The Sustainable Enterprise

Why cloud is key to business sustainability

March 2022

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Executive Summary

READY FOR ACTION?

Leaders know they have an important responsibility to transform their business models for the future and to embed environmental sustainability and social responsibility into their operations. Many organizations are years into their sustainability journey and are making bold strides towards their visions for carbon neutrality or net-zero.

Few of those organizations understand how impactful IT can be to help them achieve their goals.

In our 2021 *Capgemini Research Institute* survey of 1,000 business leaders, the Capgemini Group found that less than half have considered the environmental impact of their IT systems.[1]

This paper, authored by the Capgemini Group, aims to address this lack of understanding and explores how organizations can act on and benefit from sustainable IT, fast.

It considers the environmental and operational significance of sustainable IT, and why many enterprises are reluctant to address the issue. It then examines the outsize impact and importance of cloud computing for business sustainability, and how organizations can achieve *truly* sustainable IT via cloud.

Throughout, we refer to innovative solutions offered by Microsoft to support organizations along their sustainable IT journey. This includes its new power-matching technology in Sweden, which will deliver breakthrough sustainability benefits to Azure enterprises in the region.

SUSTAINABLE IT, CODIFIED

Within the Capgemini Group – which includes Capgemini, Capgemini Invent, Capgemini Engineering and Sogeti – our message for enterprises seeking sustainable IT is clear: building efficiency into IT operations is not just a question of system change, but of cultural change. Without the right people, practices and processes, organizations will be unable to achieve their sustainable IT potential.

Accordingly, the Capgemini Group has developed a sustainable IT model and services to help enterprises plan, implement and embed sustainability across all parts of their IT.

This forms part of our commitment to help our clients to save 10 million tonnes of CO2 emissions by 2030.[2]

The sustainable IT model comprises four pillars:

- **Sustainable IT strategy:** Qualitative and quantitative diagnosis of organizations' sustainability performance and potential, using lifecycle assessment methodologies. With this, the Capgemini Group develops organizations' sustainability vision and targets.
- **Sustainable IT transformation:** Reducing enterprises' IT environmental impact using our library of hardware, infrastructure, application and data tools.
- **Sustainable employees:** Engaging employees to deeply transform their organizational culture regarding sustainability.
- **IT for sustainable business:** Developing new technology solutions that reduce enterprises' environmental impact, using global insight from our Applied Innovation Exchange (AIE).

OUR PILLARS

SUSTAINABLE IT STRATEGY

SUSTAINABLE IT TRANSFORMATION

SUSTAINABLE EMPLOYEES

IT FOR SUSTAINABLE BUSINESS

We are committed to partnering with you on your climate transition, helping you to reinvent your organization to create enduring sustainable value and impact."

– CYRIL GARCIA,
Capgemini Group Executive Boardmember
and Sustainability Sponsor

The sustainable IT model and related research form the framework for the insight in this paper.

The Capgemini Group constantly expands our sustainability frameworks to leverage new thinking and adapt to market developments. Sharing this sustainability intelligence is an important part of our work. To read more papers like this one, click here.

LEADING BY EXAMPLE

Having already achieved our target to reduce employee emissions by 30%, in 2020 the Capgemini Group committed to becoming carbon neutral by 2025, and to achieve net-zero emissions for our operations by 2030.

To reach this goal, the Capgemini Group is focused on meeting six Science-Based Targets (SBT's) around CO2 emissions, each validated by the Science-Based Targets Initiative (SBTi). They are:

- To improve the sustainability of our offices and reduce absolute scope 1 & 2 emissions – those emitted directly and indirectly via delivery of our services – by 75% by 2025, and 80% by 2030.
- To transition to 100% renewable electricity by 2025.
- To reduce business travel emissions per employee by 38% by 2025, and by 50% by 2030.
- To reduce employee commuting emissions by 35% by 2025, and 50% by 2030.
- Finally, to reduce scope 3 emissions – those embodied in our wider value chain – from our purchased goods and services by 50% by 2030.

