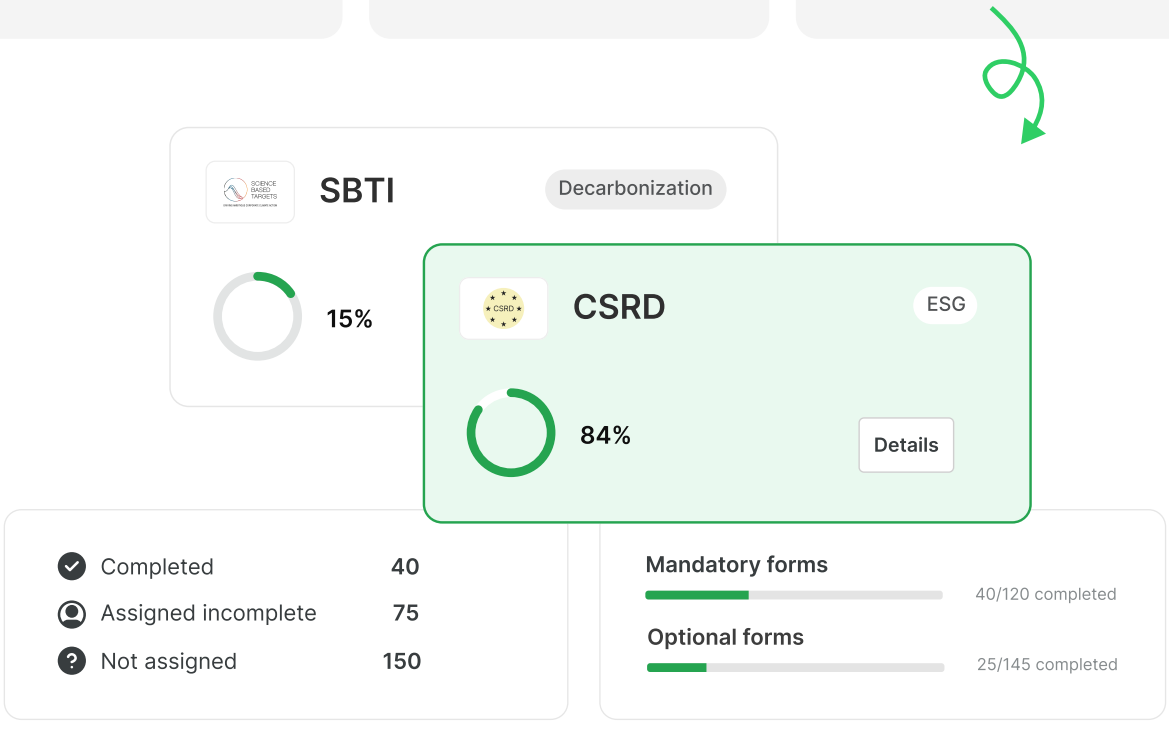
The platform's sophisticated trajectory simulation tool helps businesses explore different carbon reduction pathways and develop long-term 5 strategies for decarbonization. By generating multiple scenarios, companies can evaluate the impacts of different emission reduction strategies, balancing operational constraints with sustainability objectives.

Reduction Action Plans:

Greenly possesses an extensive library of reduction strategies, from optimizing data transfer schedules to adopting low-carbon hardware. With the addition of prioritisation tools, Greenly can help businesses focus on high-impact actions that align with operational and resource constraints.

Continuous Tracking and Reporting:

Additional to complying with regulations and standards, Greenly's continuously updating dashboard enables clear communication of progress to stakeholders, fostering trust and credibility. Greenly empowers tech companies to turn ambitious climate commitments into measurable achievements.



Why Greenly Matters for the Technology Sector

Greenly's solutions not only help technology companies navigate the complexities of sustainability but also position them as leaders in environmental responsibility. As the technology sector continues to innovate, Greenly's expertise in sustainability can help companies to do so grow responsibly, aligning business success with environmental stewardship across all three scopes of emissions. With Greenly, the path to sustainability becomes not just achievable but transformative.

Essential Data for Tailored Greenly Solutions

01

Emissions Data

In the 1990s, ICT electricity consumption was approximately 450 TWh annually, generating around 150 million metric tons of CO2 (World Bank, 2024). By 2020, this rose to 915 TWh and 763 million metric tons of CO2 - reflecting a compound annual growth rate (CAGR) of about 2.8% for electricity use and 5.5% for CO2 emissions due to increased fossil fuel dependency and operational scale (World Bank, 2024). This escalation stems from exponential growth in data centers, network infrastructures, and consumer devices.

Data centers remain the largest contributor, responsible for approximately 300 million metric tons of CO2 emissions in 2020 - a 150% increase since 2000 (Reuters, 2024). Network infrastructure follows, emitting around 250 million metric tons in 2020, driven by expansion of video streaming and generative AI applications, which account for 8-10% annual growth in energy demands (Tech Monitor 2022). Device manufacturing is also a significant contributor; smartphones alone are responsible for 77 million metric tons of CO2 annually, equivalent to the emissions of 20 coal-fired power plants (Tech Monitor 2022).

In the U.S., ICT operations account for about 2% of total emissions, with data centers consuming 2% of national electricity use and generating around 70 TWh annually. European emissions show a similar trend (McKinsey, 2024). France's ICT sector emits approximately 20 million metric tons annually, while Germany leads with around 30 million metric tons. Projections suggest ICT emissions will rise by 35% by 2035, largely due to generative AI and cloud computing (McKinsey, 2024).

2%

of national electricity use and generating around 70 TWh annually.

8-10%

annual growth in energy demands (Tech Monitor 2022).

The global ICT emissions mix in 2021 included CO2 (~763 million metric tons), CH4 (~5 million metric tons), N2O (~3 million metric tons), and fluorinated gases (~12 million metric tons) (World Bank, 2024).

Manufacturing emissions are equally significant. For instance, producing a single smartphone emits approximately 55 kg of CO2 equivalent, and with over 1.4 billion smartphones produced annually, this equates to 77 million metric tons of CO2.

Tech giants like Apple report that 70% of their corporate emissions stem from product manufacturing, while Google attributes 66% of its emissions to supply chain activities (CNBC, 2021).

Progress on decarbonization remains uneven. Microsoft, for example, has pledged to be carbon-negative by 2030, yet data on its Scope 3 emissions - a category that includes supply chain and user-driven emissions - remains incomplete (Financial Times, 2024).

Greenly addresses the challenges of emission reporting with precision and scalability. By automating emissions tracking across Scopes 1, 2, and 3, it achieves up to 100% categorization of emissions points - spanning cloud services, IT infrastructure, and supply chains.

