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Sustainable IT

Why it's time for a Green revolution for your organization's IT

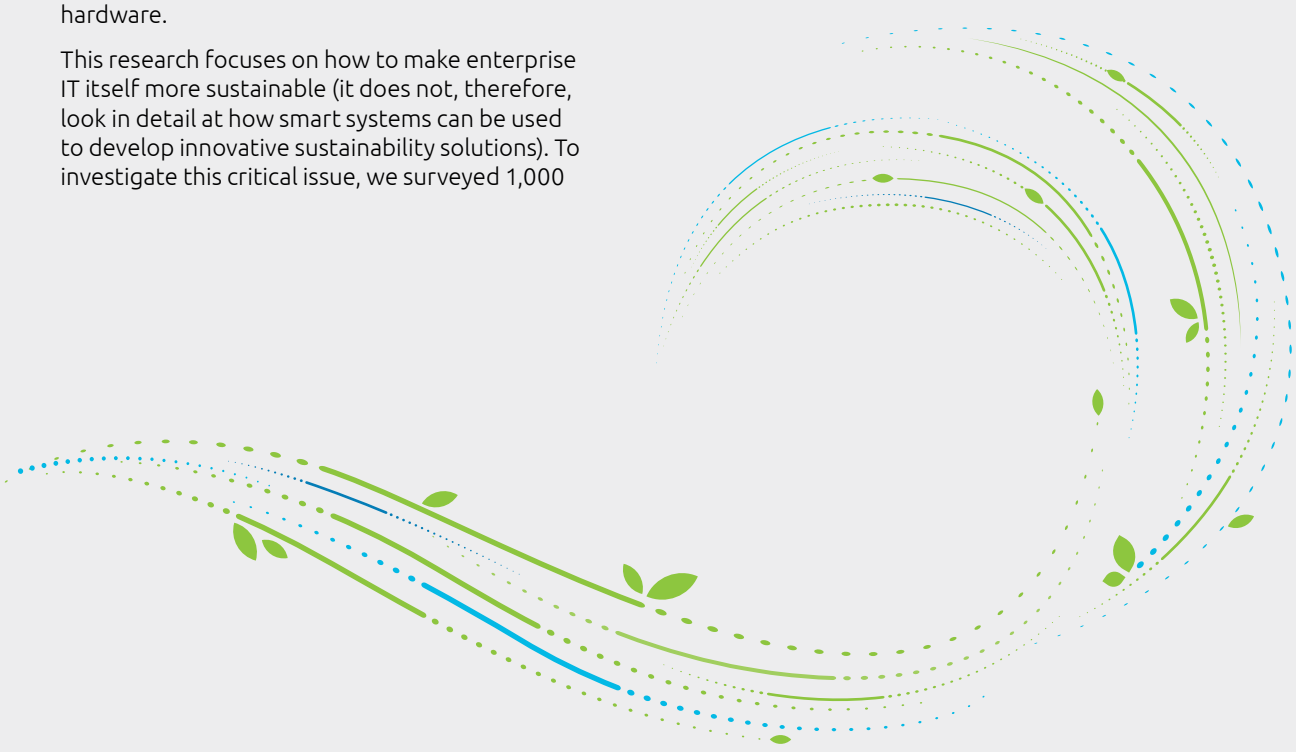
Introduction

As organizations around the world look to balance their growth objectives with the need to build sustainable businesses, it is important to ensure that balance extend to the use of technology as well. While tech solutions can help solve environmental issues, IT as a whole, has a significant carbon footprint itself. For instance, data centers represented nearly 1% of the world's energy demand in 2019.[1] And the digital acceleration that we have seen during the COVID-19 pandemic will further increase the enterprise IT carbon footprint.

The tech industry is urgently addressing this critical issue. For example, Microsoft is experimenting with approaches that help reduce the energy requirements of data centers. Microsoft's Project Natick, for instance, aims at testing the performance and energy efficiency of underwater data centers.[2] But this focus on sustainable IT does not seem to be important for most organizations. We found, for instance, that 89% of organizations recycle less than 10% of their IT hardware.

This research focuses on how to make enterprise IT itself more sustainable (it does not, therefore, look in detail at how smart systems can be used to develop innovative sustainability solutions). To investigate this critical issue, we surveyed 1,000 organizations with annual revenues in excess of USD1 billion to understand their outlook when it comes to sustainable IT. We also interviewed senior IT executives, sustainability professionals, as well as senior executives from core functions such as human resources, finance, and marketing. In this research, we address the following questions:

1. What is the impact of enterprise IT on the environment and how is it growing?
2. To what extent are organizations aware of the environmental impact of IT?
3. Are organizations prioritizing sustainable IT?
4. What are the benefits of implementing sustainable IT initiatives and what are the key use cases that organizations should focus on?
5. What is the roadmap for organizations to accelerate the implementation of sustainable IT initiatives?



Executive summary

Enterprise IT contributes significantly to the world's carbon footprint

- In 2019, 53.6 million tons of e-waste were generated worldwide – an increase of 21% in five years.[3]
- 89% of organizations recycle less than 10% of their IT hardware.

But despite significant growth in the carbon footprint of IT, sustainable IT is not a priority for most organizations...

- Globally, only 43% of executives say they are aware of their organization's IT footprint.
- 50% of firms say they have an enterprise-wide sustainability strategy, but only 18% have a comprehensive sustainable IT strategy with well-defined goals and target timelines.

...and adoption and deployment of solutions is undermined by a lack of tools and expertise

- 49% say a major challenge, when it comes to implementing sustainable IT initiatives, is the lack of tools or standards/ratings to evaluate the carbon footprint of IT
- 53% say they do not have the required expertise for sustainable IT implementation.

As a result, organizations are missing out on a significant performance opportunity

- Only 6% of the organizations in our survey can be classified as highly mature when it comes to sustainable IT
- 61% of those highly mature companies have improved their ESG (environmental, social and governance) score and brand image
- 56% have improved customer satisfaction.

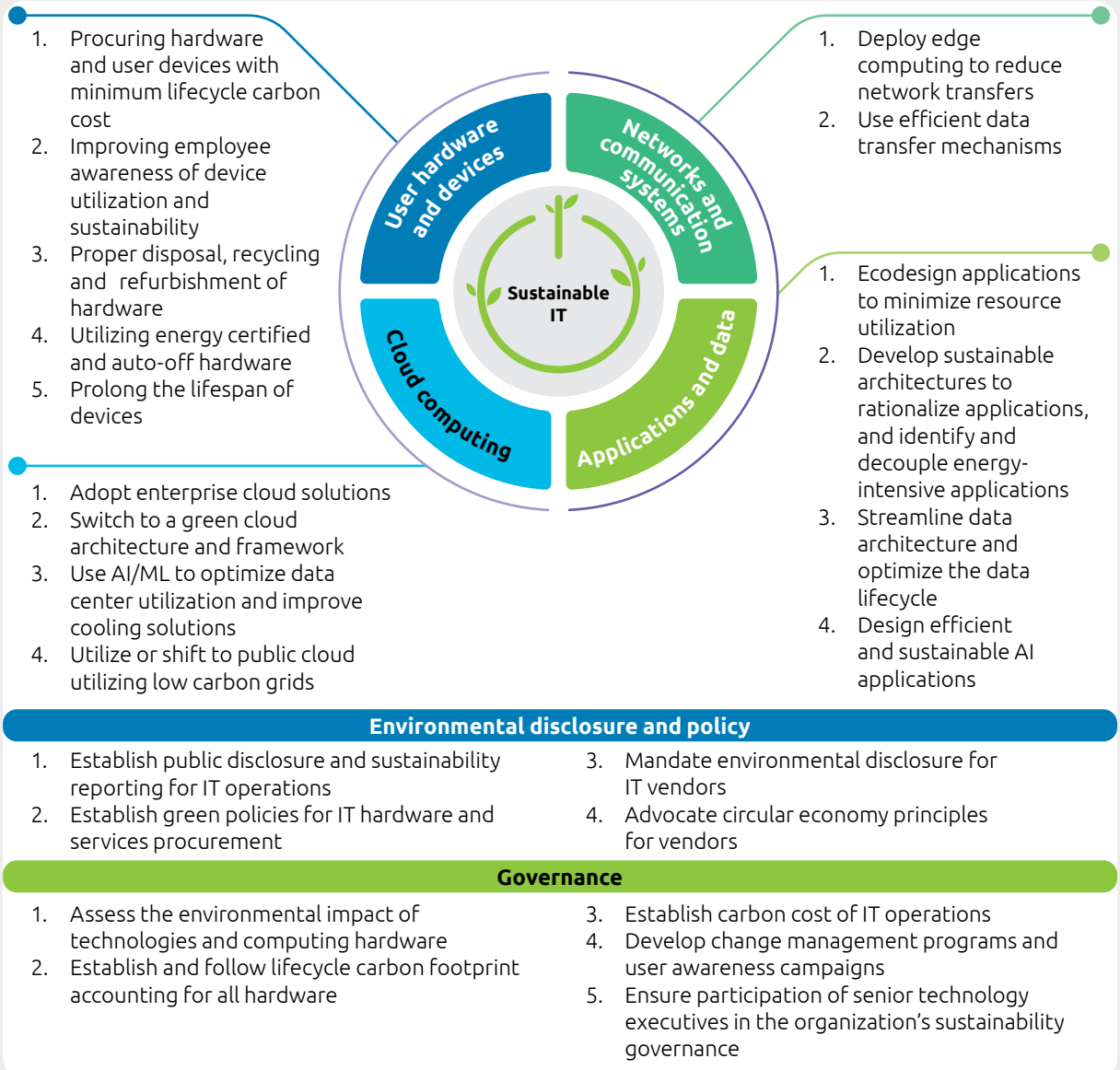
A three-stage roadmap is key to driving progress and seizing the sustainable IT prize

1. Set the foundations with a qualitative and quantitative diagnostic assessment and a sustainable IT strategy that aligns with the organizational sustainability strategy
2. Create a robust governance approach with a dedicated sustainable IT team and support from the top leadership team
3. Operationalize sustainable IT initiatives, with sustainability a key pillar of software architecture.

Defining sustainable IT

Sustainable IT is an umbrella term that describes an environment-focused approach to the design, use, and disposal of computer hardware and software applications and the design of accompanying business processes. The term also extends to activities such as responsible mining of rare metals used to develop IT hardware, water conservation, and the application of circular economy principles across the technology lifecycle. Our research spans all areas of enterprise IT, including user hardware and devices, networks and communication systems, applications and data, and cloud computing (see Figure 1). We look at key aspects of sustainable IT in each of these areas including the application of ecodesign principles and the design of sustainable IT architectures. We also focus on organizational reporting related to environmental disclosures and the governance of sustainable IT initiatives.

Figure 1: Sustainable IT – applying an environment-focused approach across the enterprise IT landscape



Source: Capgemini Research Institute.

Why sustainable IT matters

The environmental impact of enterprise IT is a growing area of concern

The rising demand for computing power and data storage poses a significant environmental challenge. The number of connected devices is expected to reach 55.7 billion by 2025, of which 75% will be connected to an IoT platform.[4] The data generated by connected IoT devices is expected to grow fourfold, from 18.3 zettabytes in 2019 to 73.1 zettabytes by 2025.[5] The storage and processing of this data will in turn lead to increased demand for data centers. A major cloud computing solution provider's operation footprint, for instance, increased 4.31 times from 2015 to 2019.[6] The growth in data volumes will also lead to growing adoption of technologies, such as AI, which are critical to drawing value from massive stores of data. Our previous research has shown that the adoption of AI across organizations has been rising steadily with more than one in two organizations (53%) moving beyond pilots or proofs of concept in a few or more use cases.[7]

All of these factors are contributing to the growing carbon footprint of enterprise IT. We look at each of these in detail below:

Data centers: Data center operations are energy intensive. In 2019, data centers accounted for nearly 1% of the world's energy demand.[8] In the US, data centers are responsible for 2% of the country's electricity use.[9] Some of the world's largest cloud hyper-scalers have taken significant steps towards powering their data centers with renewable energy. Microsoft, for instance, has announced plans to switch to 100% renewable energy to run its data centers by 2025.[10] Google also plans to shift completely to carbon-free energy by 2030 to power its data centers.[11] However, barring such actions from some organizations, the majority of data centers are still largely powered using fossil fuels. Only 17% of organizations in our survey, for instance, have deployed measures to use green energy sources in their data centers.

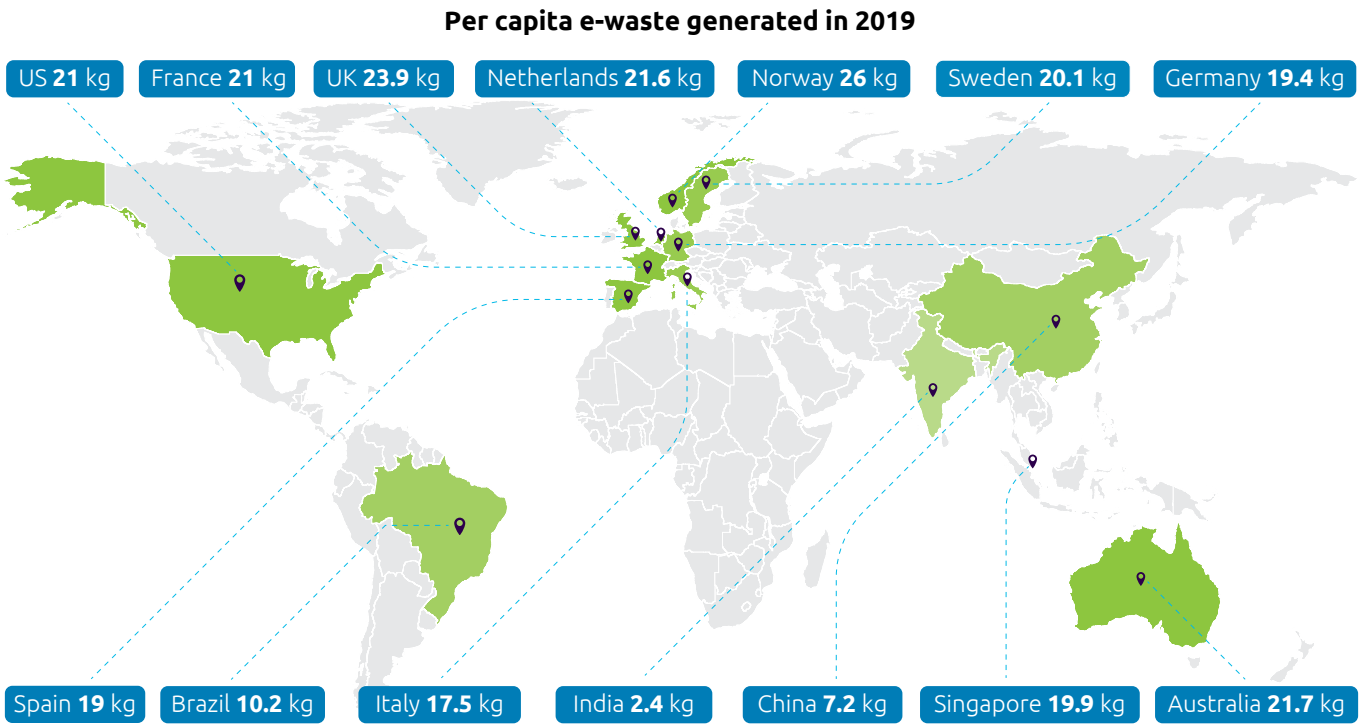
User devices: The production and disposal of electronic devices have a significant environmental impact. The extraction of metals used to manufacture smartphones, for instance, is linked with ecological destruction and generates large volumes of toxic waste. In addition, many of the rare metals used to manufacture smartphones are finite resources.[12] Overall, estimates indicate that the carbon cost of producing these devices is nearly equal to, or exceeds the carbon cost of using them.[13] Extending the lifespan of electronic devices is therefore critical. Netherlands-based phone manufacturer, Fairphone, for instance, offers sustainably designed phones whose modular components allow them to be easily repaired,[14] increasing their longevity.

Hardware disposal also poses a significant threat to the environment. E-waste contains toxic substances that are hazardous to human health and the environment. In 2019, 53.6 million tons of e-waste were generated worldwide – an increase of 21% in five years (see Figure 2). The volume of e-waste is expected to grow to 74 million tons by 2030.[15] Proper disposal of e-waste is therefore critical. However, current levels of e-waste recycling fall far short. Only 17.4% of global e-waste generated in 2019 was recycled.[16] Our research also shows that current recycling levels are very low. The vast majority (89%) of organizations we surveyed recycle less than 10% of their IT hardware.