Our Ten Point Action Plan to achieve these six targets is in fig. 1. The plan is focused on carbon reduction, with carbon offsetting used only for residual emissions.

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Fig 01 **The Capgemini Group's Ten-Point Action Plan for net-zero, as set out in our Environmental Sustainability Performance Report, 2020/2021**

1. Improve our office sustainability and reduce absolute scope 1 & 2 emissions by 75% by 2025 and 80% by 2030
2. Transition to 100% renewable electricity by 2025
3. Reduce business travel emissions per employee by 38% by 2025 and by 50% by 2030
4. Reduce employee commuting emissions by 35% by 2025 and by 50% by 2030
5. Transition to a 100% electric vehicle fleet by 2030
6. Reduce scope 3 emissions from our purchased goods and services by 50% by 2030
7. Empower our people to help create the sustainable future we want
8. Lead globally on sustainability
9. Collaborate with clients and partners
10. Neutralise the impacts of residual emissions with carbon removal offsets

The current global situation with the COVID-19 pandemic has amplified the importance of the need to live in balance with our planet. Capgemini has had a decade-long focus on reducing environmental impacts and whilst much has been achieved to date, we are now announcing our increased ambition.

"I have put acting on climate change at the heart of our Group priorities with a focal point of our ambitious target of net-zero by 2030. A strong set of actions have been put in place, that range from expanding our digital workplace initiatives and working from home, through to leveraging technology to help our clients drive down their own emissions."

– AIMAN EZZAT,
Capgemini Chief Executive

Why Sustainable IT matters

Too few enterprises are aware of the impact that sustainable IT practices can have on our environment and their business performance. As a result, they're holding back their sustainability journey and missing out on cross-enterprise benefits. Why?

HIDDEN IMPACT

To understand the full environmental impact of IT, it's important to have a holistic view of the IT value chain, taking into consideration both upstream and downstream activities. These generate 'scope 1, 2 and 3' emissions, as defined by the GHG Protocol Standard (see fig. 2.)

Today, the scope 1, 2 and 3 emissions generated by digital technology are responsible for 4% of CO2 emissions worldwide[3] – one and a half times more than those generated by the aviation industry.

These figures mask considerable variation. Globally, data centers account for 1% of energy usage – but in the US, the rate is 2%.[4] IT operations for some sectors are much more energy-intensive than others, as shown in fig. 3.

Taken as a whole, the energy intensity and emissions generated by enterprise IT deserve to be taken seriously and are set to grow significantly over the next decade.

INCREASING INTENSITY

Between 2010 and 2025, energy consumption for IT operations is expected to triple,[5] and its share of global scope 1, 2 and 3 emissions is set to double[6] (see fig. 4.)

The increasing importance and evolution of data operations will help to drive this trend.

Data generated by Internet of Things (IoT) devices is expected to increase by a factor of four, from 18.3 zettabytes in 2019 to 73.1 zettabytes in 2025.[7] The use of AI (Artificial Intelligence) is set to increase 33.2% annually over the same period.[8] While AI has the potential to help combat climate change,[9] it also carries its own footprint. Training an AI instance to analyze and respond to text or voice data (Natural Language Processing, or NLP), for example, can generate the same CO2 emissions as a roundtrip flight from New York to San Francisco.[10]

Demand for energy-intensive IT infrastructure will grow to accommodate these changes. This shift has already started, with major cloud providers' operational footprint increasing fourfold between 2015 and 2019.[11]