02

Energy Consumption and Patterns

The ICT sector's emissions grew from approximately 1.5% of global GHG emissions in 2000 to 3-4% today - nearly doubling over two decades, exceeding even the emissions of some entire 7 nations. Data centers alone account for around 2% of global carbon emissions - comparable to the aviation industry - with projections suggesting a 10% increase in energy consumption by 2030 due to rising demand for cloud computing and AI (World Bank, 2024). In 2023, Google's energy consumption equaled a quarter of Finland's annual energy usage.

Data centers dominate energy use, consuming around 1% of global electricity - equivalent to the annual energy needs of some countries. Scandinavian data centers achieve up to 70% renewable energy reliance, showcasing regional efficiency; however, many global operations remain tied to fossil fuels (McKinsey, 2024). Networks contribute an additional 300 TWh annually, reflecting a 50% increase since 2005. Device manufacturing adds another substantial share, with production processes for ICT hardware accounting for 213 million metric tons of CO2 in 2021 (WEF, 2023).

Renewable energy adoption is accelerating but remains uneven. Tech companies led 60% of global renewable power purchases in 2021, yet grid capacity and supply intermittency pose significant challenges. Google reports 67% renewable energy usage for its operations and Microsoft exceeds 70%, yet both face persistent challenges in reducing Scope 3 emissions (Financial Times, 2024).

Looking ahead, electricity consumption in the ICT sector is projected to grow by 35% by 2035. Despite this, aggressive energy efficiency measures and renewable energy expansion could limit emissions growth to under 20% - if executed effectively (McKinsey, 2024).

Greenly integrates advanced APIs to automate energy data collection, such as kWh usage and carbon intensity by region (e.g., Ireland, Oregon). The platform identifies inefficiencies and offers actionable pathways, such as adopting energy-efficient alternatives and achieving reductions of up to 55% in emissions intensity.

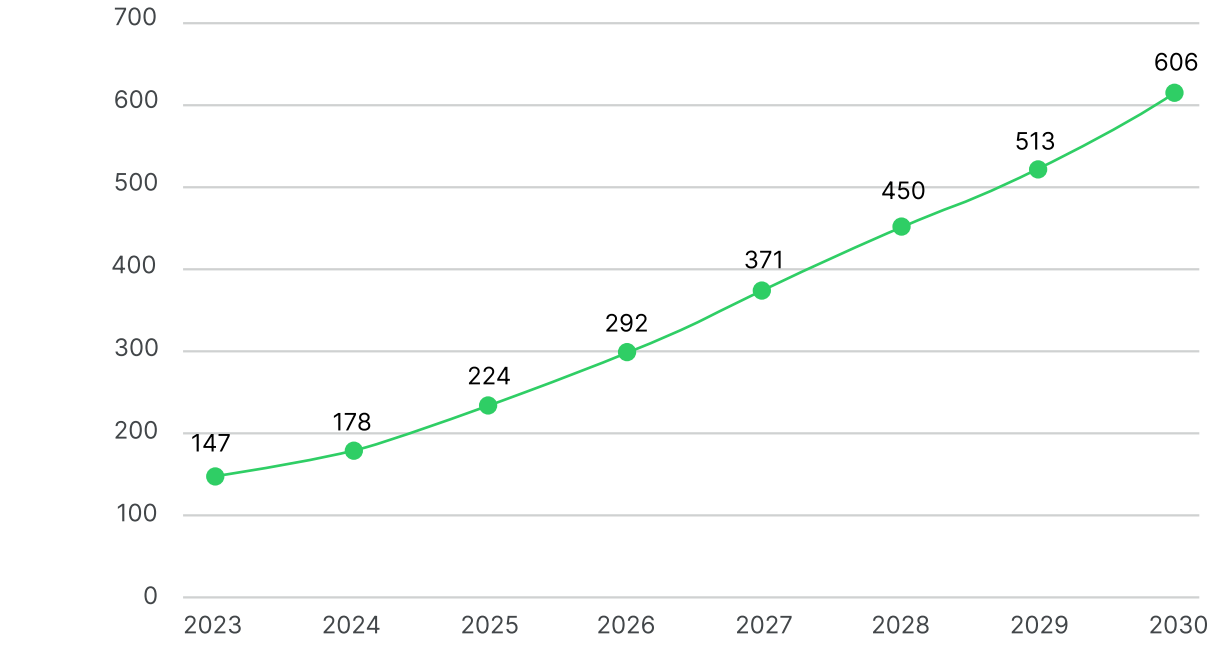
Global cloud computing emissions exceed those from commercial aviation

Share of global CO2 emission generated by sector/category

Source: Climatic Analysis, The Shift Project, OurWorldinData

Demand for power for data centers is expected to rise significantly in the United States.

Terawatt-hours (TWh) of electricity demand, medium scenario



	2023	2024	2025	2026	2027	2028	2029	2030
Share of total US power demand,%	3.7	4.3	5.2	6.5	8.0	9.3	10.3	11.7

03

Sustainability commitments: overview of targets and frameworks adopted by retail companies

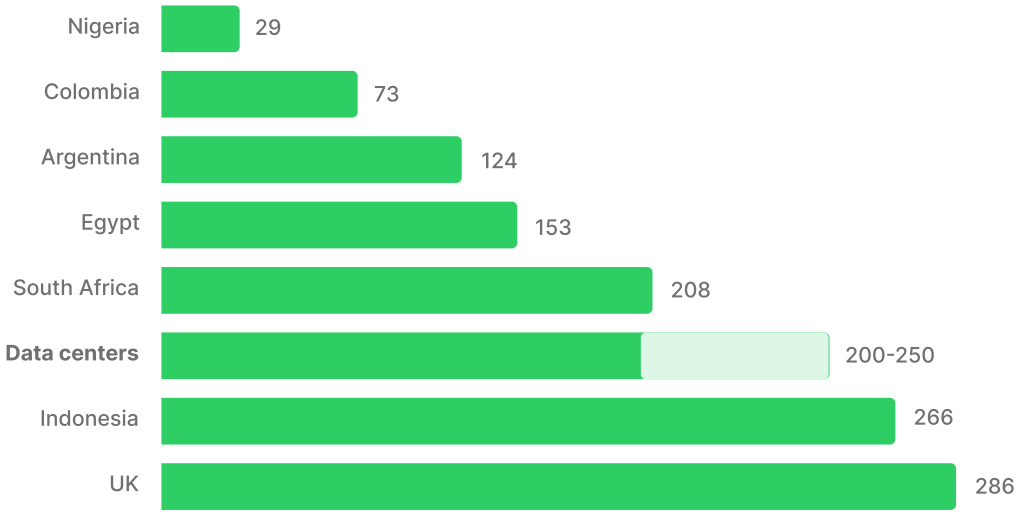
Without addressing Scope 3 emissions at scale, achieving full decarbonization across the retail sector will remain out of reach.