89%

of organizations recycle less than 10% of their IT hardware.

Figure 2: E-waste is a growing sustainability issue



The volume of e-waste generated globally is expected to grow from 53.6 million tons in 2019 to 74 million tons in 2030

Source: Global E – waste Statistics Partnership[17]

Figure 3: A glance at the enterprise carbon footprint of leading firms

Major cloud computing solution provider – carbon footprint of operations[T]	**295 thousand metric tons of CO_2e** in **2019 4.31** times increase from **2015**	64 thousand cars on the road for a year
Leading consumer electronics manufacturer – carbon footprint of end-user devices*	**24 $MtCO_2e$** in **2019**	6.1 coal-powered plants for a year
Global telecom service provider – carbon footprint of telecom operations[T]	**1.3 $MtCO_2e$** in **2019**	236 thousand homes powered for a year

*Covers assembly, transportation, utilization and refurbishment of end-user devices.[T] Including Scope 1 and Scope 2 emissions, market-based

Source: Carbon Disclosure Project and the United States Environmental Protection Agency.

Artificial intelligence: While AI has huge potential to be at the heart of climate action and help combat climate change, it also carries its own carbon footprint. While it needs to be recognized that natural language processing (NLP) models are among the largest AI models (given their objective of mastering the human language),[18] a study found that training an AI language processing system produced 1,400 pounds of carbon-equivalent emissions – about the amount produced by flying one person roundtrip between New York and San Francisco.[19]

In previous research, we estimated the GHG footprint of key AI use cases (see Figure 4).[20] Our analysis showed that the GHG emissions produced in training and executing AI systems vary widely, from a few grams of CO_2 equivalent to a few kilograms, which is small compared to the overall GHG footprint of a large organization. However, with growing adoption of AI, organizations will need to be mindful of AI's carbon footprint and take measures to design and deploy sustainable AI applications.

Figure 4: The GHG footprint of a sample of AI applications

AI use case	GHG emissions produced in...		Average organization emissions
	Build/training phase	Run/execution phase	
Image recognition system for quality control at a plant	**10 kg** of CO_2 eq.	**0.3 kg** of CO_2 eq.	**6 million tons of CO_2 eq.** – the average annual Scope 1 emissions for a top 30 consumer products manufacturer.
AI-based optical character recognition for a large energy company	**0.78 kg** of CO_2 eq.	**0.96 kg** of CO_2 eq.	**40 million tons of CO_2 eq.** – Scope 1 emissions for a large oil & gas major in Europe.

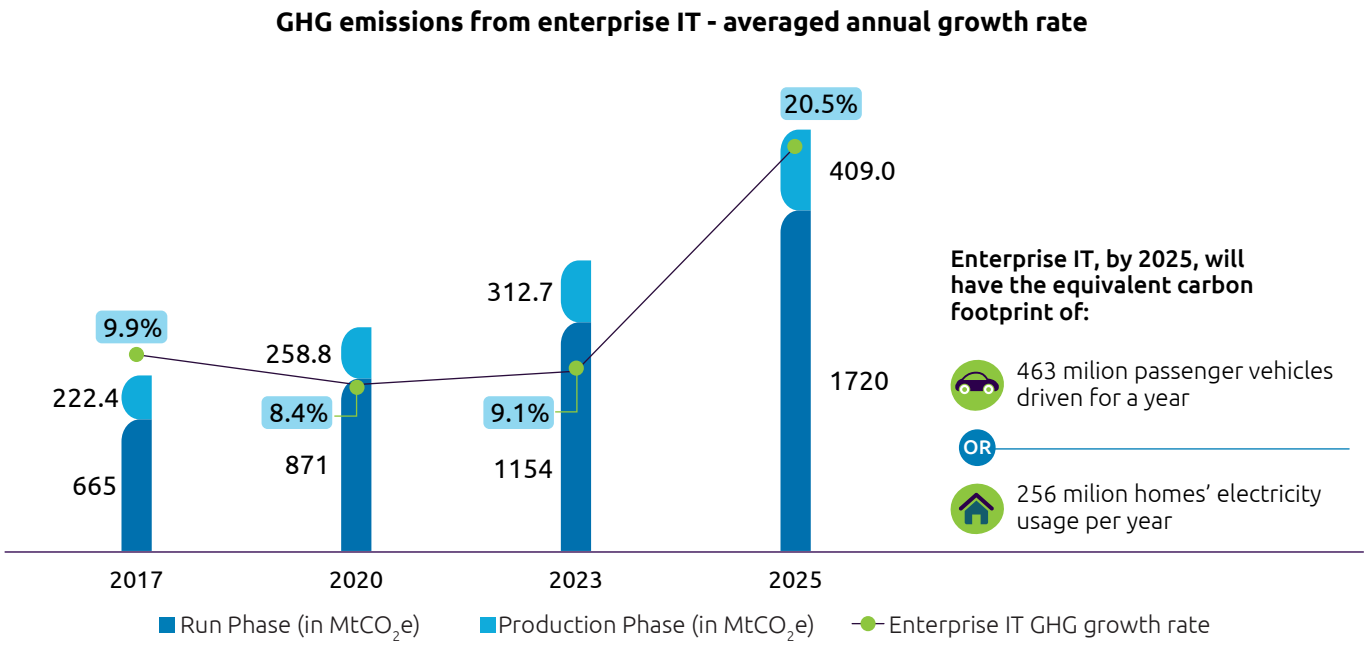
Source: Capgemini Research Institute Analysis*. Carbon Disclosure Project, Climate Change 2019 reports submitted by large organizations across sectors.

**The analysis was conducted as part of our previous research on the use of AI to drive climate action. The analysis aimed at ascertaining the GHG footprint of some of the popular AI use cases. The factors that were used to arrive at these analyses were: duration of the process, average power drained, cooling consumption factor, and unit conversion factor.*

The enterprise IT carbon footprint is expected to grow significantly

As organizations continue to invest in digital technologies, the enterprise IT carbon footprint is set to expand as well (see Figure 5 on the growth rate of enterprise IT GHG footprint). However, organizations do not view this as an area of concern: 78% plan to reduce less than one-fourth of their carbon footprint through sustainable IT in the next three years without carbon offsets.

Figure 5: CO_2 equivalent emissions due to enterprise IT are increasing



Sources: The Shift Project, "Lean ICT–Towards Digital Sobriety." The forecast as based on expected evolution/growth of enterprise IT (for calculation see below*).[21] Forecast years are from 2020 onwards. $MtCO_2e$ stand for mega tons of CO_2 equivalent GHG emissions.

*Using the "Expected Scenario" outlined in the report titled "Lean ICT – Towards Digital Sobriety" by the Shift Project, we estimated the growth rate of the enterprise IT GHG footprint. For the purposes of this calculation, we assumed that 40% of all shipped desktops, laptops, and monitors, 5% of all smartphones, and 10% of all tablets are used by enterprise users.

In the next section, we look at the level of awareness among organizations regarding the environmental impact of IT and the steps being taken towards sustainable IT.

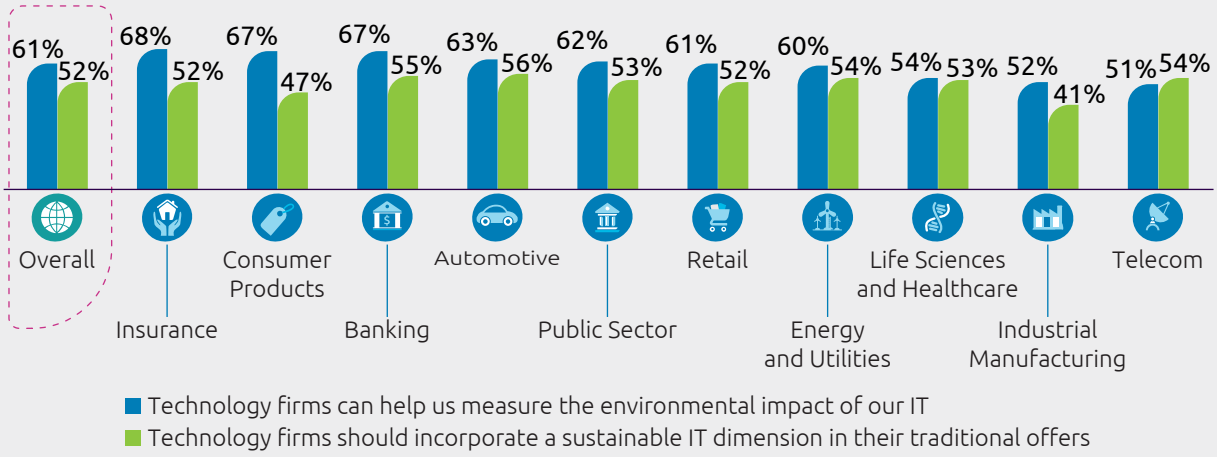
Many organizations are looking to the tech industry to help them drive sustainable IT

Perhaps reflecting the lack of maturity in many organizations, companies across sectors are looking to the tech industry to lead the charge when it comes to sustainable IT. Our research shows that they want technology vendors to drive sustainable IT as part of their value proposition and are willing to pay more for sustainable IT products and services:

As Figure 6 shows, 52% say technology firms should incorporate a sustainable IT dimension in their products and services and 61% want tech firms to help them measure the environmental impact of their IT.

Close to half (48%) say technology firms should be setting standards and deciding the norms for sustainable IT and close to a quarter (23%) have rejected technology vendors who do not adhere to their sustainability procurement rules (i.e., the environmental issues that companies insist vendors follow if they want to sell a technology product or service). 90% of organizations in France and UK believe that technology firms can help them measure the environment impact of IT.

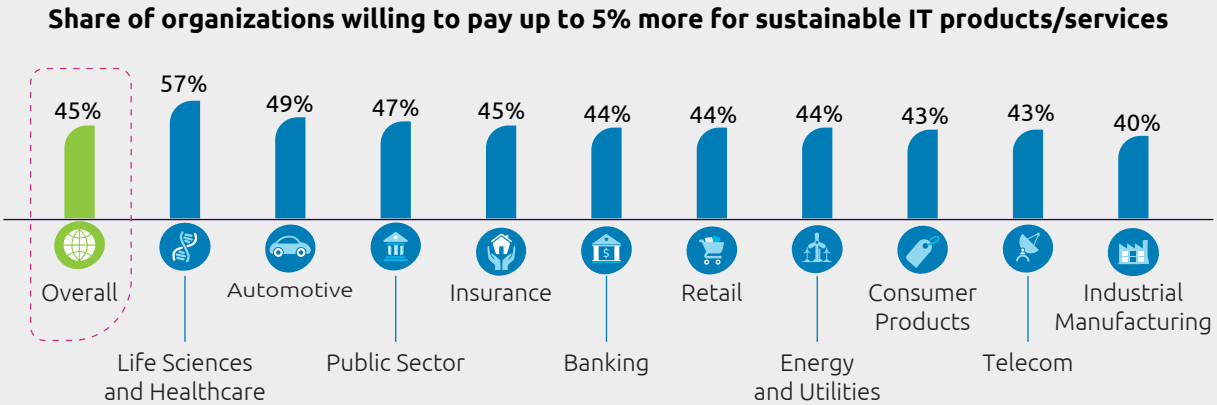
Figure 6: Organizations have high expectations from technology firms



Source: Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N=915 organizations.

The business case for the tech industry of meeting this demand is also clear. Overall, 45% of organizations are willing to pay a premium of up to 5% for sustainable IT products and services (see Figure 7).

Figure 7: 45% of organizations are willing to pay up to 5% more for sustainable IT



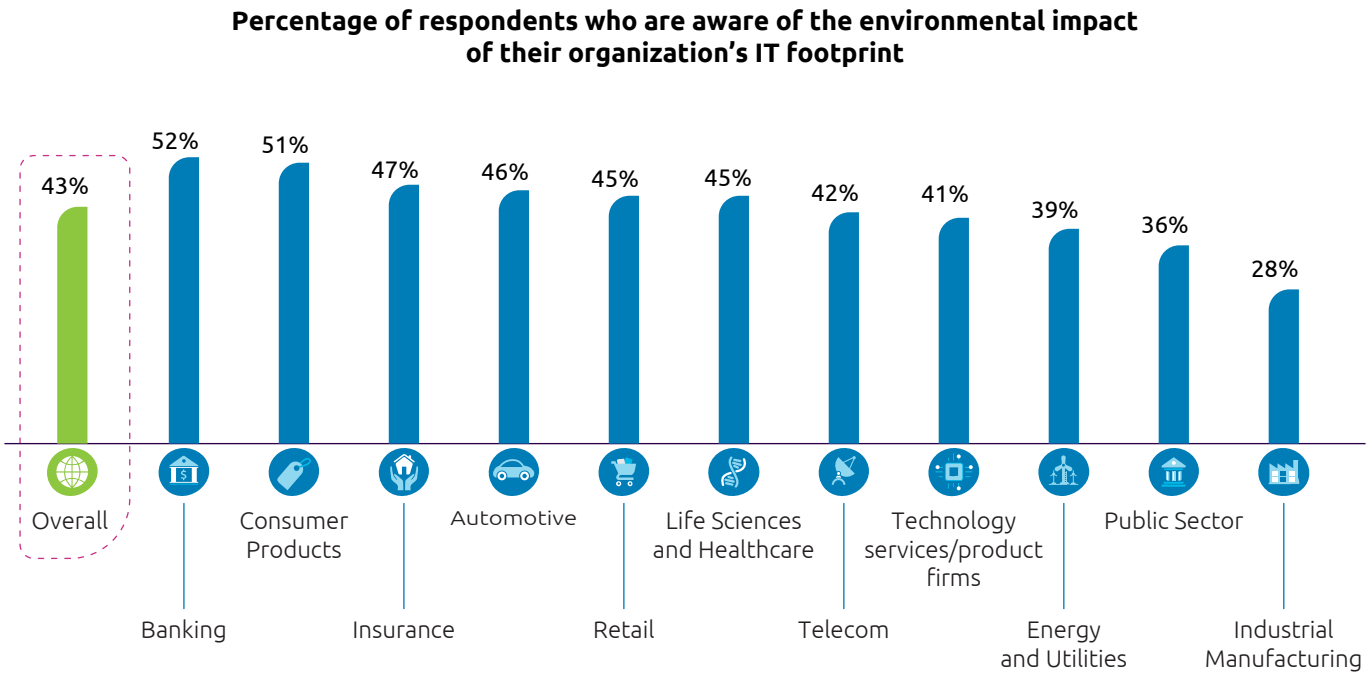
Source: Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N = 915 organizations.

Despite the growing IT carbon footprint, sustainable IT is not a priority for most organizations

Organizations are largely unaware of the environmental impact of IT

Our research revealed gaps in awareness regarding the overall environmental impact of IT. For instance, only 34% are aware that the production of mobiles and laptops has a higher carbon footprint than the usage of these devices over their lifetime. Awareness of a company's own IT carbon footprint is also lacking. Globally, less than half of executives (43%) say they are aware of their organization's IT footprint. The level of awareness varies by sector: the banking and consumer products sectors for instance show relatively higher levels of awareness, while the industrial manufacturing sector shows the lowest level of awareness among the sectors covered in our research (see Figure 8).