4%

of global CO2 emissions are generated by digital technology

11m tons

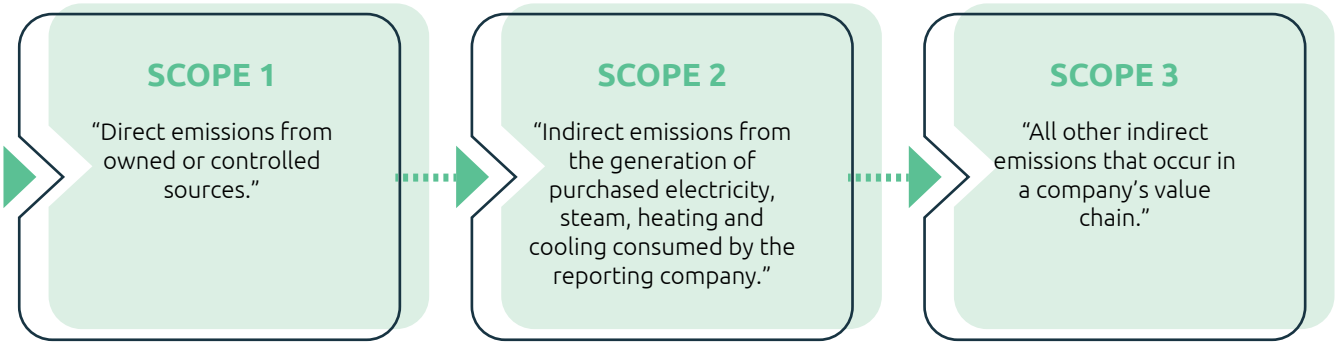
of CO2-equivalent emissions are generated by IT annually

55.5m tons

of e-waste was generated in 2020

Sources: 'The Shift Project: Lean ICT – Towards Digital Sobriety' [accessed December 2021]; The Global eWaste Statistics Partnership, cited by Capgemini in 'Is enterprise ready to become sustainable IT?' [accessed November 2021]

Fig 02 The three types of emissions generated by organizations, as defined in the Greenhouse Gas Protocol Standard



Sources: Carbon Trust, 'What are Scope 3 emissions?' [accessed November 2021]

Fig 03 Example carbon footprints at leading US enterprises

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

Sources: Carbon Disclosure Project and the United States Environmental Protection Agency, cited in Capgemini: Sustainable IT – Why it's time for a Green revolution for your organization's IT, 2021

WAR ON WASTE

Clearly, as the energy intensity of global IT operations increases, emissions generated also increase.

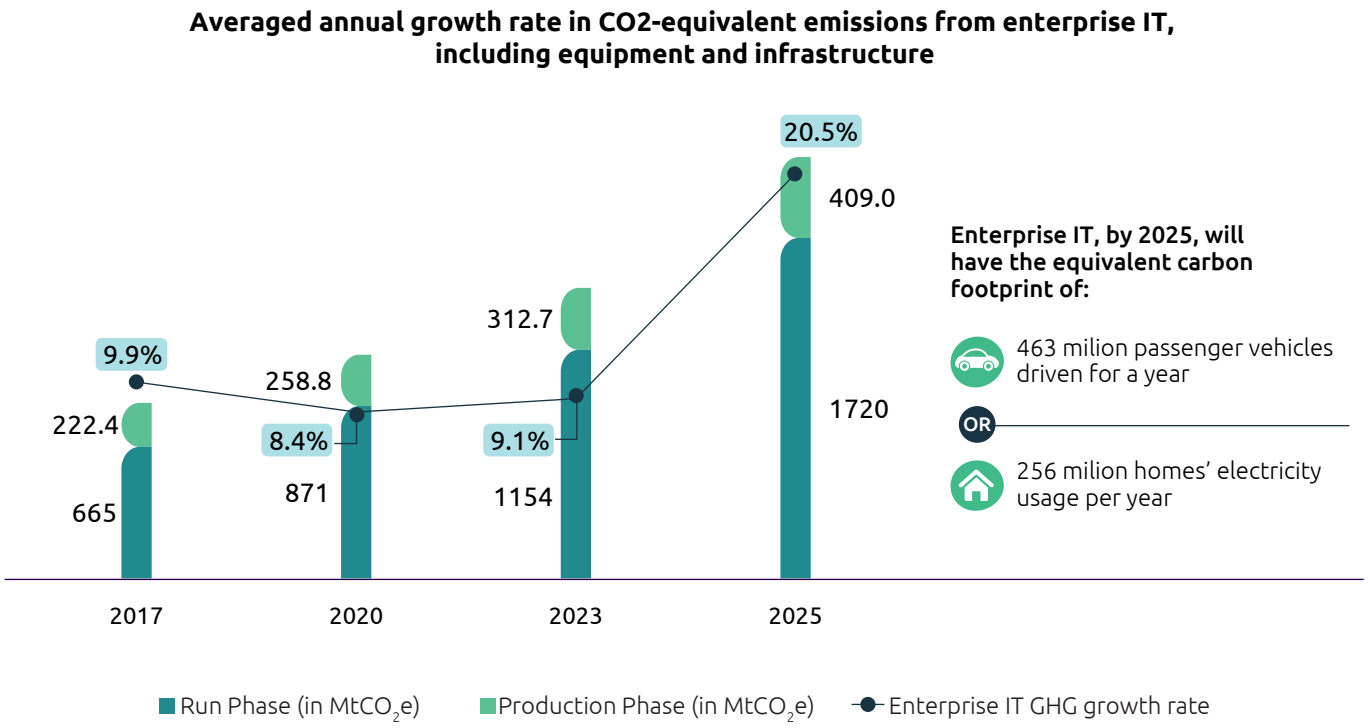
It's important to note that the example emissions given so far are scope 1 and 2 emissions – those generated in the delivery of services. 40% of enterprises' emissions globally fall under 'scope 3'[12] – that is, other emissions generated as a result of their business activities, across their value chain (see fig. 5.)