To structure and validate their sustainability efforts, retailers are aligning with established frameworks such as the Science-Based Targets initiative (SBTi), the Greenhouse Gas Protocol, and the Carbon Disclosure Project (CDP) (ONS, 2024). These frameworks provide guidelines for measuring, reporting, and reducing emissions in line with global climate goals (Statista, 2024).

Recognizing that a significant portion of emissions originates from the supply chain, retailers are engaging with suppliers to promote sustainable practices. This includes setting sustainability criteria for suppliers, collaborating on emissions reduction initiatives, and supporting the transition to renewable energy within the supply chain (Greenly, 2024).

Data centers use more electricity than entire countries

Domestic electricity consumption of selected countries vs. data centers in 2020 in TWh



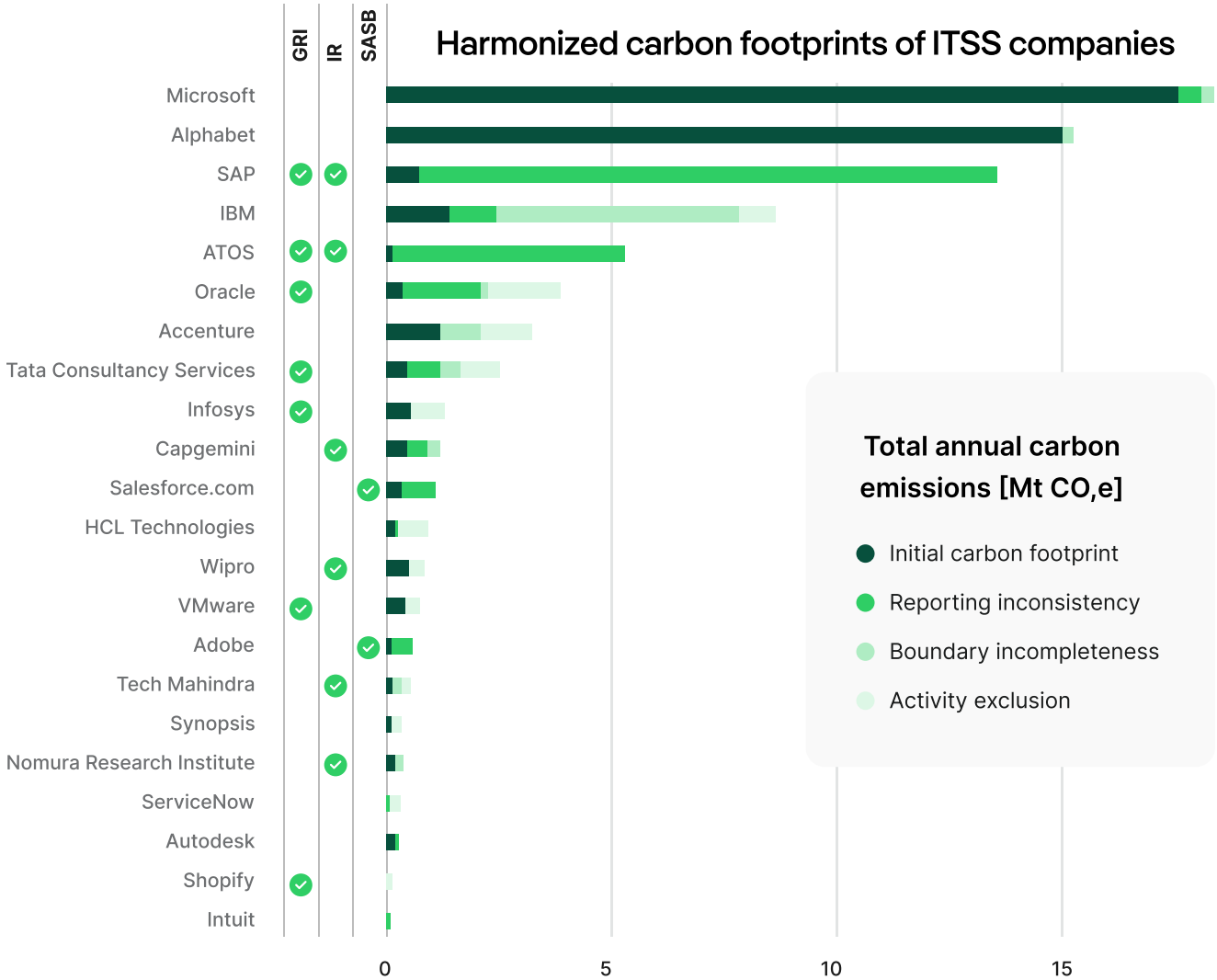
Source: Enerdata, IEA

04

Sustainability Commitments

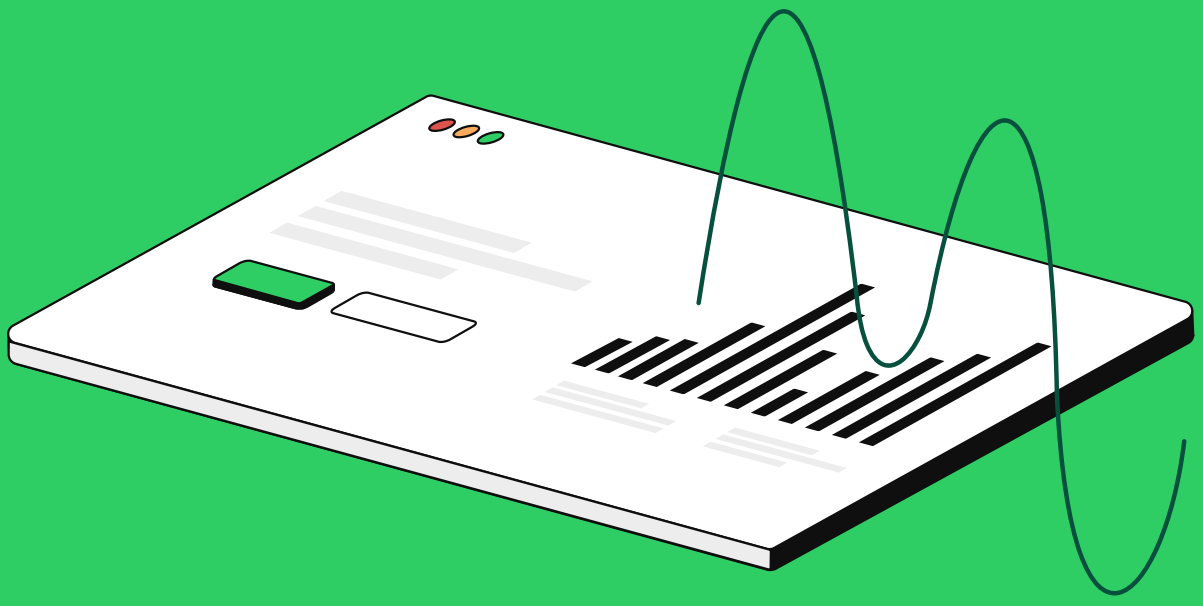
ICT companies have pledged ambitious sustainability goals, yet challenges persist. Microsoft aims to achieve carbon negativity by 2030, while Google and Amazon target 100% renewable energy reliance by 2030 (IEA). As of 2021, Microsoft reported a 70% renewable energy usage rate, and Google achieved 67%, reflecting substantial progress. However, Scope 3 emissions - accounting for up to 70% of total emissions, including supply chain and user activity - remain largely unaddressed (McKinsey, 2024).