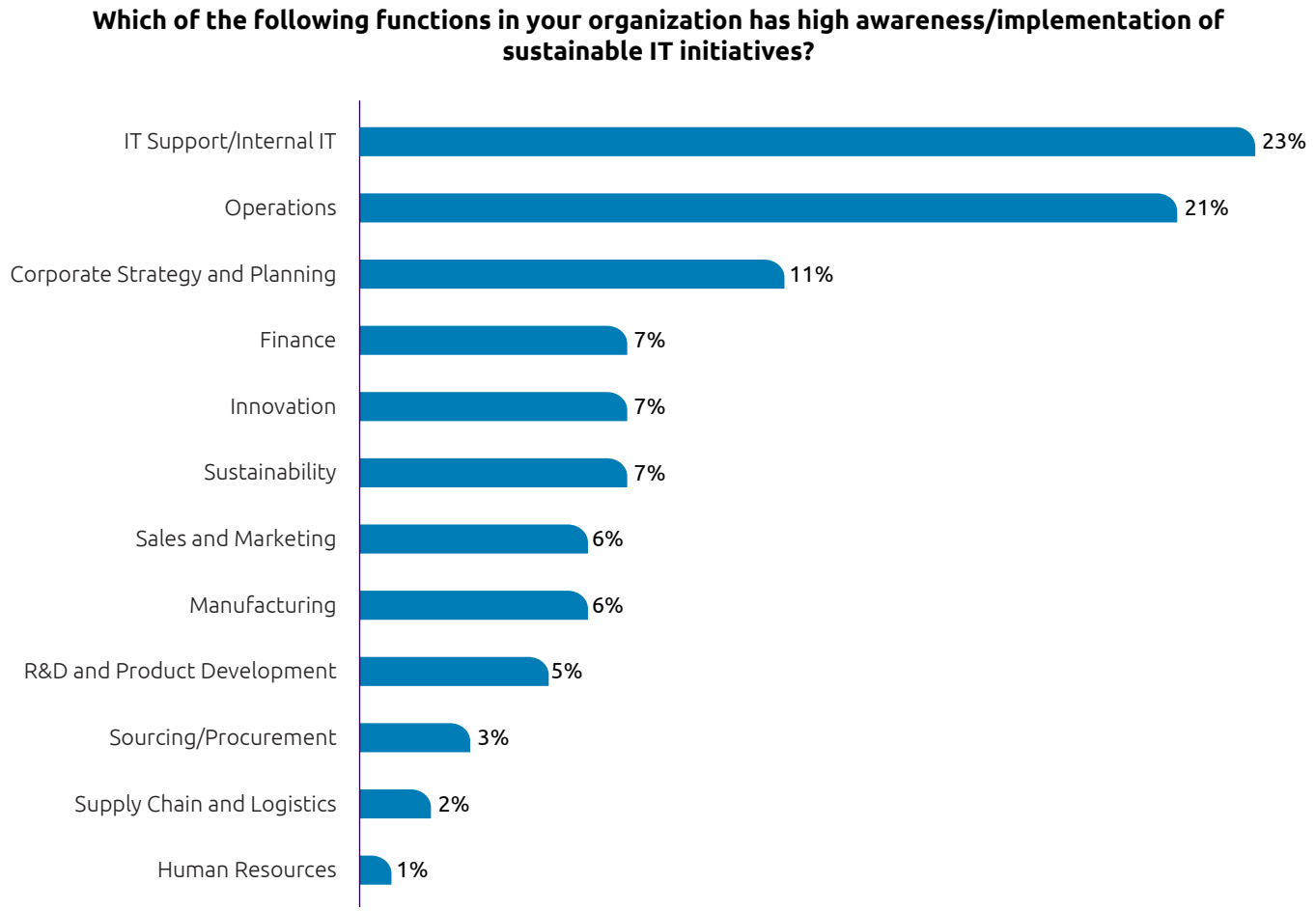
Figure 8: Gaps in awareness regarding the environmental impact of organizations' IT footprint



Source: Capgemini Research Institute, Green IT survey, December 2020 – January 2021, N = 1000 organizations.

As Figure 9 shows, executives feel non-IT functions in the business need to build their sustainability IT awareness. We asked respondents to nominate the one function in the business that has the highest sustainable IT awareness. While the IT function, perhaps not surprisingly, is ranked number one when it comes to awareness, HR is at the bottom.

Figure 9: Ranking of business functions by sustainable IT awareness



Source: : Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N=1,000 organizations.

50% of firms say they have defined an enterprise wide sustainability strategy, however only 18% say they have a comprehensive sustainable IT strategy

Sustainable IT is disconnected from the wider sustainability agenda

While half of firms say they have defined an enterprise-wide sustainability strategy, less than one in five (18%) say they have a comprehensive sustainable IT strategy with well-defined goals and target timelines. Figure 10 shows that this is an issue across multiple sectors.

Figure 10: Across sectors, organizations lack an overarching sustainable IT strategy

Source: Capgemini Research Institute, Green IT survey, December 2020 – January 2021, N = 1000 organizations.

On a geographic level, the gap is most pronounced in the UK, where 74% say they have an enterprise-wise sustainability strategy, but only 19% have an enterprise-wide sustainable IT strategy. In contrast, organizations in the US report a much narrower gap: 41% say that their organizations have a sustainability strategy and 36% say they also have a comprehensive sustainable IT strategy.

For many, sustainable IT is a work in progress: 62% are still working on developing their strategy and 19% have a local approach but have not achieved enterprise-wide scale.

Opportunities to reduce enterprise IT's carbon footprint not being seized

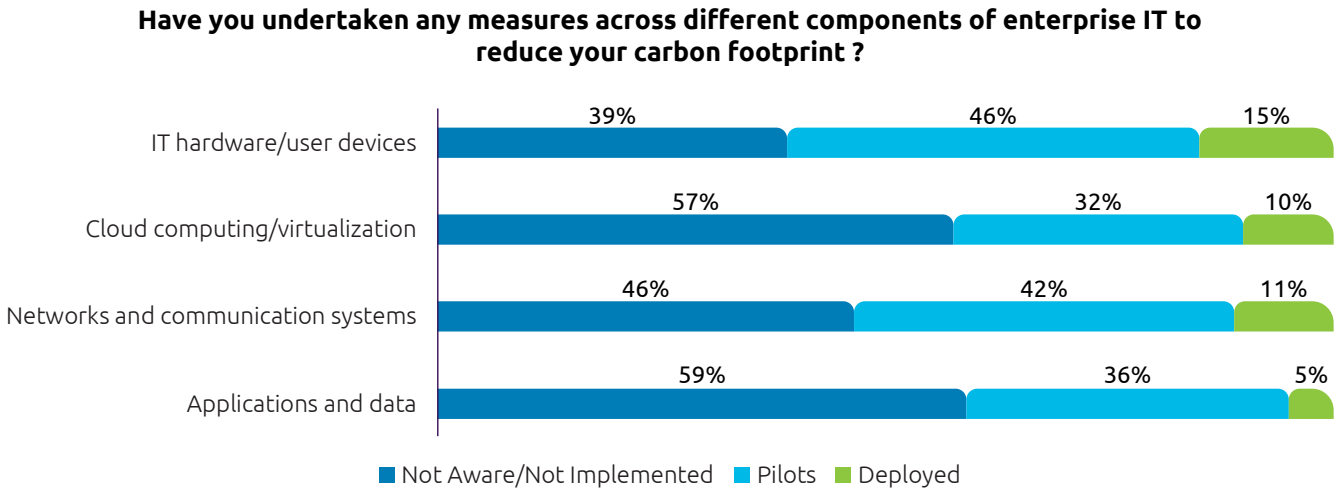
This section examines:

1. The extent to which organizations have implemented measures to reduce their carbon footprint across their enterprise IT landscape.
2. The extent to which organizations have established the necessary governance mechanisms and environmental disclosure policies needed to support these measures.

1–Implementation progress

As Figure 11 shows, scaled implementation of carbon reduction solutions is rare. Only 15%, for example, have taken steps to reduce the carbon footprint of IT hardware, with 46% only at pilot stage, and 39% taking no action at all.

Figure 11: Low utilization of opportunities to reduce environmental impact of enterprise IT



Source: Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N=1,000 organizations.

User hardware and devices. Despite the enormity of the e-waste problem,[22] many organizations do not treat it as a priority. We found that only 35% measure the environmental impact of disposing of their hardware. Dell, in contrast, has been running a program to reuse plastic recovered from computers that have reached end of life to make new parts.[23]

Applications and data. The application landscape of an organization is often overlooked from a sustainability perspective. We found that only 19% measure the energy impact of the pre-production application environment (the development and testing of applications) and only 21% measure the sustainability impact of the production environment (live applications). Measures such as the use of sustainable application architectures can help organizations rationalize applications and identify and decouple energy-intensive applications. However, 59% of organizations are either not aware of or have not implemented these sorts of architectures.

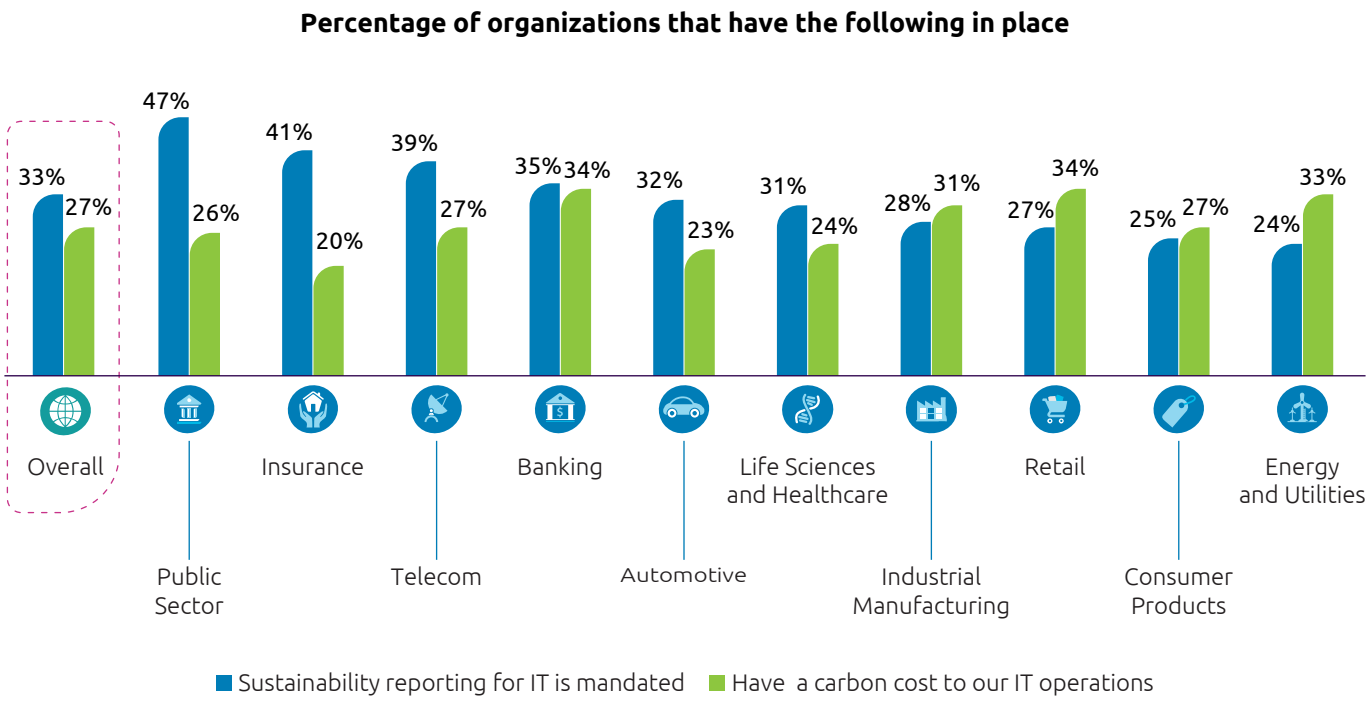
Networks and communication systems. Organizations can also optimize their energy use by adopting more energy efficient data-transfer mechanisms. A shift to edge computing, for instance, can reduce energy use by processing data closer to the source. This reduces the need for data to be transmitted to a data center that may be located several hundred miles away. However, only 15% have deployed edge computing initiatives and 36% are not aware or not implemented these so far.

Cloud computing. Moving from on-premises infrastructure to cloud computing offers significant energy savings.[24] While organizations worldwide are adopting cloud computing, few are aware of its environmental impact. We found that only 19% measure cloud's environmental impact. Further, 60% are not aware of or have not implemented a switch to a green cloud architecture and framework that aims to reduce power consumption. Lance Pierce, president of Carbon Disclosure Project, North America, says, *"When organizations choose low-carbon cloud computing, they are taking an important step forward on sustainability. Sustainable digital transformation, powered by a cleaner cloud, enables the creation of a sustainable and thriving economy that works for people and planet in the long term."*[25]

2–Disclosures and governance

Overall, only a third of organizations have established policies mandating the reporting of the enterprise IT carbon footprint (see Figure 12). In addition, most organizations do not extend disclosure requirements to their vendors. Effective reporting is also difficult when few organizations (27%) have established the carbon cost of their IT operations, with only 29% using carbon assessment tools.

Figure 12: Few organizations have a robust approach to reporting and KPIs/measures



Source: Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N=1,000 organizations.

In most organizations, the governance mechanisms for sustainable IT initiatives – such as committed top leadership support and user awareness programs – are lacking. For instance, only 34% say that sustainable IT is part of their board level agenda and only 39% have a governance body to oversee sustainable IT. Further, only half say that their CIOs are part of their organization's sustainability governance team. This indicates that, in many organizations, the IT function is not necessarily seen as a key stakeholder in driving the overall sustainability agenda.

33%

of organizations have established policies mandating the reporting of the enterprise IT carbon footprint

Why are organizations not prioritizing sustainable IT?

Complexity of common standards or ratings by IT vendors to measure impact on environment

Many organizations find it difficult to measure their IT's carbon footprint: 49% said this is because they do not have access to the tools – and common measurement standards or ratings – needed to tackle what is a multi-layered issue. All digital interactions – such as email, video or voice calls, data storage and sharing – have an associated carbon cost. But, many are not aware of this fact as it is not commonly known or routinely published. A senior executive for environmental sustainability adds, *"The energy impact of infrastructure, like a boiler, has been studied so well that organizations are very clear on the carbon impact. But that is not true of IT infrastructure yet. I think the IT industry has to come up with green labeling for their products, which would then make it easier for companies like us to make greener purchase decisions."*

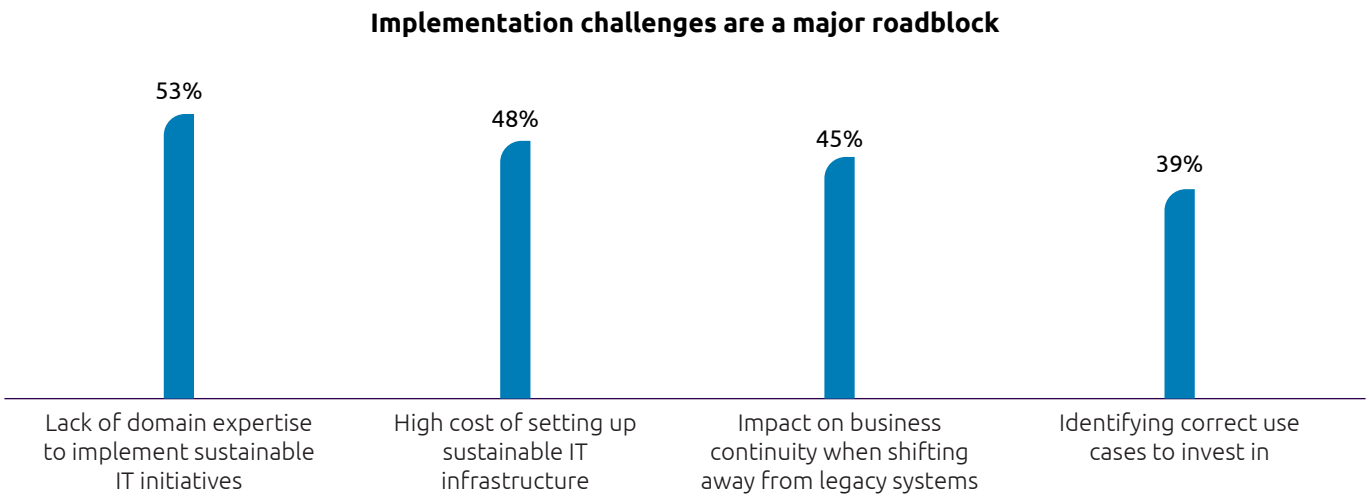
Additional research on the carbon footprint associated with both the manufacture and use of IT hardware is essential. Ian Whitfield – CEO of RED, part of Engine Impact, a firm focusing on accelerated sustainability transformation for corporations, cities and governments – has said, *"To tackle the challenges of carbon footprint, two things are needed. First, more research is required to understand the real carbon footprint of the various materials used in a data center. Secondly, the way in which materials are used needs to advance to improve performance and reduce footprint. The key to understanding a data center's embodied carbon footprint lies in establishing the footprint of each component used to build the facility and their origin."*[26]

Implementation challenges are a major roadblock for sustainable IT

Implementation issues are still a major challenge for sustainable IT, ranging from organizations lacking the expertise to implement to concern that deploying sustainable IT could compromise business continuity. As Figure 13 shows, over half (53%) say they do not have the required expertise and 48% are concerned about the high cost of setting up green infrastructure.