Electronic waste ('e-waste') is among the most prevalent sources of these 'other' emissions.

The proliferation of consumer and business technology meant that organizations generated 55.5 million tons of e-waste in 2020 – 20% more than in 2015.[13] This figure is projected to grow to 74 million tons by 2030[14] – with 89% of organizations recycling less than 10% of their unused IT hardware.[15]

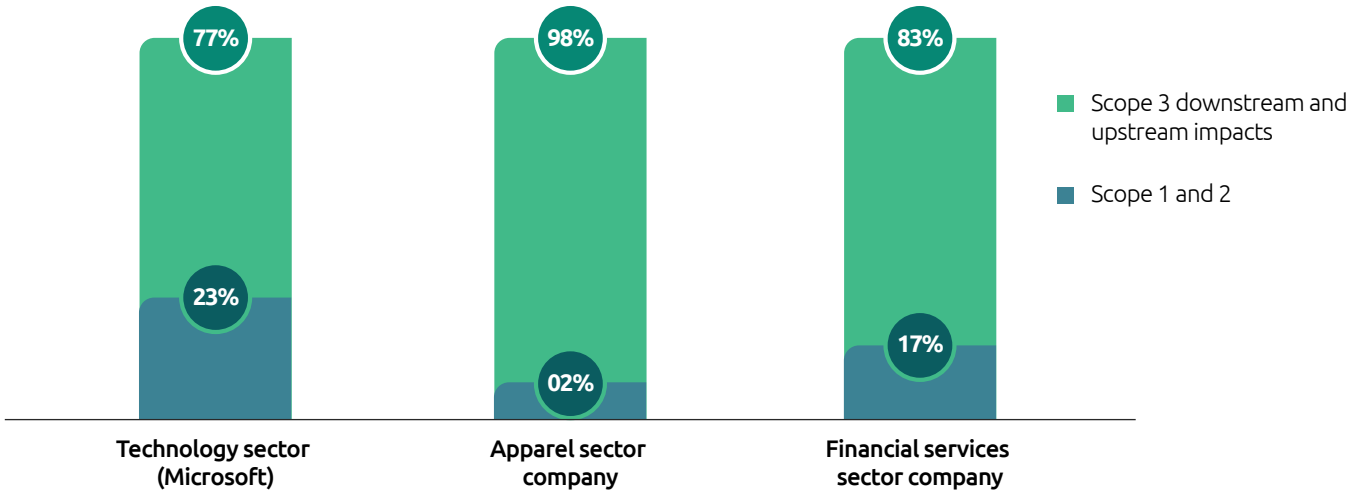
This waste contains harmful materials, including precious metals. Replacing the dumped hardware also means manufacturing anew – the stage at which devices generate a significant proportion of their lifetime emissions. Research shows, for example, that in the first four years of use, the carbon footprint of the average laptop is 422.5kg – 331kg of which is generated during manufacture.[16]