Tech companies accounted for 60% of global renewable energy purchases in 2021, but grid limitations and intermittent renewable supply hinder broader adoption (WEF, 2023). Despite this, projections indicate that comprehensive sustainability efforts, including renewable investments and efficiency innovations, could cap ICT sector emission growth at under 20% by 2035 - substantially below the anticipated 35% rise under current practices (WEF, 2023).



Greenly's Customer Reach and the Climate Suite Overview

The IT sector's challenges are compounded by its reliance on scalable infrastructure, multi-cloud environments, and energy-intensive technologies. Energy consumption from data centers accounts for approximately 1-1.5% of global electricity use, with significant regional variation in carbon intensity. Greenly addresses these challenges by offering a product suite that ranges from GHG compliance to comprehensive decarbonization, automating energy data collection and providing actionable recommendations (WEF, 2023).



The typical rollout process spans between 1 and 3 months, significantly outpacing traditional in-house approaches. The "Climate Action Ready" package allows businesses to establish emissions tracking, complete data collection, and generate a compliant GHG report within three months, leveraging automated APIs and Greenly's sophisticated project management tool suite. More advanced offerings, such as the "Net Zero Contributor" package, expand this scope to include trajectory modeling, tailored action plans, and strategies for achieving long-term carbon reduction, catering to organizations with ambitious sustainability objectives.

Central to this accelerated process is Greenly's ultra-granular analysis, delivering a level of precision beyond what traditional cloud platforms offer. IT companies can monitor emissions not only at the organizational or regional level but also down to specific activities like server utilization or cooling system efficiency.

To illustrate, some of our clients have pinpointed high-energy-consuming equipment, such as specific power-hungry processors, and transitioned to more efficient alternatives, achieving emission reductions of up to 35% in IT operations. Our suite of predictive modeling tools further enhances decision-making, enabling businesses to simulate reduction scenarios and prioritize impactful strategies while considering operational constraints.

Greenly's rollout ensures seamless integration with existing systems while guaranteeing compliance with regulatory standards such as CSRD and SBTi. By automating data centralization and reporting, the platform delivers audit-ready documentation, eliminating non-compliance risks. Businesses benefit from streamlined workflows, transparent tracking, and measurable progress toward sustainability targets, cementing Greenly's position as an indispensable cost-saver and partner in emissions reduction and regulatory adherence.

Sub-Verticals Focus for Tech Vertical

Software, Media & Communications

Software, Media, & Communications are the engines of global digitalization, making our world more interconnected than ever. Nevertheless, their profound environmental impact cannot be overlooked. The use of digital software is associated with significant operational emissions, with about a third of ICT emissions attributed to end-user devices (Stocker, 2024).

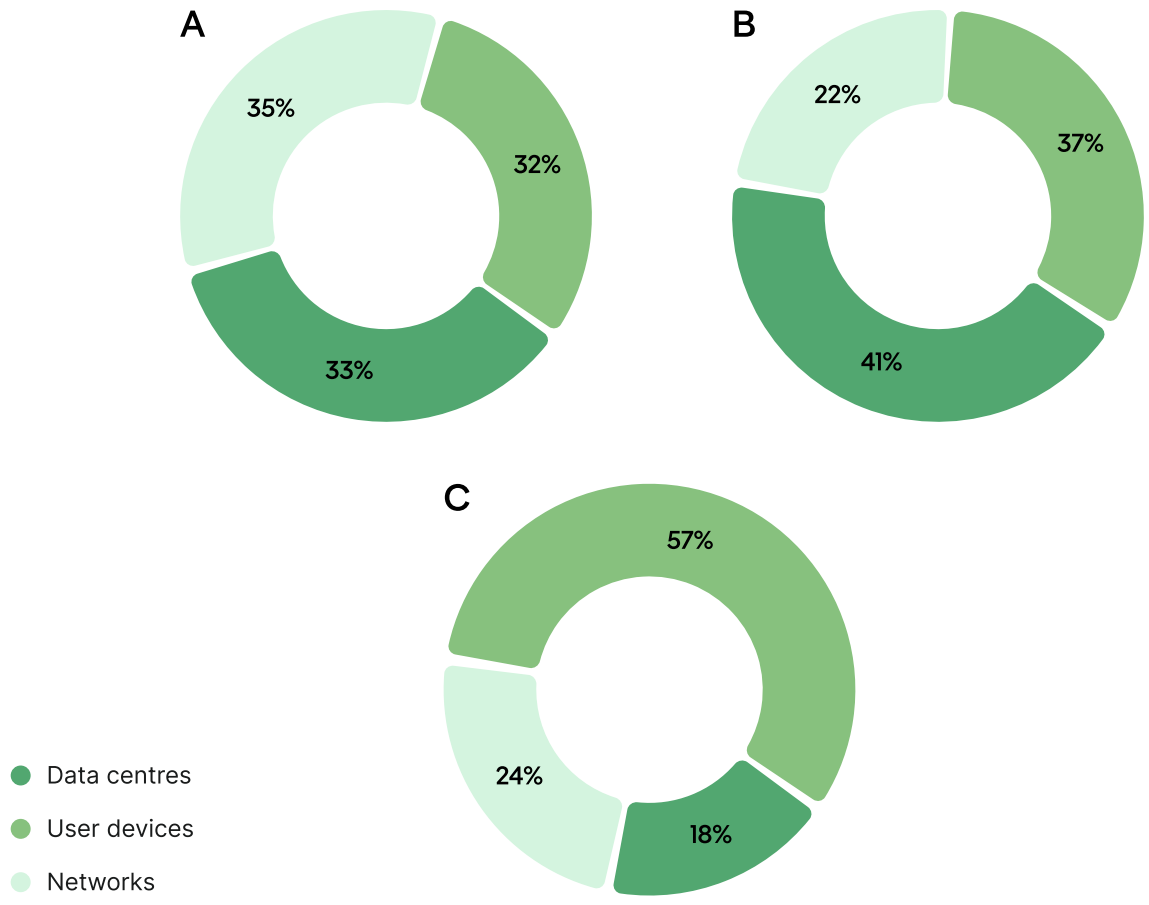


Figure 3 - Proportional breakdown of ICT's carbon footprint, excluding TV (Freitag et al., 2021)

Environmental Impact

The software sector is characterised by significant Scope 3 emissions, which are difficult to measure and control. Those include downstream emissions from customers as well as upstream emissions from the manufacturing process (Guarraia et al., 2024).