A senior executive for environmental sustainability said that perception issues affect how some organizations see the impact of sustainable IT deployment on continuity of operations and security. *"Production IT infrastructure plays such a critical role in day-to-day operations as well as in data security,"* he explains. *"Therefore, there is a fear that you don't want to take a risk with any. The idea is that you are somehow compromising on quality if you go for a greener product. It's more of a perception issue."*

Figure 13: Implementation challenges for sustainable IT



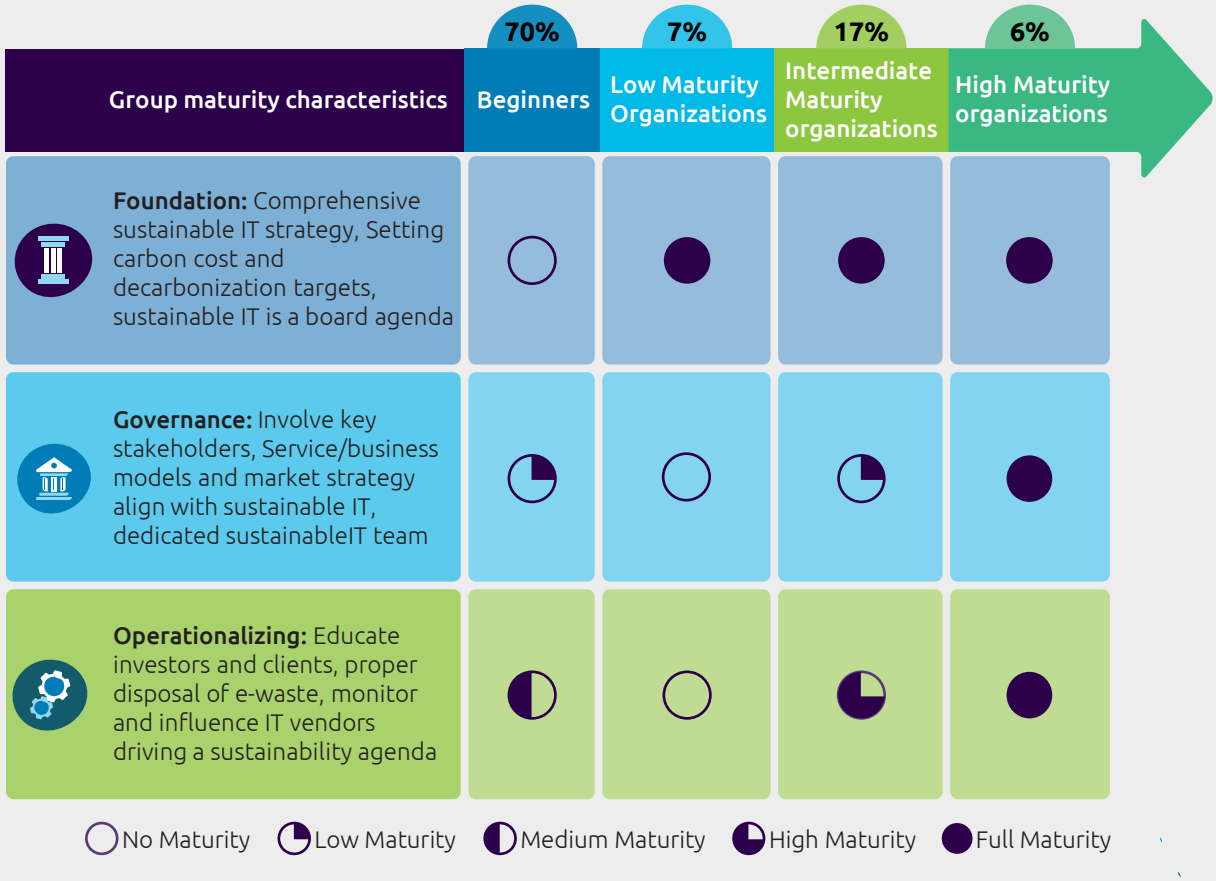
Source: Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N=1,000 organizations.

The benefits of sustainable IT

High maturity organizations deliver significant benefits

We analyzed the maturity of the 1,000 organizations in our cross-sector sample when it comes to sustainable IT, from those who have no mature approach to those who have a highly mature approach. As Figure 14 shows, significant maturity across all three areas – foundational steps, governance, and operationalizing sustainable IT – is rare. Overall, only 6% of organizations (which we call the *High Maturity Organizations)* show maturity in terms of their end-to-end approach for sustainable IT initiatives.

Figure 14: Organizations are at different levels of maturity when it comes to sustainable IT

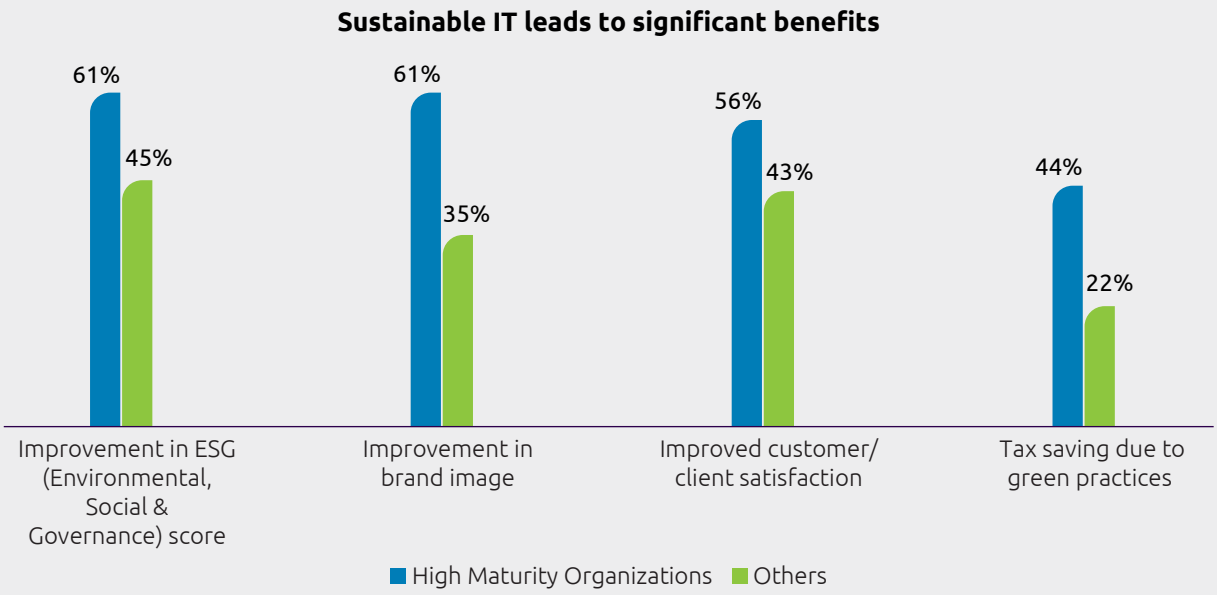


Source: Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N = 1000 organizations.

Organizations that have scaled sustainable IT use cases have achieved, on average, a 12% cost reduction. *High Maturity Organizations* deliver significantly more benefits across multiple parameters compared to other organizations, as Figure 15 shows:

- 61% of *High Maturity Organizations* have improved their ESG (environmental, social, and governance) score and brand image, compared to 45% of other organizations.
- 56% have improved customer satisfaction (vs 43%).
- 44% say green practices deliver tax savings (vs 22%).

Figure 15: Organizations with high maturity across foundational steps, governance and operationalizing sustainable IT initiatives derive considerable benefits



Source: Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N=1,000 organizations.

Which sustainable IT uses cases deliver the most benefits?

We assessed 24 sustainable IT use cases across six categories. The analysis, which is summarized in Figure 16, shows use case adoption and scaling as well as the use case that delivers the most benefits in each category.

The six categories include:

1. **IT hardware/user devices:** The auto switch-off hardware/features use case delivers the highest cost savings (14% on average) from power reduction while reducing carbon in this category. Chandramouli Subrahamanayan, head of IT at Citrix, an American software firm, says, *"We ensure that our sustainability principles are driven through our applications. when our customers use our Virtual desktop infrastructure platform for compute we automatically turn off or use 'send to sleep' mode whenever any computer resources are not being used. Those type of things add a lot more value to the sustainability cause."* According to Christophe Debuysscher, ICT Sustainability Manager at the European Patent Office, *"As an example of one quick-win is with your fleet of printers. When you have several hundreds of them on-premise in your organization and you change the settings of the standby, low power, or sleep modes, this will result in energy savings. With available printer dashboards on energy consumption, accessible to everyone, this is a concrete and 'tangible' thing which everyone can see."*
2. **Cloud computing/virtualization:** Switching to a green cloud architecture and framework has delivered a 19% cost savings among organizations that have been able to scale the solution organization-wide.
3. **Applications and data:** Developing sustainable architectures to rationalize applications, identify and decouple energy-intensive applications offers 11% cost savings. Organizations should audit their applications so they can identify the most energy-intensive applications and take steps to address the worst offenders.
4. **Cooling technique:** Data centers are an organization's second largest consumer of energy, with 35% of this energy taken up by powering cooling equipment. Any initiative that can reduce data center cooling will help to make a significant contribution to carbon reduction.[27] Using machine learning to optimize cooling systems delivers 8% cost savings. Verizon – the American telecommunication organization – has used machine learning for cooling management to save 55 million kilowatt-hours of energy per year across its 24 data centers.[28] The location of data centers also plays a very important role in energy consumption. Microsoft tested an underwater data center, which provides edge connectivity in coastal areas. The sub-surface sea water provides free and continuous cooling, creating an energy-efficient data center design. [29]Among all the use case categories, the most beneficial use case is also the most adopted in this group.
5. **Utilization:** Using AI/ML to optimize data center utilization delivers cost savings of 9% among those who have deployed it. AI/ML have significant potential when it comes to sustainability (see our research on AI for climate action[30]). Optimizing workflows and enabling dynamic scheduling based on renewable power are critical load balancing techniques that AI/ML can deliver. Google shifts execution of non-urgent workloads in their data centers to when low-carbon sources of energy are abundant.[31]
6. **Energy efficiencies and usage:** The cost of running and cooling servers far exceeds the initial price of hardware. It is therefore critical that energy-rated servers like "Energy Star" are mandated in procurement.

"As an example of one quick-win is with your fleet of printers. When you have several hundreds of them on-premise in your organization and you change the settings of the standby, low power, or sleep modes, this will result in energy savings. With available printer dashboards on energy consumption, accessible to everyone, this is a concrete and 'tangible' thing which everyone can see."

Christophe Debuysscher

ICT Sustainability Manager at the European Patent Office

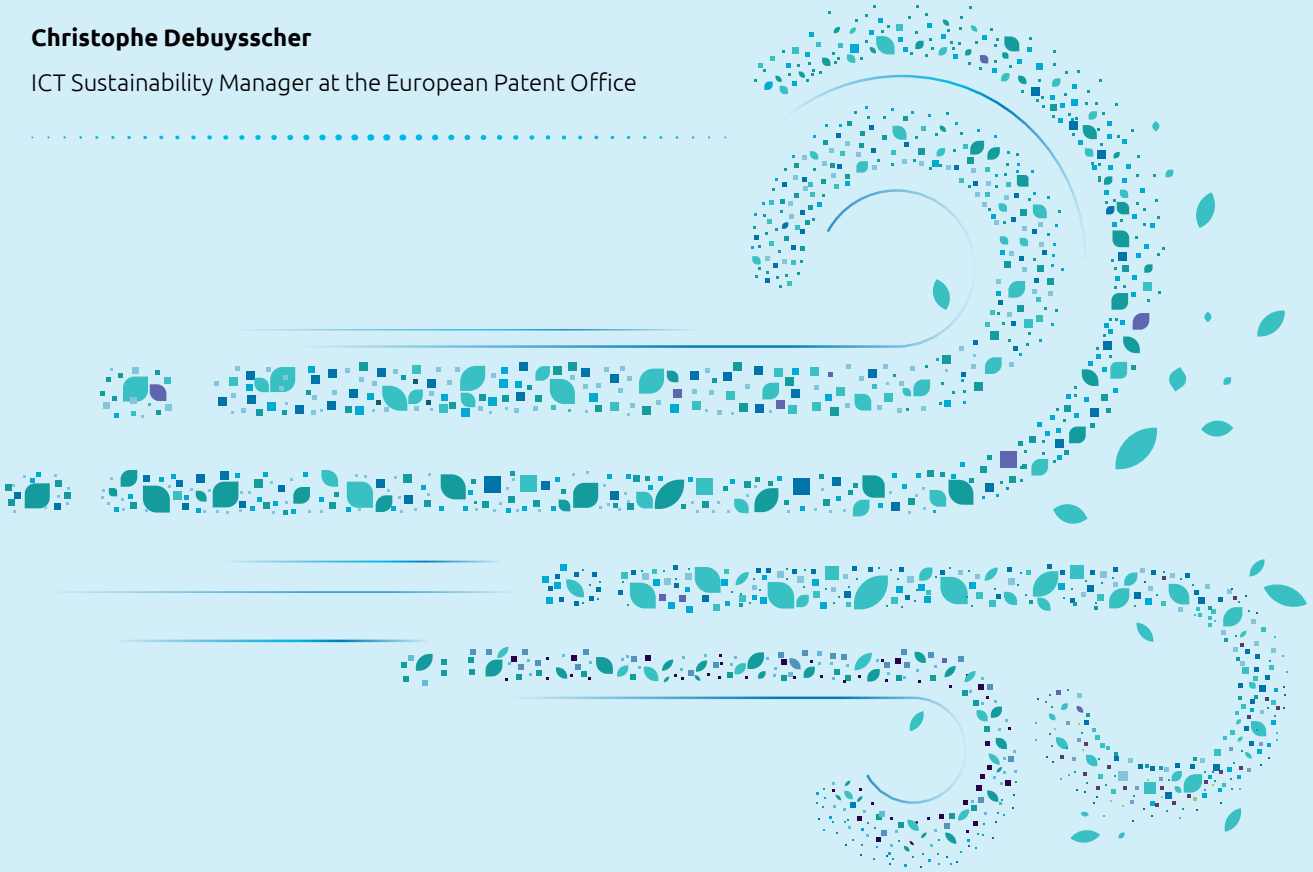
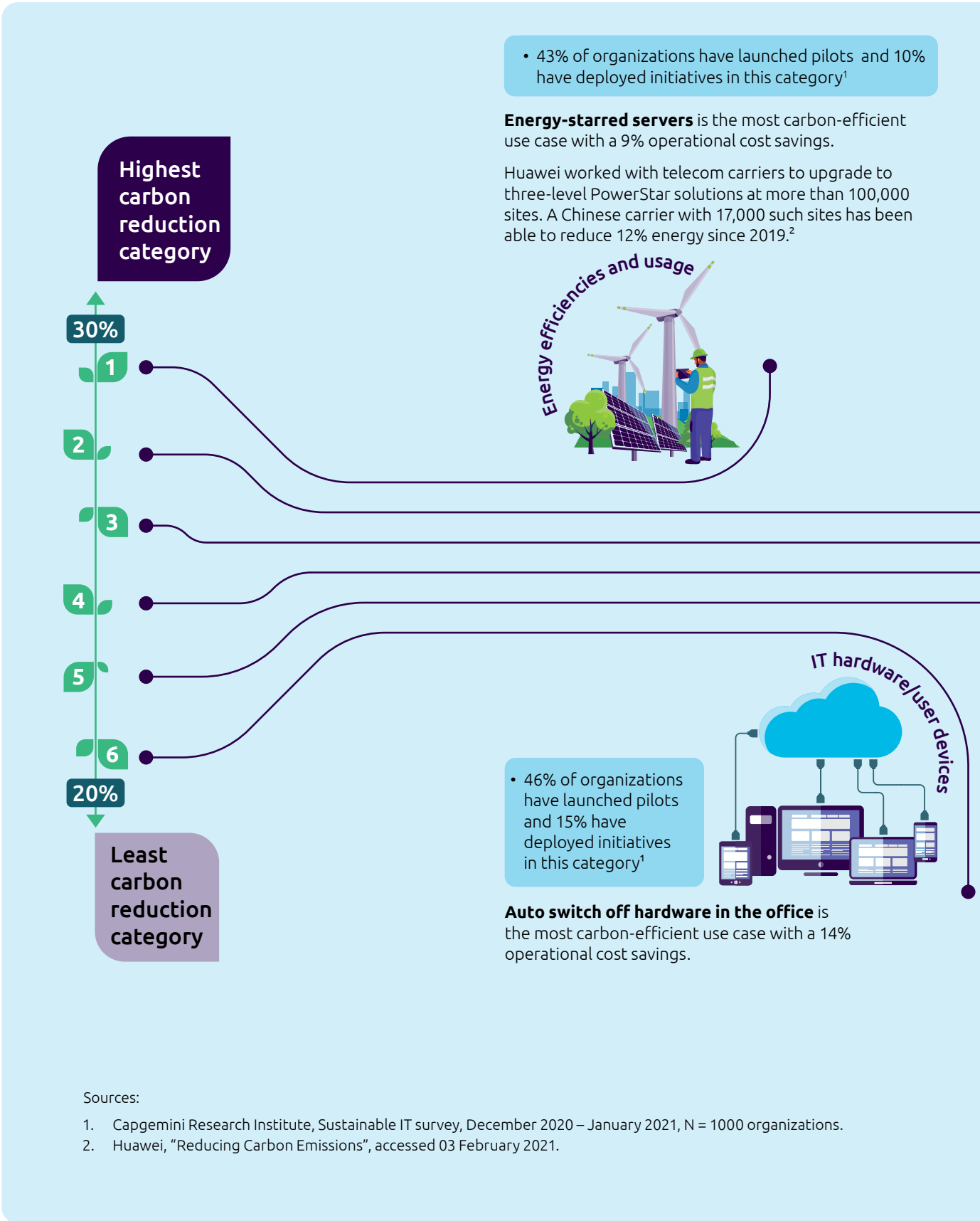


Figure 16: Sustainable IT use cases adoption and benefits across enterprise IT landscape



Sources:

1. Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N = 1000 organizations.
2. Huawei, "Reducing Carbon Emissions", accessed 03 February 2021.