Fig 04 **CO2 equivalent emissions from enterprise IT are set to increase further**



Reproduced from Capgemini: Sustainable IT – Why it's time for a Green revolution for your organization's IT, 2021. MtCO2e stands for mega tons of CO2 equivalent GHG emissions. Estimates created using "Expected Scenario" outlined in the report titled "Lean ICT – Towards Digital Sobriety" , and assume that 40% of shipped desktops, laptops, and monitors, 5% of smartphones, and 10% of tablets are used by enterprise users. 'Production phase' refers to energy consumed to manufacture devices.

Fig 05 Example greenhouse gas emissions from companies in different sectors



Reproduced from Microsoft: 'A new approach for scope 3 emissions transparency' [accessed December 2021]

SOLUTION: SUSTAINABLE IT

The Capgemini Group developed our sustainable IT model and services to help organizations tackle these emissions challenges. The case studies in fig. 6 capture the types of results possible with this framework.

In the future, sustainability in IT will form part of businesses' legal requirements to monitor and report on their sustainability performance.[17] Enterprises shouldn't wait for regulation to act, however. Building sustainable IT operations delivers business *and* environmental benefits, as shown in fig. 7.

The Capgemini Research Institute survey of 1,000 US enterprises showed that those invested in sustainable IT as part of a wider sustainability program outperformed those that had yet to make similar changes (see fig. 6.)

Fig 06 Comparing the business performance of 1,000 US enterprises with and without sustainable IT programs

How Sustainable IT boosted business performance at 1,000 US enterprises

Improved their Environmental, Social and Governance (ESG) score, compared to 45% of businesses without a Sustainable IT program.

Improved their brand image, compared to 35% of businesses without a Sustainable IT program.

Improved customer satisfaction, compared to 43% of businesses without a Sustainable IT program.

Benefited from tax savings, compared to 22% of businesses without a Sustainable IT program

Sources: Capgemini: Sustainable IT – Why it's time for a Green revolution for your organization's IT, 2021

Performance improvements like these are accessible to all enterprises, given that – with the right planning, implementation and monitoring – sustainable IT can be both cost-effective and cost-saving. The 'high maturity' sustainable IT enterprises that the Capgemini Research Institute surveyed saved 12% on their IT costs, on average.[18] Our research shows that savings of up to 40% are possible, using the sustainable system design and responsible IT policies in our sustainable IT framework. These are explored in more depth in the next chapter.[19]

Fig 07 **Examples of sustainability efficiencies achieved with the Capgemini Group sustainable IT program**