Electricity-intensive use:

In 2020, ICT, including data centers, communication networks, and user devices, was responsible for 4-6% of global electricity use (Christie & Ross, 2022). Worldwide, large language models, such as ChatGPT, are used on a daily basis, with 300 million recorded users in December 2024 and 13 million unique visitors per day (Cerullo et al., 2023). Given the proliferation of digital technologies, software, media, and communications are only expected to have a more profound environmental impact due to high levels of energy consumption (Curry, 2025). In fact, an average ChatGPT query consumes 10 times as much electricity as a single Google search (Goldman Sachs, 2024).

Cloud computing:

Cloud computing refers to storing data in global shared data centers before it is accessed through web-enabled services. It has become a default solution for commercial and government systems. Environmental implications of cloud computing include vast electricity consumption to power and cool servers. In most cases, cooling accounts for 40% of total data center energy consumption and up to 80% in areas with a warmer natural climate (Zhang et al., 2017). On the other hand, cloud infrastructure plays a major role in promoting more sustainable IT due to its upward and downward scalability and potential to be powered by renewable energy, reducing GHG emissions (Tan & Fosu Appiah, 2024).

Streaming:

While streaming services are energy- and carbon-intensive, their environmental impact remains modest compared to other sectors. Continuous technological improvements, including the development of more energy-efficient viewing devices, help decrease energy consumption.The IEA estimated that, as of 2019, an hour of video streaming was associated with 36g CO_2 emission (Kamiya, 2020). Carbon Trust reports similar figures, associating one hour of video-on-demand streaming with 55g CO_2 emissions - a small number relative to other daily activities (2021).

Being a First Mover:

Compliance with frameworks such as France's RGESN eco-design guidelines can position companies as sustainability leaders, creating a competitive advantage while meeting environmental goals. Early adoption of such guidelines also signals a proactive commitment to industry-wide decarbonization efforts.

Opportunities for sustainability

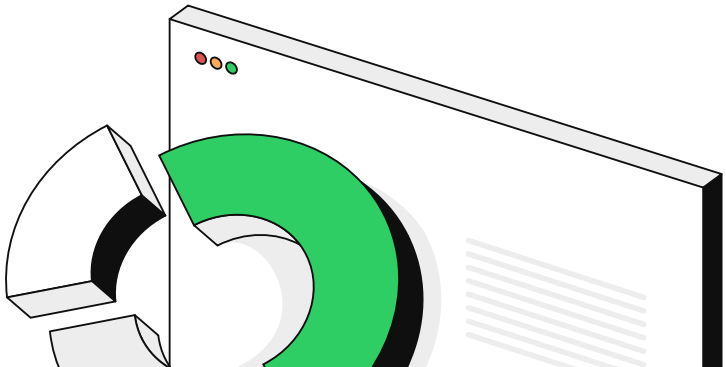
While energy consumption associated with using digital technology is expected to rise, its environmental impact can be mitigated through several strategies:

01 Green coding:

According to McKinsey, implementing sustainability strategies within the realm of software has the potential to lower CO2 emission by approximately 5% by 2030 (Srinidhi et al., 2022). Here, green coding is a significant opportunity. It involves writing code in a way that decreases energy consumption, minimizing adverse environmental impacts. As digital consumption grows, increasing the volume of processed data and energy use, green coding aims to build carbon- and energy-efficient software applications. These applications consume low-carbon-intensity electricity from renewable sources, such as solar, hydropower, and wind. Green coding also promotes the use of hardware-efficient applications, prolonging product life cycles. Additionally, green coding practices promote networking efficiency by streamlining data routes to avoid unnecessary data transmission (Devsu, 2024). Ultimately, green coding is about writing efficient software code that minimises resource usage, such as CPU cycles, power consumption, and memory (Rusakova, 2024). While implementing green coding practices is a long-term commitment requiring a consistent business strategy it has the potential to make a tangible environmental impact.

02 Renewable energy for data centers:

The world's largest cloud computing providers, including Amazon, Google, and Microsoft, have shown commitment to improving the environmental impact of data centers. Google has been carbon neutral since 2007, using renewable energy and carbon offsets. Amazon's data centers are powered by over 50% of renewable energy (Beardmore, 2020). In recent years, Amazon has also focused on investment in wind farms. Nevertheless, the adoption of renewable energy has not been uniform across Amazon's largest data centres in Virginia, which in 2019 used only 12% of renewable energy (Beardmore, 2020). Relocating data centers to regions with colder natural climates presents another opportunity to reduce electricity use for cooling (Beardmore, 2020). Decarbonizing electricity is a substantial opportunity with a potential to mitigate climate impacts of internet consumption (Istrate et al., 2024).



03 Efficient content delivery:

When assessing the environmental impact of digital technology the sustainability of Content Delivery Networks (CDNs) ought to be considered. CDNs are crucial for smooth, quick, and efficient content provision, especially in streaming services. CDNs offer substantial sustainability opportunities by decreasing the physical distance that data needs to travel. A shorter data journey implies lower energy consumption and, thus, lower carbon emissions. In order to strategically adjust CDNs, their energy consumption patterns must be understood and optimized. Technologies such as AI algorithms, HTTP/3, and QUIC can enhance CDN performance by minimizing latency and improving connection establishment times. Collaborating with local Internet Service Providers (ISPs) is also a powerful tool to shorten value chains, reducing the carbon footprint of CDNs (Team, 2024).

The environmental impact of digital technology and communication streams extends beyond just their use.

Data, Hardware & Tech Manufacturing

Environmental Impact

The environmental impact of digital technology and communication streams extends beyond just their use. The vertical's negative impact on the environment derives from high electricity consumption during the manufacturing process, carbon-intensive hardware production, supply chain emissions, and e-waste.

01

Electricity-intensive hardware production:

Producing GenAI hardware, such as processing units (GPUs) that run GenAI systems behind large language models such as Chat GPT or Gemini, requires significant electricity inputs, affecting the global electricity supply and local communities. Taiwan Semiconductor Manufacturing Company's (TSMC) new manufacturing site in Taichung is expected to consume 25% of the city's electricity and 6% of its water, having a clear impact on residents (Hosseini et al., 2024). The water consumption by data centers is substantial, as an example, in 2021, Google's large data centers used as much as 450,000 gallons of water per day - enough to irrigate 17 acres of turf lawn grass (Hölzle, 2022). Additionally, producing hardware components such as microchips and semiconductors requires mining resources, including gold, copper, and aluminium.