- 36% of organizations have launched pilots and 5% have deployed initiatives in this category[1]

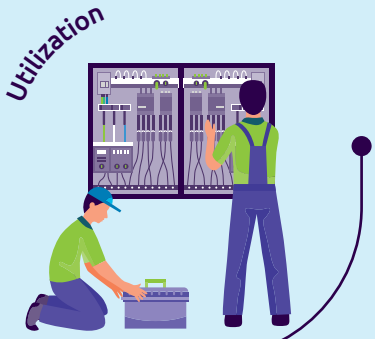
Develop sustainable architecture to rationalize applications is the most carbon-efficient use case with 11% operational cost savings.

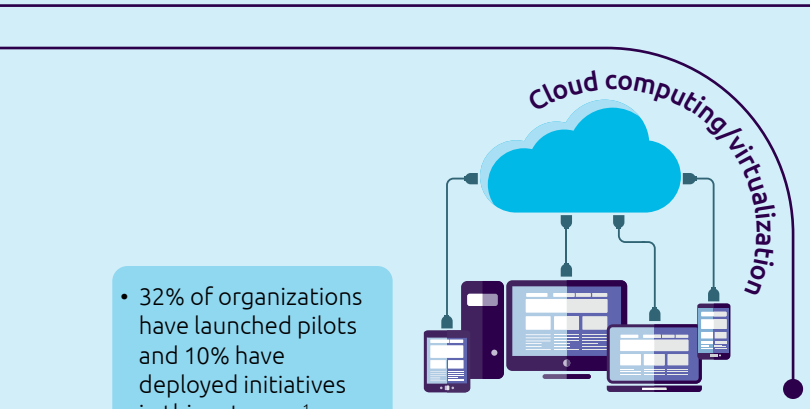
Intel developed the Software Development Assistant, which enables programmers and engineers to take energy measurements from a system as it executes specific workloads.[3]

- 46% of organizations have launched pilots and 12% have deployed initiatives in this category[1]

Machine learning to optimize data center utilization is the most carbon-efficient use case with a 9% operational cost savings.

Google shifts execution of non-urgent workloads in their data centers to when low-carbon sources of energy are abundant.[4]

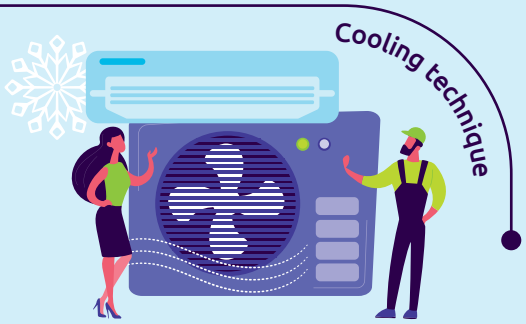




- 32% of organizations have launched pilots and 10% have deployed initiatives in this category[1]

Switch to green cloud architecture and framework is the most carbon-efficient use case with a 19% operational cost savings.

VMwave – the virtualization software provider – has avoided a cumulative 1.2 billion metric tons of CO_2 till 2019 by virtualizing computing requirements.[5]



- 34% of organizations have launched pilots and 4% have deployed initiatives in this category[1]

Using machine learning to optimize cooling systems is the most carbon-efficient use case with an 8% operational cost savings.

Google was able to reduce the amount of energy for cooling by 15%. Using the wealth of data from usage of servers in data centers, Google was able to more efficiently regulate their cooling.[6]

Sources:

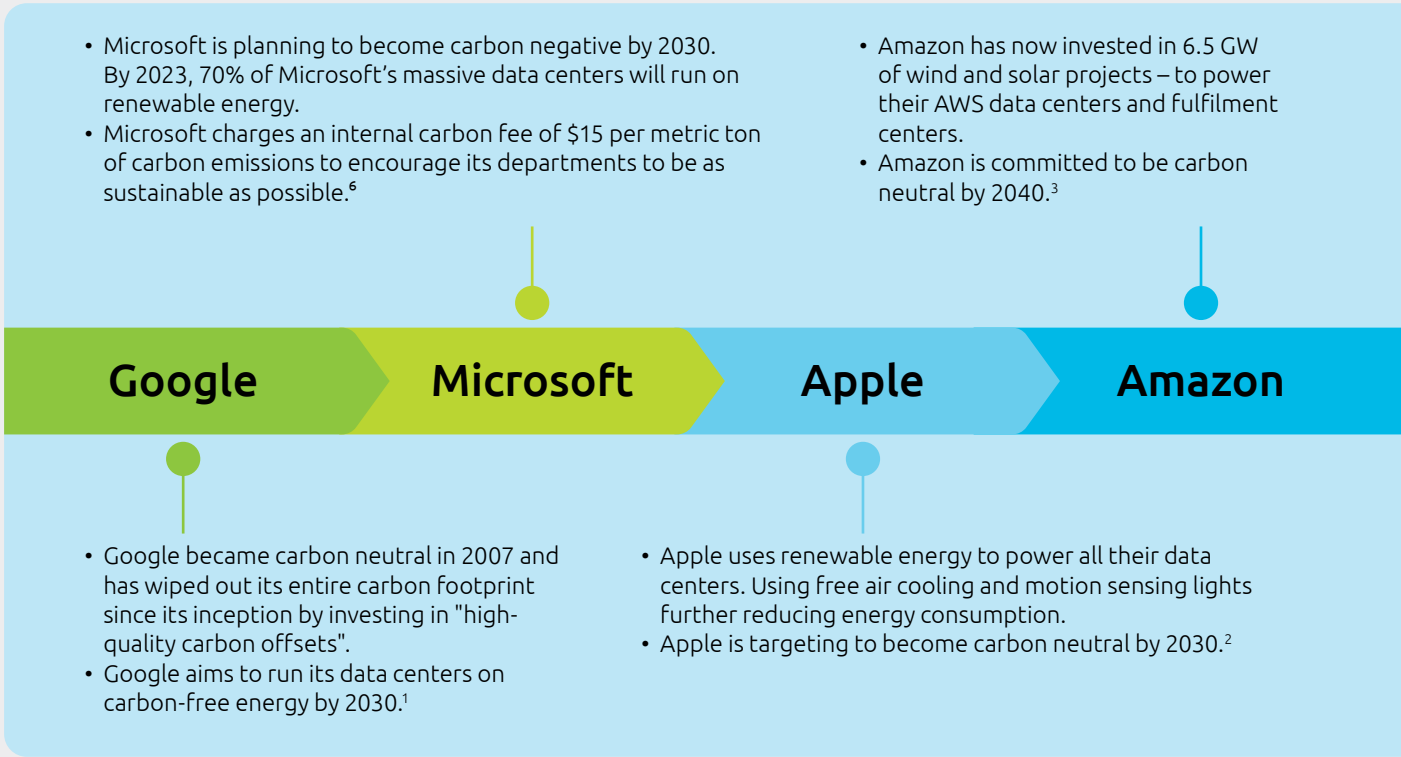
1. Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N = 1000 organizations.
3. Intel, "Energy Efficient Software Development", February 2015.
4. Google blog, "Our data centers now work harder when the sun shines and wind blows," April 22, 2020.
5. VMware, "Sustainability Report – 2019", 17 August 2019.
6. Guardian, "Google uses AI to cut data center energy use by 15%," July 2016

Technology firms are becoming more sustainable

The technology sector is well placed to drive the sustainable IT agenda and also play a role influencing and advocating for policy change globally. Technology firms are taking proactive steps to decarbonize their IT operations, services, and products. Multiple technology firms are implementing sustainable IT initiatives (see Figure 17) and have also announced targets to become carbon neutral:(i)

- Google became carbon neutral in 2007 and has offset its entire carbon footprint since its inception by investing in "high-quality carbon offsets." Google also aims to run its data centers on carbon-free energy by 2030.
- Microsoft is planning to become carbon negative by 2030, promising to remove more carbon from the atmosphere than the company emits.
- Apple is aiming to become carbon neutral by 2030 across its entire business and manufacturing supply chain.

Figure 17: Technology firms leading the way in pledging sustainable IT contribution



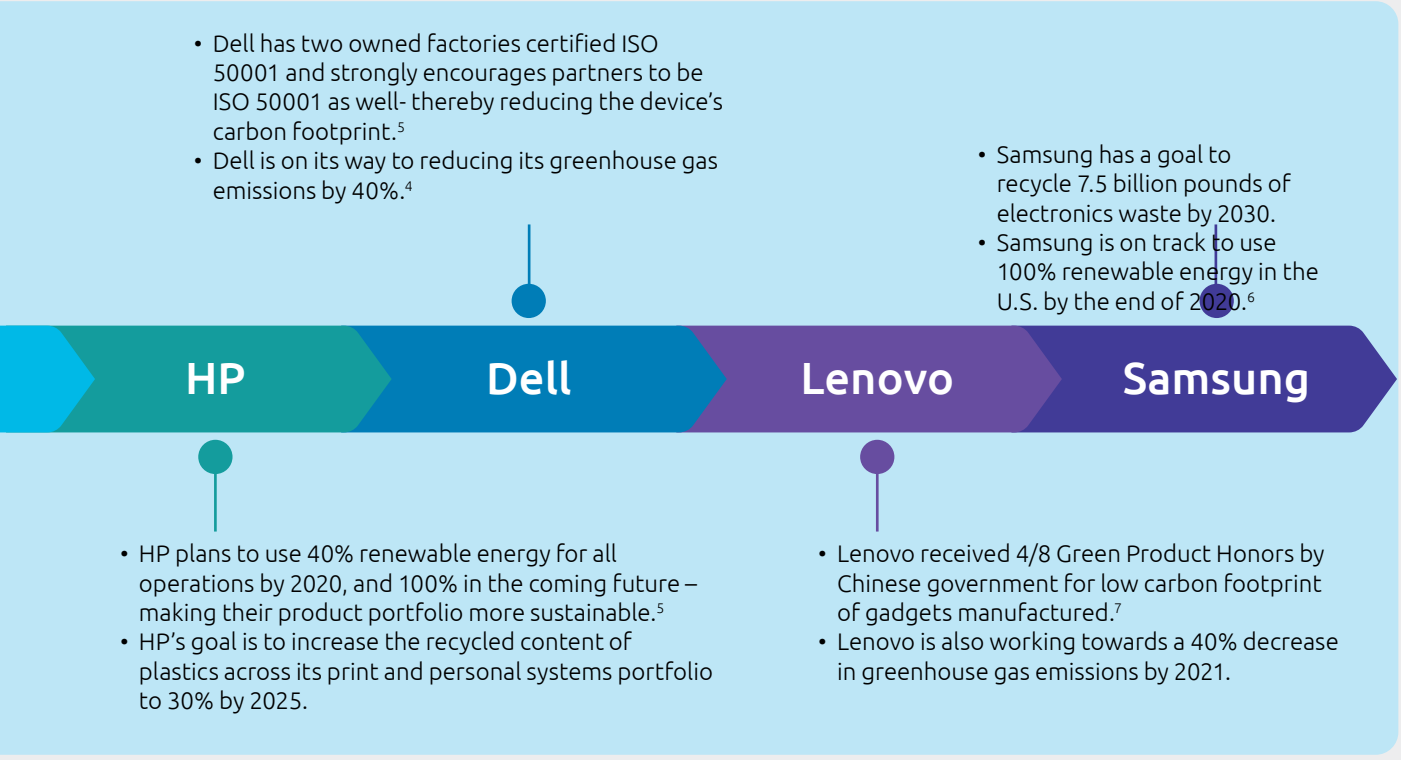
Sources:

i. BBC, "Google says its carbon footprint is now zero," September 2020.
ii. Who's saving the planet, "Green Coding: Sustainability in Software."
iii. Cornell University, "Green Algorithms: Quantifying the carbon footprint of computation," December 2020.
1. BBC, "Google says its carbon footprint is now zero," September 2020.
2. Apple, "Apple now globally powered by 100 percent renewable energy," April 10, 2018.

- Amazon aims to be carbon neutral by 2040.

Sustainable IT is not only limited to the migration to greener hardware and energy. Organizations are trying to be more sustainable through initiatives, such as apps rationalization and green coding:

- Apps: Strategically identifying business applications across the organization to understand which application need to be retired, replaced, or kept reduces redundancy and unwanted energy consumption.
- Coding: Programing languages that are written to produce algorithms that have minimal energy consumption can be an innovative approach to sustainability:
  - Netflix, Google and LinkedIn use programming languages that are designed to consume minimal energy.[ii]
  - Cornell University has developed an online tool to help users estimate the carbon footprint of their computation.[iii]

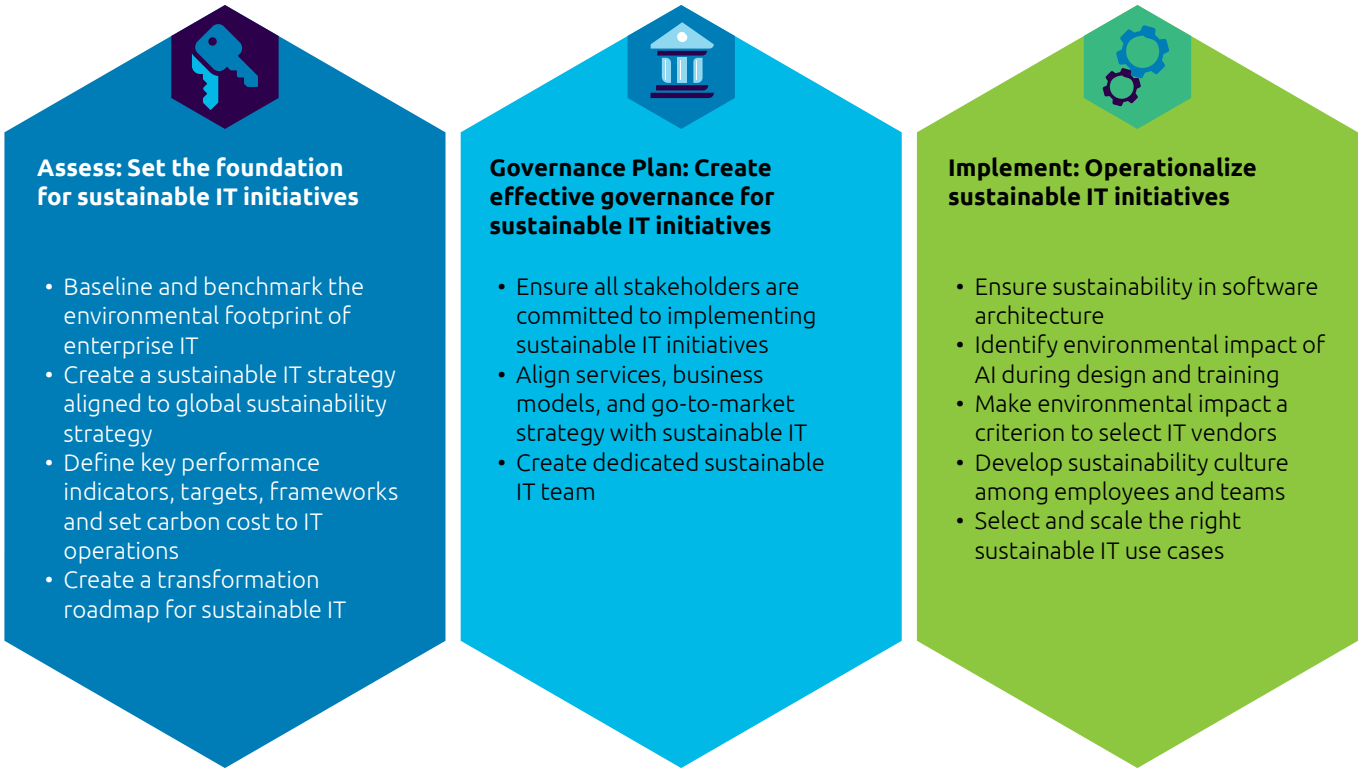


3. Amazon, "Amazon Becomes World's Largest Corporate Purchaser of Renewable Energy, Advancing its Climate Pledge Commitment to be Net-zero Carbon by 2040," December 10, 2020.
4. Dell Technologies, "Climate Change," Environment + Energy Leader, "How HP Plans to Reach 100% Renewable Energy Across Global Operations," April 6, 2020.
5. Forbes, "10 Most Sustainable Consumer Tech Companies," November 2020.
6. Lenovo Story Hub, "Lenovo Recognized Among Top Companies Going Green in China for Manufacturing and Supply Chain Innovation," August 2, 2019.