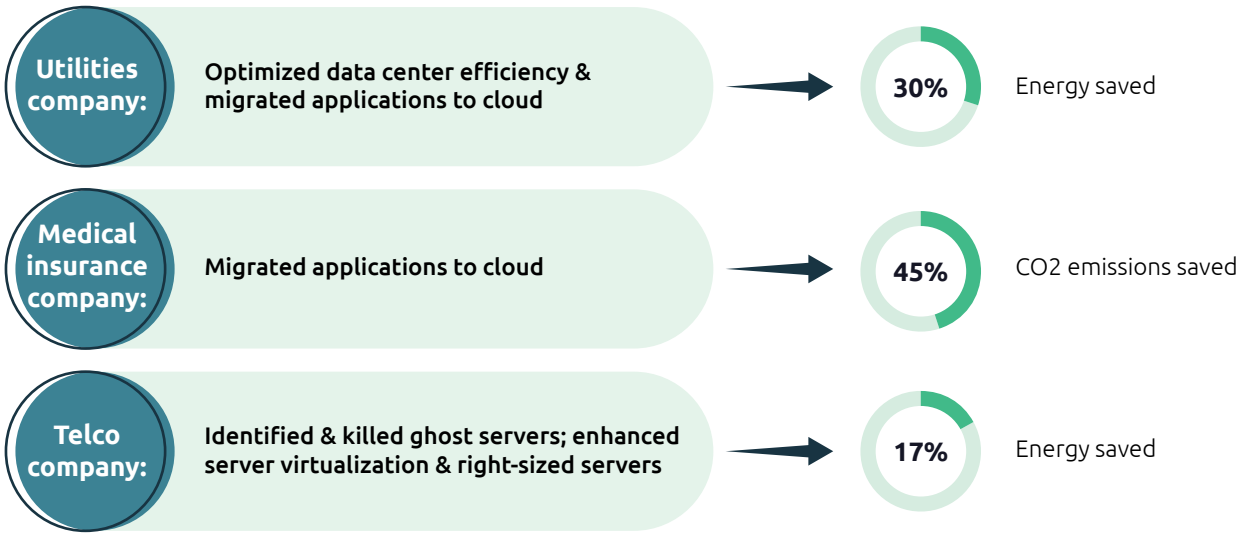
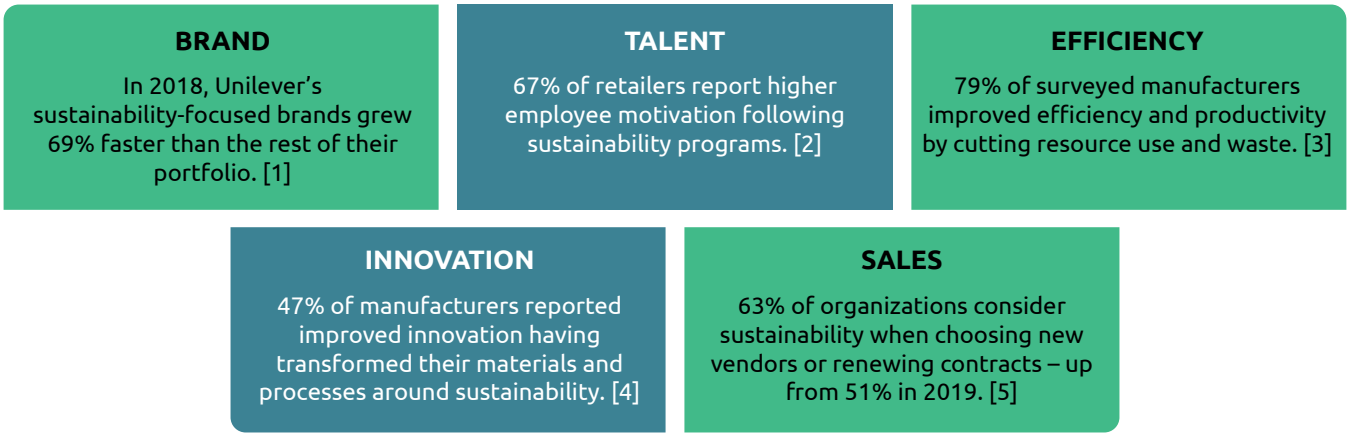


Fig 08 **Business benefits realised via enterprise sustainability initiatives**



Sources: [1] We Mean Business Coalition, Company profile: Unilever, 2019; [2] Capgemini Research Institute, Sustainability in Consumer Products and Retail Survey, 2020; [3] Capgemini Research Institute, Sustainability in Manufacturing Operations, 2021; [4] Capgemini Research Institute, Sustainability in Manufacturing Operations, 2021; [5] EcoVadis, Sustainable Procurement Barometer, 2021

MISSED OPPORTUNITIES

Sustainable IT represents an important opportunity for enterprises. However, awareness of the issue is low across business sectors worldwide (see fig. 9 and 10.)