This process is associated with water contamination, air pollution, and soil degradation, further harming local stakeholders.

Another environmental challenge arises across data centers used for GenAI processing. By 2030, they are estimated to consume more than 8% of US' and 5% of Europe's electricity for cooling (Goldman Sachs, 2024). Data centres themselves currently consume around 1-2% of power worldwide (Goldman Sachs, 2024). In 2022, this translated to 460 terawatt-hours (TWh), on a trajectory to reach more than 1000 TWh by 2026 - equivalent to Japan's total electricity consumption (Iea, 2024).

02 Carbon-intensive hardware production:

Emissions generated during the lifecycle of hardware products are categorised as either embodied (upfront) or operational (in-use). Embodied emissions are those directly associated with the hardware production process, including mining raw materials, manufacturing, transportation, and disposal. In contrast, operational emissions occur when using the hardware. About a quarter of ICT emissions can be classified as embodied, while the rest is operational, highlighting the environmental impact of technology beyond just the production process (Stocker, 2024). The complete production process of a single data server is associated with 1750kg of CO2 emissions - a significant figure considering that hyperscale data centers replace up to 400,000 servers a year. The data center market is growing rapidly, increasing from 500,000 centers worldwide in 2012 to 8 million in 2019. Hardware manufacturing is associated with significant CO2 emissions (Nordic Computer, 2025). Given the carbon-intensive nature of the sector, it cannot sustain continuous growth without implementing sustainability measures.

03 Supply chain emissions:

Most emissions within the technology sector are Scope 3 emissions, generated from upstream supply chains or downstream product use. For hardware manufacturers, Scope 3 emissions incorporate mainly downstream electricity use and upstream emissions from sourcing materials and minerals (Guarraia et al., 2023). In 2021, a lifetime CO2 emissions footprint in semiconductor manufacturing - essential for making hardware - was just below 500 megatonnes. Within that, 20% came from Scope 1 and 2 emission, in particular from device design and manufacturing. The remaining 80% were Scope 3 emission, 65% from downstream device use, processing and disposal, and 15% from upstream materials and equipment sourcing (Tembey et al., 2023). According to BCG, CO2 emissions from semiconductor production are expected to increase at an 8% annual rate, peaking in 2045 (Tembey et al., 2023).

04 E-waste:

The last critical environmental impact of Data, Hardware & Tech Manufacturing is e-waste, defined as waste from electrical and electronic equipment (European Commission, 2025). In 2022, an average EU citizen produced 11.2 kg of e-waste, making it one of the fastest growing waste streams (European Commission, 2024). If not managed properly, e-waste can have disastrous environmental and health impacts. E-waste is considered hazardous as it can contain toxic materials, such as dioxins, lead, and mercury, which appear in the WHO's list of 10 chemicals of public health concern.

E-waste is especially dangerous to women and children. In some developing countries, children are involved in waste picking, risking exposure to hazardous substances.

It is estimated that in 2020, 16.5 million children worked in the industrial sector, including waste processing. The irreversible health effects of e-waste exposure include cancers, miscarriages, neurological damage, and diminished IQ levels (GEN, 2024). E-waste is not biodegradable and accumulates in the environment, highlighting the need for recycling. As of 2022, the average EU e-waste collection rate was 40.1% (European Commission, 2024). Globally, the figure was even lower at 22.3% (WHO, 2024).

Opportunities for sustainability

The Data, Hardware & Tech Manufacturing vertical presents significant opportunities for sustainability:

01 Circular economy:

The environmental impact of hardware manufacturing can be mitigated by extending the lifespan of data servers, ensuring they are used for longer before being replaced. This circular economy practice has the potential to decrease the need for new hardware parts purchasing and production. While data center hardware can be used efficiently for 10-15 years, original equipment manufacturers (OEMs) tend to offer warranties for only up to 3 years. However, this period can be extended through third-party maintenance providers (TPM). Extending hardware lifecycles can save up to 50 metric tons of CO_2 and reduce costs related to acquiring new equipment by 70% (Guarraia et al., 2023). Another effective circular economy practice is buying refurbished devices and recycling hardware, instead of purchasing new equipment. This approach protects scarce resources and limits CO_2 emissions that would be generated during production.

02 Sustainable sourcing:

Sustainable sourcing involves procurement of goods and services that have been produced in an environmentally and socially responsible manner. This presents a significant opportunity, as the sustainability standing of suppliers is expected to see the greatest increase in importance among all attributes relevant for supplier choice over the next five years (Keelvar, 2025). Sustainable sourcing is about using renewable and recyclable materials, as well as reducing GHG emissions, energy-use, and waste across the supply chain. It is also about ensuring the well-being of those working in the supply chain, and staying ethical and transparent about your sourcing and production practices (Keelvar, 2025). Additionally, procurement of devices with a high energy efficiency ratings lowers costs by minimising power consumption and optimising resource utilisation (WT, 2025). Finally, shifting suppliers closer to customers can reduce emission related to transportation.

03 Energy-efficient manufacturing:

There are vast opportunities for major industry players to adopt energy-efficient practices in manufacturing. One such measure is immersion-cooling technology, which has the potential to reduce the energy consumption of data centers by 30% compared to air-cooling solutions. Key industry players have hopped on this opportunity. As an example, Intel recently partnered with the chemical company Lubrizol to design immersion-cooling fluid solutions (Guarraia et al., 2024). Another energy-efficiency measure is using deduplication software, which reduces the amount of data stored by 95%, saving energy. Lastly, power infrastructure can be improved through “smart” power distribution units, which are 2-3% more energy-efficient than conventional ones (US Government, 2025).

Greenly's Role

Greenly plays a crucial role in advancing sustainability opportunities within the Data, Hardware & Tech Manufacturing sector.

01 Tools for emissions tracking across IT systems:

Greenly's Climate Suite reduces the need for manual data entry through automatic emission factor matching, precise analytics, and expert-verified reports. API connectors directly integrate with company ERP systems, enabling smooth extraction and automatically updating of client's emissions data.

02 Compliance with CDP and ISO standards:

Greenly promotes client compliance with international environmental standards such as CDP or ISO.

CDP

is an international non-profit organisation that manages one of the largest environmental databases in the world. Through answering the CDP questionnaires, clients can better understand their emissions data, become more transparent, and take concrete actions to improve their environmental standing. While CDP is not compulsory, it is advantageous, allowing companies to compare their performance to other organisations that are a part of the Climate Disclosure Project (Gendre, 2022).