Building a roadmap to accelerate sustainable IT implementation

Drawing on our survey analysis and interviews, as well as our own experience in this area, we suggest a three-stage roadmap for accelerating the sustainable IT agenda (see Figure 18):

Figure 18: Roadmap for sustainable IT implementation



Source: Capgemini Research Institute Analysis.

Stage 1: Assess – set the foundation for sustainable IT initiatives

Baseline and benchmark the environmental footprint of enterprise IT

Conduct diagnostic assessment to understand the environmental impact of IT

Half of organizations are hampered by the absence of tools and standards/ratings to evaluate the carbon footprint of their enterprise-wide IT. For example, only 29% use carbon emission assessment tools for all functions in the organization.

These sorts of tools are critical. They can help organizations calculate the carbon footprint for their application portfolio and data centers; the emissions savings that could be made by decommissioning applications and moving to the cloud; and help set a carbon cost based on the assessment data. Use of diagnostic tools will enable organizations to baseline and benchmark the environmental impact of IT and help build a target operating model for sustainable IT.

This is an area where AI can provide potential solutions, with over a third (37%) of organizations saying AI will be essential to measure IT's carbon footprint. This will require a close collaboration between AI product teams and IT.

Conduct sustainable IT maturity assessment for organization and business units

Conducting maturity assessments within business units and across the overall organization provides context on where the organization is placed on the sustainable IT agenda and where critical action is required. The assessment should include both quantitative aspects (such as potential cost or carbon savings) and qualitative aspects (such as employee behavioral impact and vendor assessments). Currently, only 41% of organizations conduct sustainable IT maturity assessments for their organization and business units (compared to 92% of High Maturity Organizations).

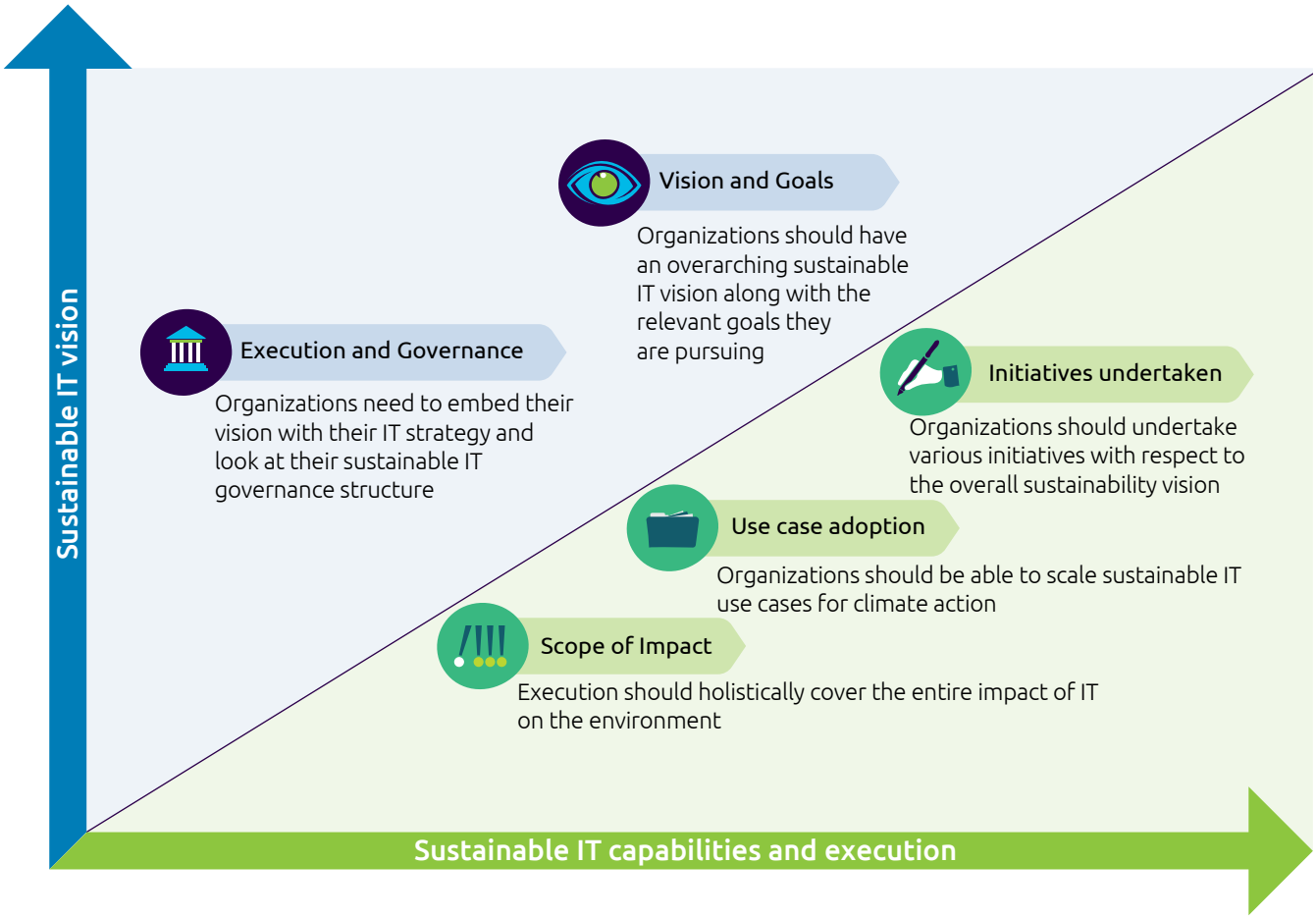
Create a sustainable IT strategy aligned to the organization's wider global sustainability strategy

Create a comprehensive sustainable IT strategy

Only 18% of organizations have a global sustainable IT strategy with well-defined goals and target timelines. While organizations may have multiple initiatives aligned to sustainable IT, a coherent corporate strategy is critical to focus efforts and accelerate progress. A sustainable IT strategy for the organization will need to include clearly defined goals and timelines, as well as showing the potential cost savings and environmental benefits for the organization.

As Figure 19 shows, a comprehensive sustainable IT strategy requires both a compelling vision and the capabilities to execute.

Figure 19: Building a comprehensive sustainable IT strategy requires both vision and execution



Source: Capgemini Research Institute Analysis.

Align sustainable IT strategy with global sustainability strategy and Environmental, Social and Governance Framework

A range of organizations have ambitious enterprise sustainability strategies:

- Google, for example, is one of the first major tech giants to invest and focus on going carbon neutral. The firm made the largest renewable energy purchase in history in 2019 and issued USD5.75 billion in sustainability bonds to become the first major company to eliminate its entire carbon legacy. Google announced plans to become the first company to operate carbon free every hour and in every region by 2030 and it plans to purchase carbon free energy everywhere they operate.[32]
- Automotive giant Ford aims to become carbon neutral by the end of 2050. It will invest USD11.5 billion globally through to 2022 with the aim of reducing CO_2 emissions across various operations.[33]

However, a strong link between enterprise strategy and sustainable IT is less common. Only 40% of organizations say that their sustainable IT strategy is aligned with the wider enterprise sustainability strategy.

One way to build alignment and cross-organization awareness of sustainable IT is to ensure the IT leadership is part of the organization's overall sustainability governance. The head of sustainability for a retail chain adds, *"We have a CSR Committee that includes our top leadership, including our CEO, CFO, IT director, and other senior executives. They are consulted on our group sustainability initiatives."*

Another tactic is to ensure that the sustainable IT strategy is part of the organization's wider approach to measuring, managing, and reporting on its performance against ESG goals. The need for credible ESG disclosures is becoming ever more important. The UK, for example, has become the first country to make the "Task Force on Climate-related Financial Disclosures" (TCFD) reporting framework mandatory. The TCFD was established with the goal of developing consistent reporting standards for companies so that investors and other stakeholders could compare different companies on their sustainability performance. The TCFD approach provides a common framework for determining which activities can be defined as environmentally sustainable and is intended to build transparency into how companies' activities impact the environment.[34]

Define key performance indicators, targets, frameworks and set a carbon cost to IT operations

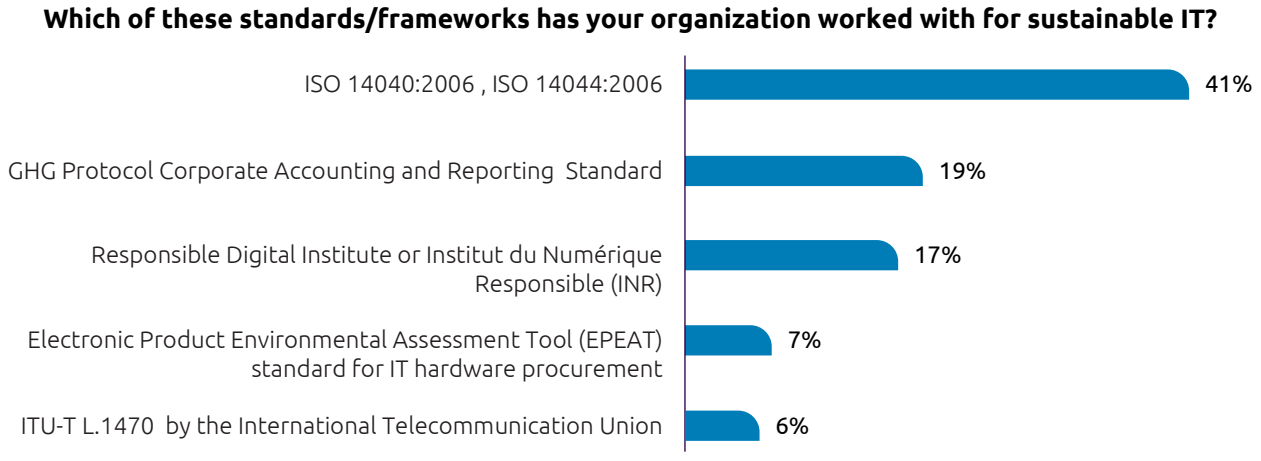
Adopt standardized frameworks and define KPIs to measure and manage sustainable IT performance

- Many organizations are not using key disciplines for measuring and managing their sustainable IT strategy. These include: Setting measurable and time-bound goals or targets to decarbonize the organization's IT footprint
- Defining key performance indicators (KPIs) to track and measure progress against the targets.

There are a range of frameworks and standards that organizations can draw on to set carbon reduction targets for their enterprise IT footprint. These include the ISO-based frameworks, and the GHG Protocol Corporate Accounting and Reporting Standard, among others (see Figure 20).

However, most organizations have not adopted internationally accepted standards and frameworks or set carbon reduction targets linked to them.

Figure 20: Standards for sustainable IT adopted in organizations



Source: Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021, N=1,000 organizations.

Our research also shows that the use of KPIs to track and measure progress on enterprise IT sustainability initiatives is not widespread. For example, only 23% measure greenhouse gas (GHG) emissions as part of their sustainable IT initiatives assessment.

Without this discipline, progress is low. In fact, only 1% of organizations have achieved their sustainable IT targets.

Set a carbon cost against IT operations

Setting a carbon cost against IT operations can help different functions within the organization really understand the impact of their IT footprint. However, only 27% have set a cost.

Microsoft, in contrast, is a pioneer in this area: it introduced internal carbon fees as far back as 2012. These are levied on internal business units for the carbon emissions associated with the company's global operations for data centers, offices, labs, manufacturing, and business air travel. This acts as a driver and incentive for sustainable IT as the business units must include the cost of carbon in their annual budget. The internal carbon fee was doubled to USD15 per metric ton on all carbon emissions in 2019.[35,36]

Create a transformation roadmap for sustainable IT

A roadmap with clear milestones is essential for organizations to chart the path to sustainable IT deployment, and we found that 95% of the High Maturity Organizations have one. Cisco, for example, has established an Integrated Greenhouse Gas Reduction (IGR) roadmap as a part of its sustainable IT strategy, which aims to reduce emissions associated with suppliers. Cisco uses its direct influence on suppliers to ensure they are using green sourcing strategies, model designs, product fulfillment, manufacturing energy use and transport mode selection. The company is working with the Carbon Disclosure Project (CDP) so that it is transparent about progress against its overall goal: cutting one million metric tons of GHG emissions across its supply chain.[37]

Stage 2: Governance plan – create effective governance for sustainable IT initiatives

Ensure critical stakeholders are committed to implementing sustainable IT initiatives

Commitment from critical stakeholders – including top leadership – is essential to drive and embed sustainable IT approaches in the organization, particularly given the low level of overall awareness that exists in many. This will also help all stakeholders understand the need for sustainable IT and ensure the process is transparent and reliable. We found that 66% of High Maturity Organizations make sustainable IT part of the board level agenda, compared to a global average of 34%.

The European Patent Office's Christophe Debuysscher stresses the importance of leadership buy-in, saying: *"You need to have C-level buy-in and they need to be convinced. Once you have this, sustainable IT needs to be part of the governance, in other words to have a seat at the Corporate Sustainability board. After this you can have a policy for sustainable IT supporting your environmental policy. Then implement concrete sustainability initiatives such as Baselining & Dashboarding your ICT assets' environmental footprint starting with energy consumption. This is where you will need to get your staff buy-in and decide what you are going to do and how you will do it. You might face some resistance, but you need to start from the C-level."*

Align services, business models, and go-to-market strategy with sustainable IT

Organizations will also need to align their services, business models, and go-to-market strategy with their sustainable IT norms, in order to ensure that their focus on sustainability is consistently reflected in their overall business strategy.

Since 2017, Google has matched global electricity consumption with 100% renewable energy and is the world's largest corporate buyer of renewable energy. By 2030 Google aims to run their business on carbon-free energy everywhere, at all times. This means tools such as Gmail, Google Search, or Google Assistant, as well as YouTube video, will run only on clean energy.[38] Apple, uses its trade-in programs – along with AppleCare and recycling programs – to divert 47,000 tons of e-waste away from landfills and direct more than 11 million devices to new users.[39]

Create a dedicated sustainable IT team

A dedicated sustainable IT team can drive greater progress. Simply putting sustainable IT initiatives with existing IT teams – or making it a priority for a number of different teams within the IT function – may not provide the singularity of purpose and coherence demanded by sustainable IT.

Currently only 39% of the organizations we surveyed have a dedicated sustainable IT team. However, this rises to 95% in the *High Maturity Organizations.*

Stage 3: Implement – operationalize sustainable IT initiatives

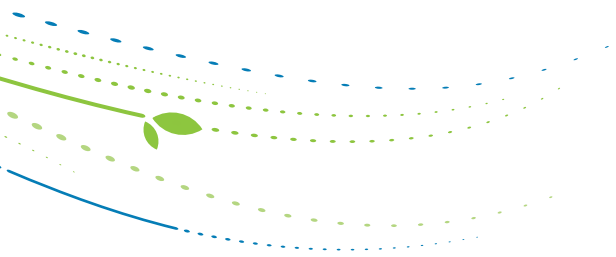
Ensure sustainability is a key pillar of software architecture

Multiple aspects of software architecture can improve an organization's sustainable IT capability. Taking a sustainability perspective with software architecture is as important as focusing on performance and cost issues. Our research also shows that most organizations that have been able to scale these approaches not only achieve a carbon reduction but also additional cost benefits.