This low awareness translates into low action. While 63% of US executives say that sustainability is 'important' to their organization[20] and 50% have published an enterprise-wide sustainability strategy[21], just 18% have a sustainable IT strategy with defined goals and target timelines.[22]

Less than half – 43% – of C-suite executives have considered the environmental impact of their IT systems. Just 6% of the enterprises the Capgemini Group surveyed have achieved sustainable IT maturity,[23] and only 17% use renewable energy sources for their data operations.[24]

EXPLAINING UNENGAGEMENT

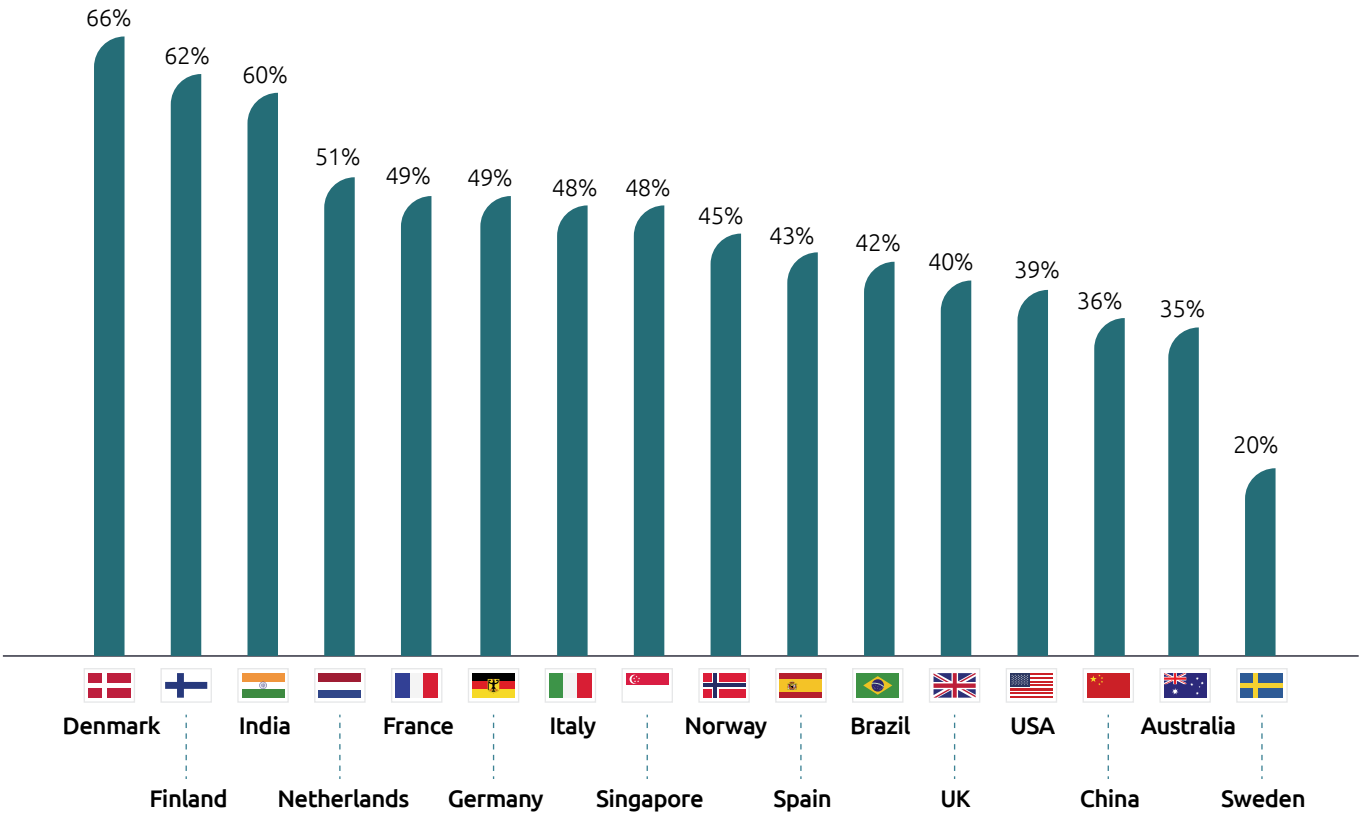
This lack of awareness, understanding and action on sustainable IT can be explained by three factors.