ISO

certifications demonstrate to key stakeholders enterprises' deep commitment to sustainability. The ISO 14001 certification can be of particular interest for companies operating within the technology sector. It regards the Environmental Management System providing clients with a framework to manage environmental responsibilities. Implementing ISO 14001 signals transition into using renewable energy sources and energy-saving processes (ISO, 2025).

03 Benchmarking for energy efficiency:

Greenly's Climate suite enables hardware manufacturers to assess facility energy performance, identify areas for carbon reduction, and optimize data center and production energy use. The platform includes Life Cycle Assessments (LCAs) by tracking emissions at every stage - from material extraction to manufacturing, distribution, and recycling. Comprehensive assessments are used to help companies set energy efficiency goals and develop strategies that allow reaching them, supporting the transition to more circular and sustainable production models.

Tech & IT Services

Environmental Impact

The Tech & IT Services sector underpins modern digital economies but comes with a high environmental cost due to high electricity consumption in IT infrastructure. Data centers alone account for 1% of global CO2 emissions and are projected to surpass 1,000 terawatt hours (TWh) of electricity use annually by 2026 (International Energy Agency, 2021). Additionally, hybrid work setups have intensified energy demands across cloud computing, video conferencing, and enterprise IT systems.

The sector's emissions profile is dominated by Scope 3 emissions, which include supply chain impacts and end-user consumption. IT hardware production and disposal contribute over 200 million metric tons of CO2 annually, with smartphones alone responsible for 77 million metric tons (World Economic Forum, 2023).

Opportunities for sustainability: Driving Energy Efficiency and Decarbonization

The transition to low-carbon IT solutions presents major sustainability opportunities:

Renewable-Powered Cloud & IT Infrastructure:

Investment in renewable energy procurement is increasing. Companies like Google and Microsoft are integrating "carbon-aware" computing, optimizing workloads based on grid emissions intensity, and reducing emissions by up to 90% in some operations (BCG, 2023).

Green Software and Low-Energy Digital Services:

Sustainable software development practices, such as eco-design principles in web development and cloud applications, can reduce digital emissions by up to 3.5 times (McKinsey & Company, 2023).

Circular Economy & Hardware-as-a-Service (HaaS):

Extending the lifespan of IT equipment through refurbishment, leasing, and modular design helps cut emissions. The global refurbished smartphone market alone is projected to reach $110 billion by 2027 (World Economic Forum, 2023).

Greenly's Role: Carbon Management for IT Services

Greenly provides end-to-end emissions tracking and compliance tools to help IT companies optimize their sustainability strategies.

Cloud Emissions Tracking:

Greenly's platform integrates with AWS, Azure, and Google Cloud to measure server-level carbon footprints and offer actionable recommendations for workload efficiency.

Regulatory Compliance & Reporting:

The platform automates compliance with CDP and ISO standards, streamlining audit-ready emissions tracking.

Energy Benchmarking & Reduction Strategies:

Greenly helps businesses to benchmark their data center power usage effectiveness (PUE) against industry standards and identify pathways to adopt low-carbon IT solutions.

The Tech & IT Services sector must take bold steps toward energy-efficient computing, sustainable hardware lifecycle management, and cloud emissions reduction. As digital transformation accelerates, sustainability must become a core priority for the sector. By leveraging Greenly's data-driven emissions management tools, companies can track, optimize, and decarbonize their digital operations, ensuring a sustainable digital future.

greenly × MERGE IT Achieve The Impossible

Greenly Case Study: Merge IT

Merge IT, a leader in digital and technology services, ranging from custom software development to IT consulting and digital transformations, sought to understand and reduce its environmental impact as part of its broader commitment to corporate responsibility.

Merge IT, a leader in digital and technology services, ranging from custom software development to IT consulting and digital transformations, sought to understand and reduce its environmental impact as part of its broader commitment to corporate responsibility. To achieve this, the company engaged Greenly, whose in-depth carbon assessment methodologies and advanced analytical tools provided a clear window into Merge IT's operational footprint. When Greenly completed its comprehensive evaluation, it found that Merge IT's total annual emissions reached 170.6 tCO2e, a figure that placed sustainability firmly on the company's strategic agenda. Further data segmentation provided valuable insights into the origins of these emissions. Approximately

46% were attributed to energy consumption, much of which stemmed from on-premise servers and the continuous operation of development environments.

Another 19% emerged from travel policies, primarily related to in-person client engagements and interoffice meetings, while the remaining 35% came from an array of other operational activities such as procurement processes, supplier relations, and general office management.

Armed with this granular breakdown, Merge IT began collaborating closely with Greenly to translate data into effective, measurable actions. One of the first areas addressed was the company's travel-related emissions. By reassessing how employees conducted meetings—replacing many in-person sessions with virtual collaboration technologies—Merge IT not only reduced its carbon footprint, but also discovered more efficient communication channels that saved time and resources. In parallel, the company evaluated its IT infrastructure with Greenly's guidance, looking for opportunities to either consolidate workloads or shift certain development tasks to more energy-efficient data centers.

This strategic pivot encouraged greater reliance on cleaner energy solutions over time, gradually reducing the environmental impact of day-to-day operations.

As these initial changes took effect, Merge IT integrated Greenly's software solutions into its internal reporting structures, ensuring sustainability metrics were easily accessible and updated on a regular basis. Over time, these metrics became a valuable component of the company's key performance indicators (KPIs), guiding decision-making and promoting ongoing accountability. The ability to monitor progress in real-time allowed Merge IT to track how new initiatives - such as shifting certain development workloads to more energy-efficient data centers or revisiting supplier agreements - impacted its environmental footprint. By continuously refining its approach, the company began to see sustainability as an integral part of operational excellence, rather than an external add-on.