Bringing sustainability into software architecture means:

- Understanding the environmental consequences of software deployment and setting clear solution-related principles on sustainability
- Ensuring the software architecture includes a sustainability perspective and making deployment decisions based on the carbon cost of infrastructure
- Creating a balance between value for money, agility, compliance, and sustainability.

Once the software architecture is available, the design of specific software modules within the architecture must also be viewed from a sustainability perspective. For instance, helping developers understand the carbon cost of their software modules and using green coding to produce algorithms that have minimal energy consumption.



Identify environmental impact of artificial intelligence during design and training phase

As AI adoption grows, IT teams will need to manage the carbon footprint of these technologies. This will need to happen during the AI design and also the training phase. Focus on this issue is growing, as our survey demonstrates:

- 46% of respondents are looking to offset the carbon footprint associated with training AI algorithms.
- A third say that, as well as accuracy, carbon footprint is a key determining factor for AI algorithms selection and training. However, only a third of all respondents are aware of the carbon footprint/energy required to run AI algorithms.

Our related research study, "AI for Climate Action,"[40] advocates the following key actions:

- Make use of publicly available tools to monitor AI's carbon footprint, which have been developed by organizations that include Stanford/Facebook,[41] Allen Institute for AI,[42] and Cornell University.[43]
- Build the capabilities needed to measure AI's carbon footprint over its lifecycle
- Conduct an impact analysis before deploying AI at scale. Scaling and training AI applications should be undertaken with a clear understanding of the environmental consequences.
- Design and deploy efficient and sustainable AI applications. Most current AI applications focus on cost and operational efficacies rather than carbon cost.
- Collaborate with the AI expert community and understand the best practices that are emerging from the academic community as well as startups.

Make environmental impact a criterion to select IT vendors

Overall, only 43% of organizations say environmental impact is critical when selecting an IT vendor. This is a significant issue given the volume of IT and services purchased from external suppliers and outsourcers. However, this issue is given more prominence in the public sector, where over half (57%) of organizations do use environmental considerations when selecting vendors.

Ensuring technology vendors are transparent and accountable on sustainable IT norms will also help organizations achieve their sustainable IT targets. A senior executive for environmental sustainability says, *"We have a green procurement policy. There is a carbon price in all our purchase decisions. We currently have it for larger investments in infrastructure like boilers, but we are on our way to place a carbon price filter into all our purchase decisions, including our IT infrastructure."*

Only 39%

of the organizations have a dedicated sustainable IT team.

41%

of organizations conduct sustainable IT awareness sessions for their employees

Develop sustainability culture and employee behaviors

To have sustainable IT operations it is important for organizations to ensure their employee are environmentally aware and engaged. However, only 40% say that their employees show a desire to change the company's practice when it comes to the initiatives that can support sustainable IT, such as employees turning their computers off during non-working hours and reducing data usage by limiting the number of emails and video streams. But the steps needed to encourage employees are lacking:

- Only 41% conduct sustainable IT awareness sessions for their employees.
- Only 31% provide incentives for employees to use IT services in a more sustainable way. Incentives can change employee behavior and create the right culture, ensuring IT is used in a way that aligns with the organization's wider sustainability goals.

Select and scale the right sustainable IT use cases

Our research shows that the sustainable IT use cases that organizations do manage to get to scale are not necessarily the ones that will deliver the highest carbon reduction. For example:

- Switching to a "green" cloud architecture and framework has given those organizations that have been able to scale the solution organization-wide a 19% cost savings.
- But, despite its potential, over one in ten have not even heard of it (15%) and 45% have not implemented it.

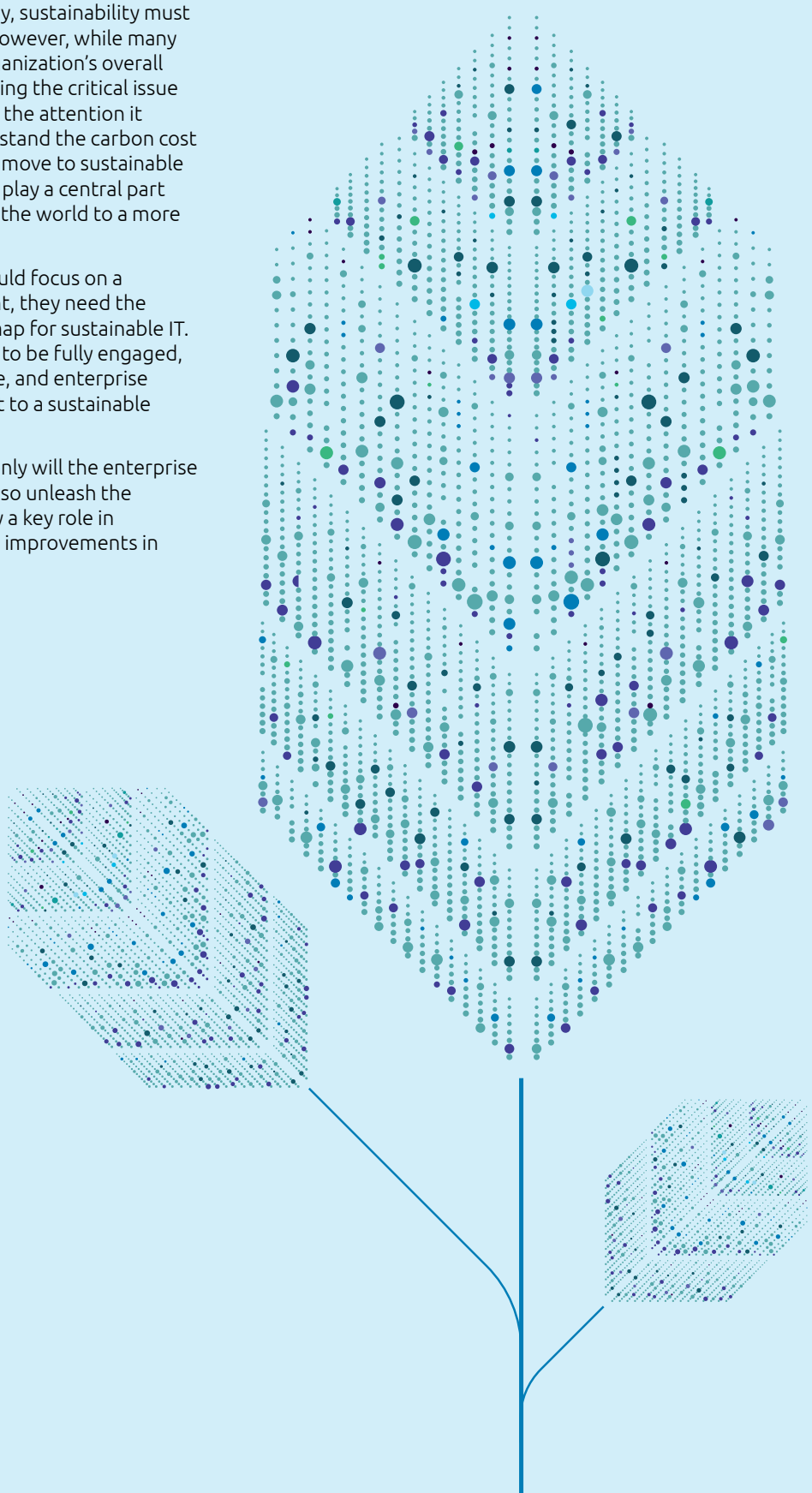
The most adopted use case is moving to enterprise cloud applications. Adoption of cloud computing could prevent the emission of one billion tons of CO_2 from 2021 to 2024.[44] However, shifting to the cloud will not be sufficient in itself if applications are shifted as-is without being redesigned from a sustainability perspective. Such a "lift-and-shift" migration approach can negate some of the sustainability benefits of moving on-premises applications to the cloud as the original application architecture may be resource inefficient and carbon-intensive. Organizations should therefore redesign their applications before migrating to the cloud. In addition, the adoption of a green cloud architecture is equally important as it reduces power consumption and improves resource utilization in the cloud-computing environment.

Conclusion

As we look to a post-pandemic recovery, sustainability must be at the core of the world's efforts. However, while many organizations are focusing on their organization's overall sustainability agenda, they are neglecting the critical issue of sustainable IT. To give sustainable IT the attention it deserves, organizations need to understand the carbon cost of our digital world and accelerate the move to sustainable systems. In this way, sustainable IT can play a central part in tackling climate change and moving the world to a more resilient and sustainable future.

To achieve this goal, organizations should focus on a number of priorities. As a starting point, they need the diagnostic tools, strategy, and a roadmap for sustainable IT. Critical internal stakeholders will need to be fully engaged, employee behavior will need to change, and enterprise software architecture will need to shift to a sustainable footing.

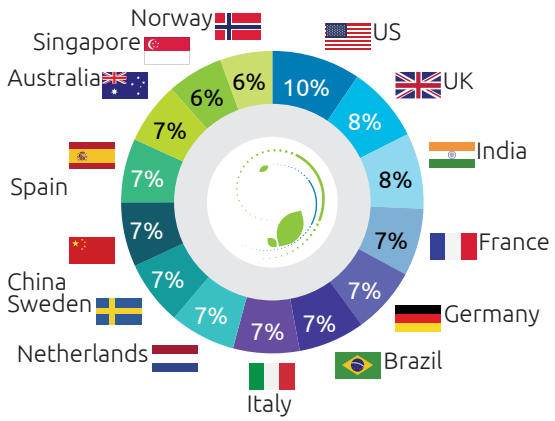
With this transformation in train, not only will the enterprise IT's footprint become greener, it will also unleash the potential of smart technologies to play a key role in driving environmental innovations and improvements in sustainability performance.



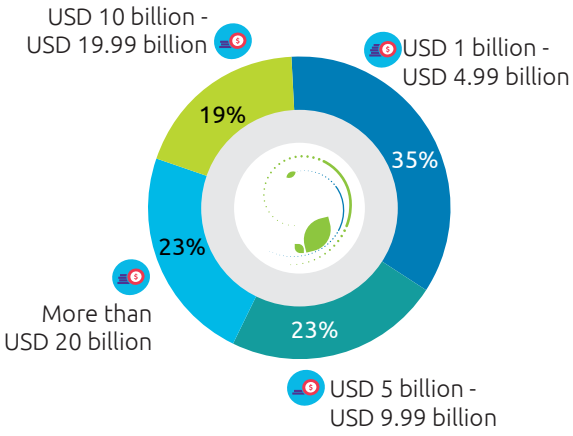
Research methodology

We surveyed 1,000 organizations with annual revenues in excess of USD1 billion to understand their sustainable IT outlook.

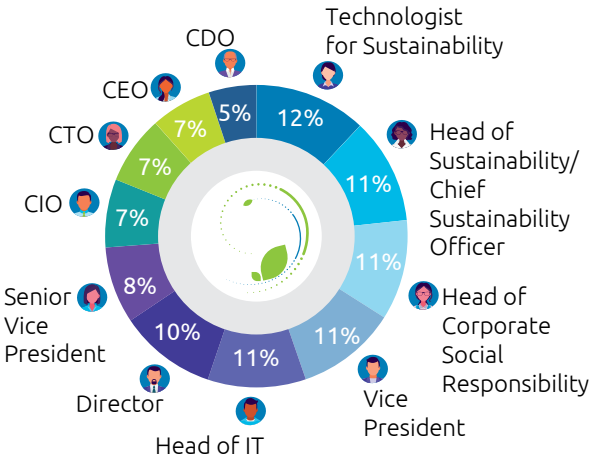
Country of headquarters



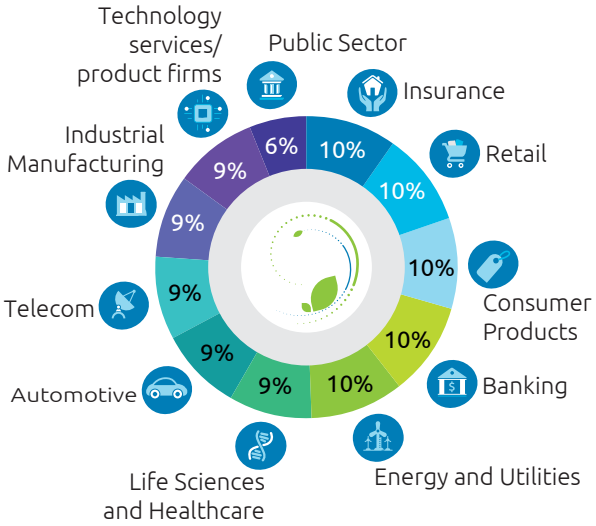
Revenue of organization – 2019



Title of respondent



Sector

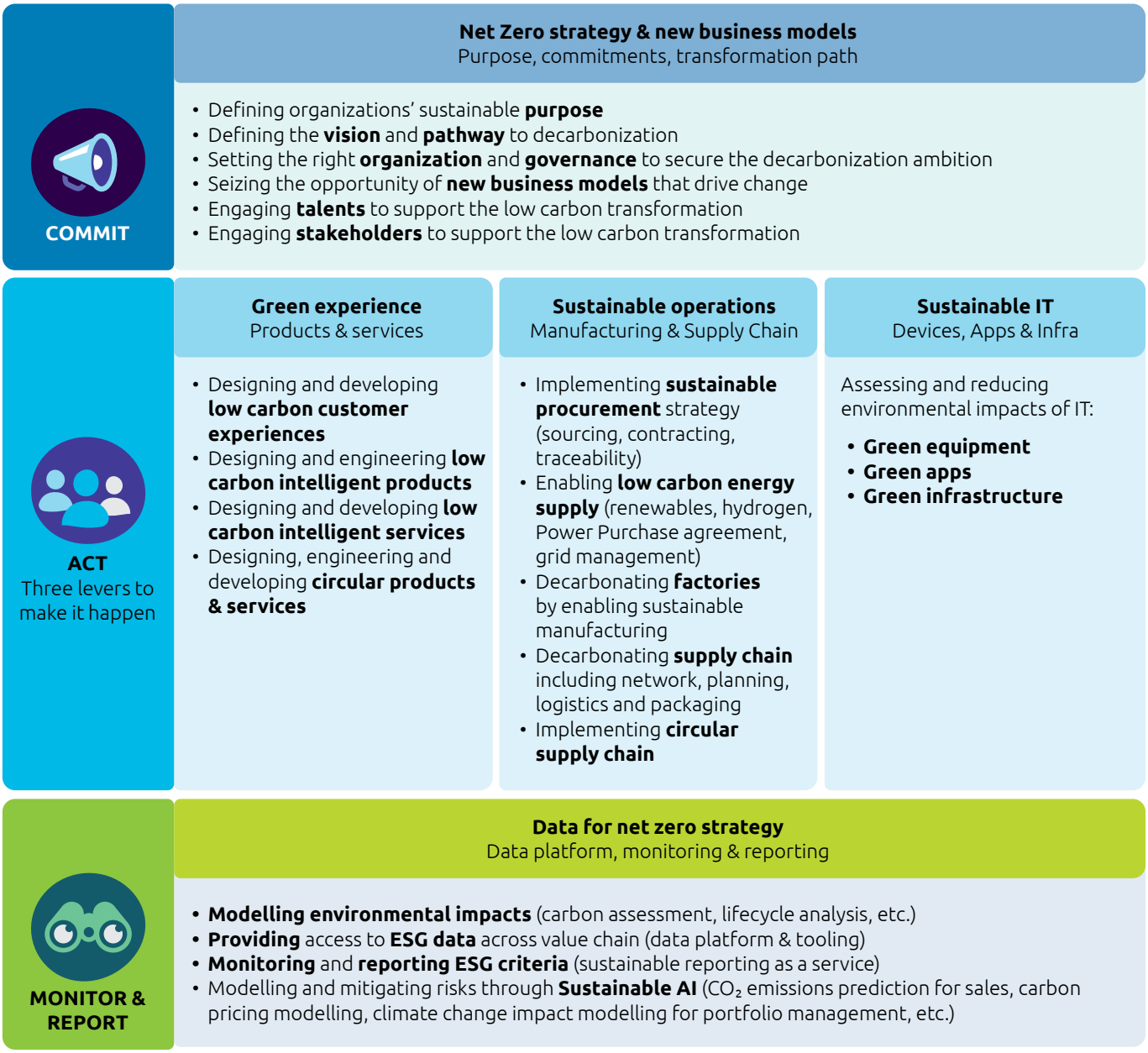


References

1. *IEA, "Global trends in internet traffic, data centre workloads and data centre energy use, 2010-2019," June, 2020.*
2. *Microsoft. (n.d.) Project Natick. Retrieved from https://natick.research.microsoft.com/.*
3. *United Nations institute for Training and Research, "GLOBAL E-WASTE SURGING: UP 21 PERCENT IN 5 YEARS," July 2, 2020.*
4. *IDC, "IoT Growth Demands Rethink of Long-Term Storage Strategies, says IDC," July 27, 2020.*
5. *IDC, "IoT Growth Demands Rethink of Long-Term Storage Strategies, says IDC," July 27, 2020.*
6. *Carbon Disclosure Project and the United States Environmental Protection Agency.*
7. *Capgemini Research Institute, "The AI-powered enterprise: unlocking the potential of AI at scale," July 2020.*
8. *IEA, "Global trends in internet traffic, data centre workloads and data centre energy use, 2010–2019," June 2020.*
9. *BBC, "Why your internet habits are not as clean as you think," March 2020.*
10. *Microsoft, "Achieving 100 percent renewable energy with 24/7 monitoring in Microsoft Sweden," November 24, 2020.*
11. *Google Cloud, "Announcing 'round-the-clock clean energy for cloud," September 14, 2020.*
12. *United Nations institute for Training and Research, "GLOBAL E-WASTE SURGING: UP 21 PERCENT IN 5 YEARS," July 2, 2020.*
13. *European Environmental Bureau, "Coolproducts don't cost the Earth," September 2019.*
14. *The Guardian, "Fairphone 3 review: the most ethical and repairable phone you can buy," September 18, 2019.*
15. *United Nations institute for Training and Research, "GLOBAL E-WASTE SURGING: UP 21 PER CENT IN 5 YEARS," July 2, 2020.*
16. *United Nations institute for Training and Research, "GLOBAL E-WASTE SURGING: UP 21 PER CENT IN 5 YEARS," July 2, 2020.*
17. *Global E-waste Statistics Partnership. (n.d.) Retrieved March 30, 2021 from https://globalewaste.org/country-sheets/*
18. *XD Ideas, "Yes, AI Has a Carbon Footprint – So How Do We Deal With It?" January 2020.*
19. *University of Massachusetts Amherst, "Energy and Policy Considerations for Deep Learning in NLP," 2019.*
20. *Capgemini Research Institute, "Climate AI: How artificial intelligence can power your climate action strategy," November 2020.*
21. *MDPI – Andrae et al.,"On Global Electricity Usage of Communication Technology: Trends to 2030,"February 2015 data updated by the Shift Project.*
22. *World Economic Forum, "The world's e-waste is a huge problem. It's also a golden opportunity," January 24, 2019; The Straits Times, "World's e-waste 'unsustainable', says UN report citing China, India and US," July 2, 2020.*
23. *Economic Times, "E-waste becoming global challenge, but initiatives by companies give hope for better future," January 22, 2021.*
24. *Microsoft, "The Microsoft Cloud can save customers 93 percent and more in energy and carbon efficiency," May 2018.*
25. *Microsoft – Stories, "The Microsoft Cloud can save customers 93 percent and more in energy and carbon efficiency,"May 17, 2018.*
26. *Energy Manager Magazine,"What next for data centres on the sustainability journey?" September 2020.*
27. *Techerati, "Carbon reduction through IT energy optimisation," November 2020.*
28. *Data center knowledge, "Not Just for Google: ML-Assisted Data Center Cooling You Can Do Today," November 2018.*
29. *Microsoft, "Microsoft finds underwater datacenters are reliable, practical and use energy sustainably," September 2020.*
30. *Capgemini Research Institute, "AI for Climate Action," November 2020.*
31. *Google blog, "Our data centres now work harder when the sun shines and wind blows," April 22, 2020.*
32. *Google, "Our third decade of climate action: Realizing a carbon-free future," September 2020.*
33. *Supplychaindive, "Ford plans to go carbon neutral by 2050," June 24, 2020.*
34. *ESGToday, "UK Becomes First Country in the World to Make TCFD-aligned Disclosure Mandatory," November 2020.*
35. *United Nations Climate Change, "Microsoft Global Carbon Fee | Global"*
36. *Microsoft, "We're increasing our carbon fee as we double down on sustainability," April 2019.*
37. *Cisco, "Pushing the Sustainability Envelope: Cisco Supply Chain to Cut 1 Million Metric Tonnes of Greenhouse Gas Emissions by 2020," June 2016*
38. *Google, " Our third decade of climate action: Realizing a carbon-free future,"September 2020*
39. *Apple Inc, "Environment," accessed January 21, 2020.*
40. *Capgemini Research Institute, "AI for Climate Action," November 2020.*
41. *Stanford University, Facebook, Mila, McGill University, "Towards the systematic reporting of the energy and carbon footprints of machine learning – a working paper," February 2020.*
42. *Allen Institute for AI, Carnegie Mellon University, University of Washington, "Green AI," July 2019.*
43. *ArXiv, "Quantifying the Carbon Emissions of Machine Learning," November 2019.*
44. *IDC, "Cloud Computing Could Eliminate a Billion Metric Tons of CO_2 Emission Over the Next Four Years, and Possibly More, According to a New IDC Forecast," March 2021.*

Capgemini's Net Zero Portfolio Offering Framework

Companies around the world are investing heavily in minimizing their environmental impact and seeking to be more resource efficient. As a responsible business, we want to play a leadership role in ensuring technology creates a sustainable future, particularly enabling our clients to be smarter about their resources in the products and services they create. We have been building on strong foundations in supporting our clients' sustainability ambitions and have created our Net Zero Portfolio offering.



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Benjamin Alleau leads the technology consulting for Capgemini Invent and is the Sustainability offering portfolio leader for the Capgemini Group. He has more than 20 years of professional experience in consulting and strategic account management with a passion for leveraging innovative technologies to improve the core processes of organizations. While he is skilled in matching business process and IT strategy, Benjamin's main skill is to identify and implement large-scale agile and tech-based initiatives with an ecosystem of partners to achieve both business and strategic outcomes. Benjamin graduated from Télécom ParisTech in 1998 as an Engineer focused in Information, Communication Science and Technology and joined Capgemini in 2011 from Accenture.

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Philippe is an Executive Vice President and a Global Leader of eAPM (Economic Application Portfolio Management). He has more than 30 years' experience in IT transformation. He is the author of the report "Best practices for mastering IT performance". Over the last 10 years, Philippe has been developing eAPM. Powered by AI, eAPM is a decision-making platform dedicated to answer CIOs' burning platforms. Sustainability subjects are more and more investigated by eAPM decision-making asset. The eAPM approach is recognized by top analysts as a unique accelerator. Carbon footprint calculation is leveraged by eAPM features at application level paving the way to enlightened trade-off decisions and more innovations in the near future.

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Gunnar is the Chief Technology & Innovation Officer for Capgemini North and Central Europe. He is one of 10 Master Certified Architects across the Group and is a lead author of Capgemini's annual TechnoVision trend series. Gunnar has led many IT transformation programs, helping and supporting large organisations in reducing their environmental impact.

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Laurence Jumeaux is responsible for the Sustainable IT offer for the group. She has been working for more than 25 years in IT transformation, including organisation, technology and competencies. She developed the offer by combining this IT Tranformation expertise and new assets to reduce the environnemental impact of IT.

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Jean-Baptiste leads Capgemini Invent's social impact business initiative : Invent for Society. With a strong background in public sector and sustainable development, he is a Vice-President within Citizen Services at Capgemini Invent France and currently develops business synergies with our most recent acquisitions including social impact agency Purpose.

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Courtney Holm is Capgemini Invent UK's newly appointed Vice President of Sustainability Solutions. Her role is to shape the way Capgemini Invent creates long term, sustainable value for clients, enabling them with fresh perspectives and digital solutions so that they can play a transformative role in addressing planetary, people and systems challenges. She has built up expertise in UK based, global businesses; starting with her role as Tesco Client Director with sustainability specialists and in her previous role, as Global Head of Sustainable Technology, driving sustainable growth using innovation and technology for Unilever. Courtney has a proven track record of implementing innovative technology solutions for sustainable development and is an expert in facilitating collaboration around complex business challenges.

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Dr James Robey has led the sustainability agenda at Capgemini since 2008, creating and driving a broad ranging program to reduce the Group's own environmental impacts whilst identifying opportunities to support Capgemini's clients with their own sustainability challenges. In addition, he teaches at a number of leading universities on the topic of Sustainable Business.

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Matt has led a number of key sustainability programmes within the Capgemini Group, developing pioneering sustainability strategies and approaches through leveraging our capabilities and services, demonstrating the vital role technology has in tackling the sustainability challenges we face today and beyond. Matt is an active member of the DEFRA DeSa working party to support the department in their Net Zero ambitions and a co-author of the United Nations and DEFRA Sustainable ICT Guide.

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Vincent leads Sustainable AI, part of Perform AI –Capgemini Group AI & Analytics offering. He has been working in sustainable ICT for more than ten years and has held IT project management and business development roles across consulting, SMEs, local authorities and NGOs.

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Jerome is head of Capgemini Research Institute. He works closely with industry leaders and academics to help organizations understand the business impact of emerging technologies.

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Kristin Kiri Trier is a passioned sustainability leader and researcher (Director, researcher rer.soc.oec) with over 10 years of international experience in Innovation & Sustainability Management. As Industry Lead Sustainability & Invent for Society DACH, she investigates the right sustainability strategy & business for Capgemini's clients encouraging them to drive sustainability from an end-to-end perspective with the right methods and measurements according to the Paris Agreement.

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Clémence has a proven track record in innovation, sustainable business modeling and product & service design within Capgemini across many industries including financial services and technology. She has recently accelerated the structuring and development of the sustainability offerings for Capgemini.

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About the Capgemini Research Institute

The Capgemini Research Institute is Capgemini's in-house think tank on all things digital. The Institute publishes research on the impact of digital technologies on large traditional businesses. The team draws on the worldwide network of Capgemini experts and works closely with academic and technology partners. The Institute has dedicated research centers in India, Singapore, the United Kingdom, and the United States. It was recently ranked number one in the world for the quality of its research by independent analysts.

Visit us at *www.capgemini.com/researchinstitute/*

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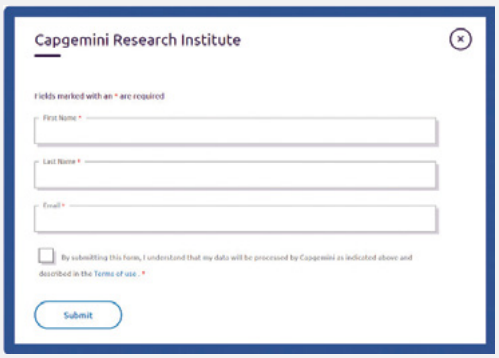

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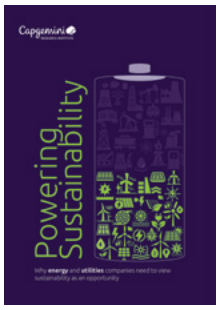
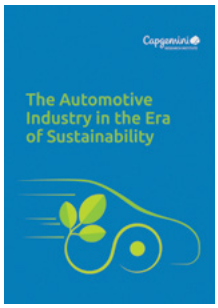


Sustainability in energy and utilities



The Automotive Industry in the Era of Sustainability

How sustainability is fundamentally changing consumer preferences

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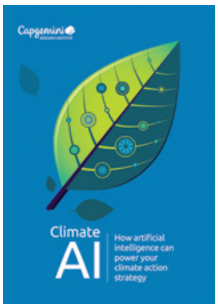
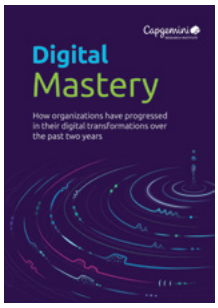


Climate AI



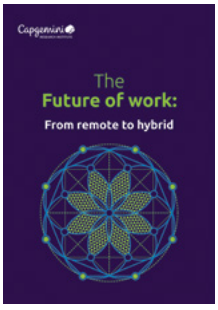
Digital Mastery

The data-powered enterprise

Scaling innovation

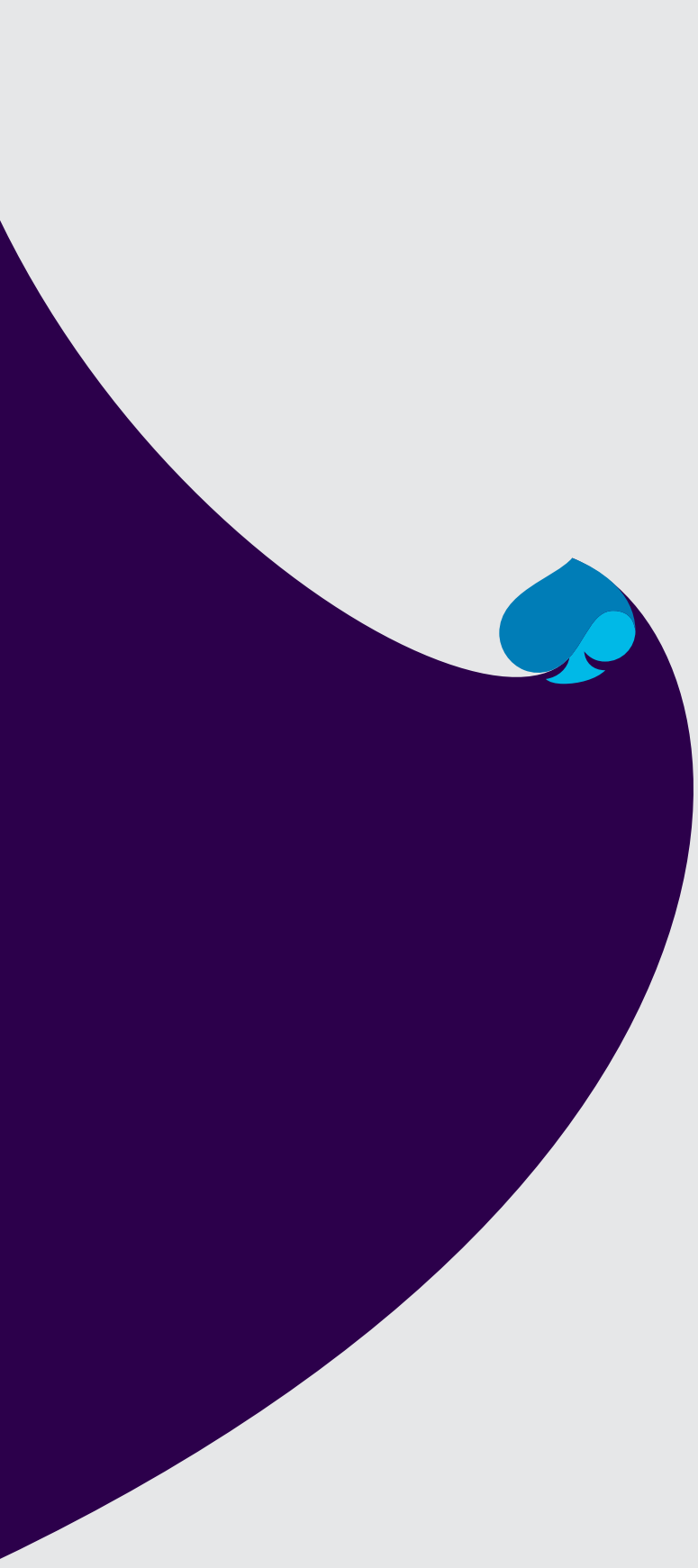
AI in Cybersecurity

The AI-powered enterprise



The Future of Work

Agile at scale



About Capgemini

Capgemini is a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. The Group is guided everyday by its purpose of unleashing human energy through technology for an inclusive and sustainable future. It is a responsible and diverse organization of 270,000 team members in nearly 50 countries. With its strong 50 year heritage and deep industry expertise, Capgemini is trusted by its clients to address the entire breadth of their business needs, from strategy and design to operations, fuelled by the fast evolving and innovative world of cloud, data, AI, connectivity, software, digital engineering and platforms. The Group reported in 2020 global revenues of €16 billion.

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