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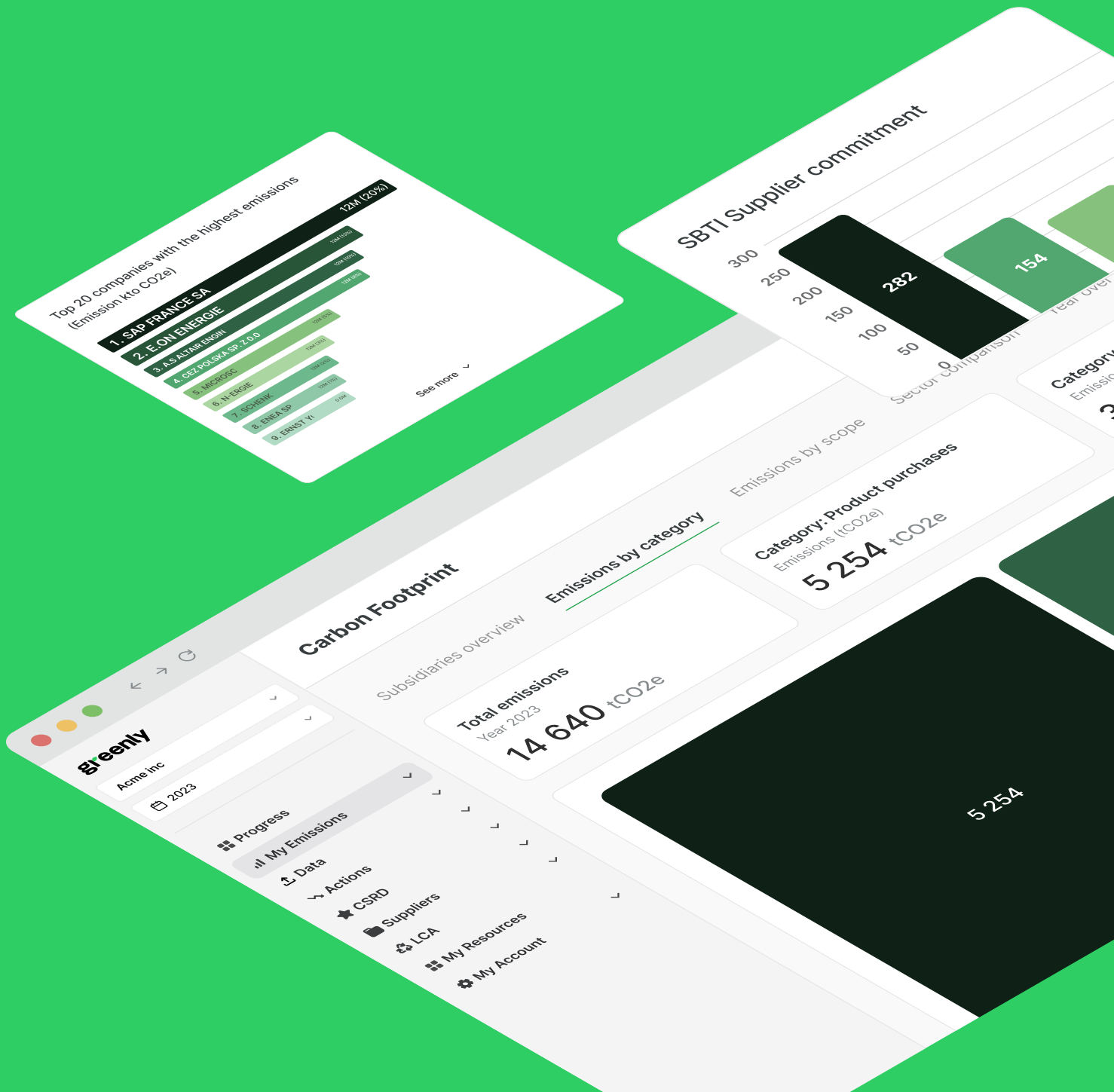

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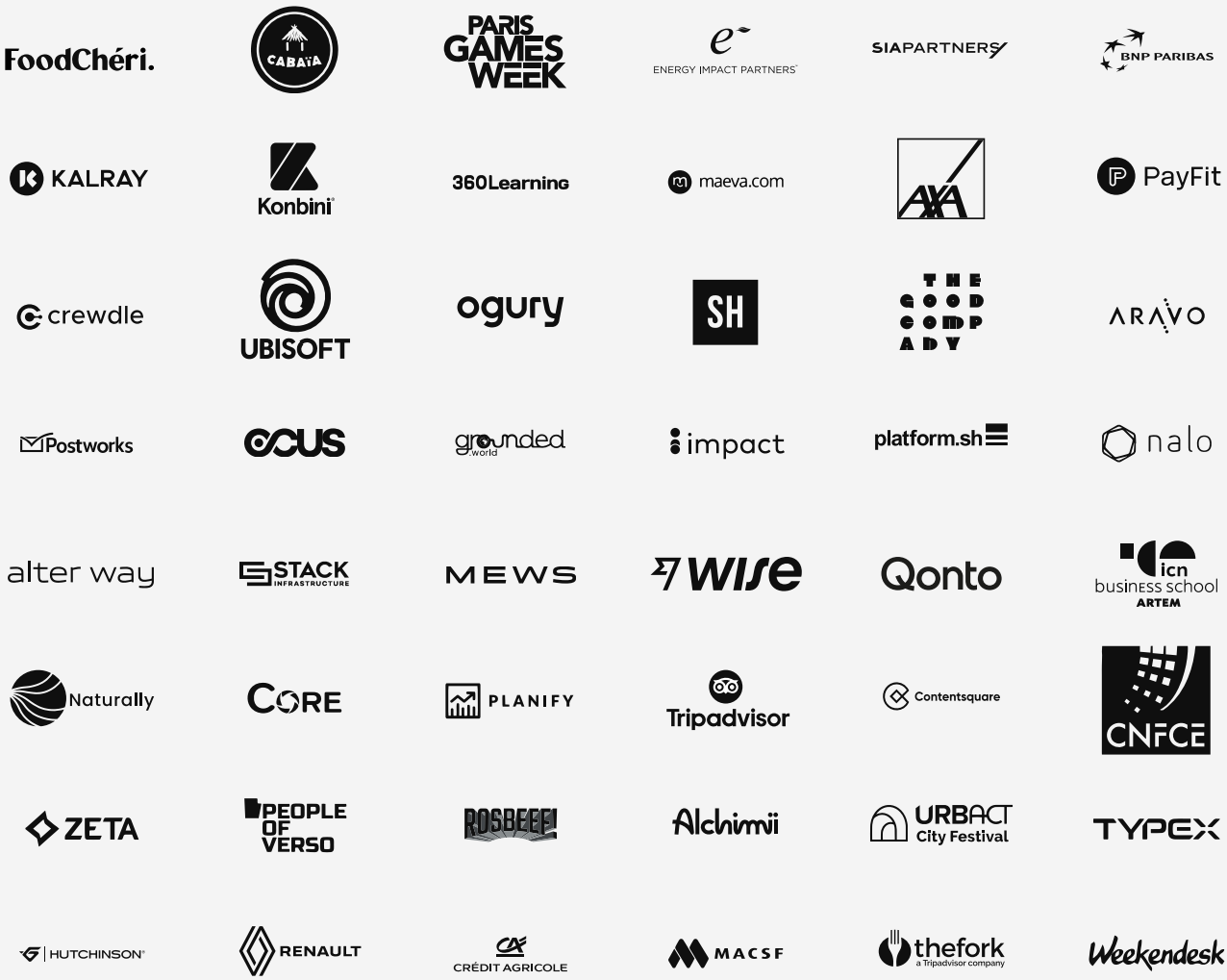

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