First, expertise. 53% of organizations lack the knowledge to implement sustainable IT systems and practices.[25] 39% are unable to identify the most relevant IT use cases for sustainability within their operations.[26]

Second, tools. 49% of organizations lack systems to effectively implement, measure and evaluate sustainability in IT across their operations. This is made worse by a lack of access to sustainability standards, and a lack of published data on carbon emissions generated by IT hardware.[28]

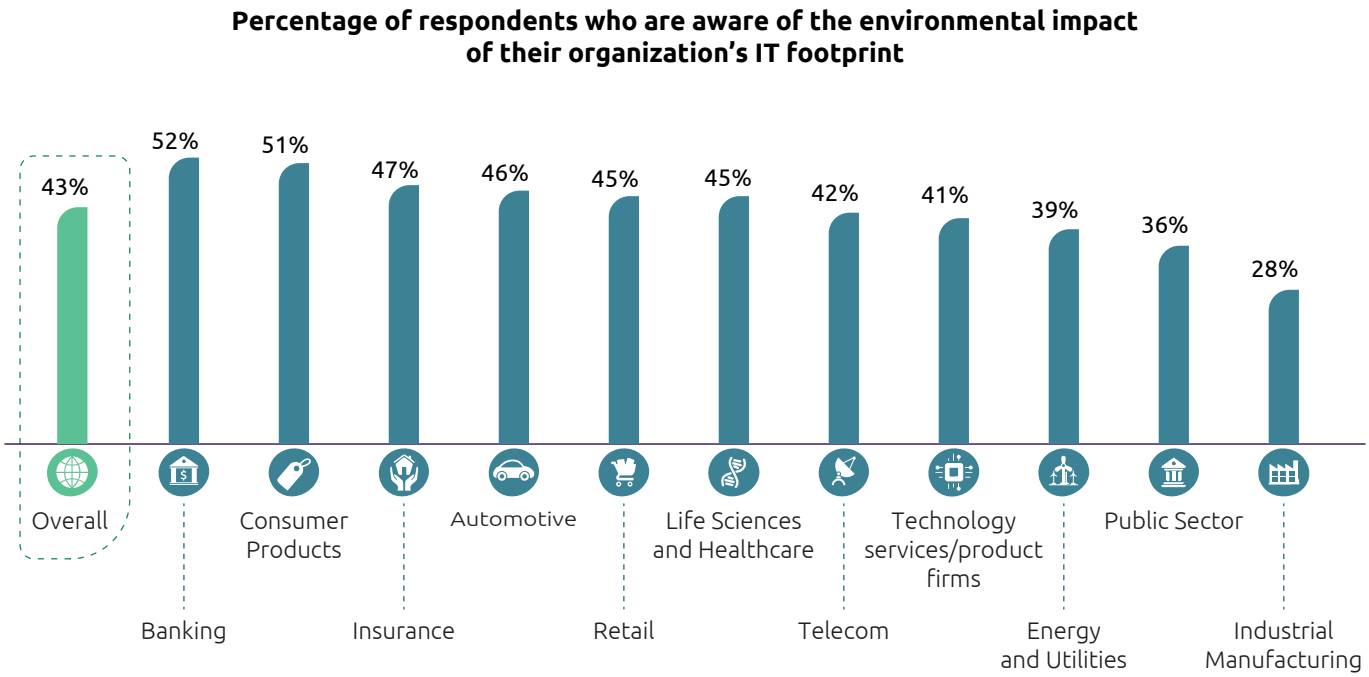
Third, impact. 48% of organizations face internal resistance to the cost of sustainable IT infrastructure, misunderstanding and concern around business continuity and other issues.[29]

Fig 09 **Awareness of the environmental impact of enterprise IT among business leaders, by country**



Sources: Capgemini Research Institute, Sustainable IT survey, December 2020 – October 2021 (N=1150¬¬ organizations)

Fig 10 Awareness of the environmental impact of enterprise IT, by sector



Sources: Capgemini Research Institute, Sustainable IT survey, December 2020 – January 2021 (N=1000 organizations)

KEY INSIGHTS

- **Enterprise IT operations generate significant, under-appreciated and growing greenhouse gas emissions, including significant amounts of e-waste.**
- **Improving sustainability in IT should therefore be an important focus for organizations seeking to minimize their environmental impact. In the future, regulation will require them to act, but the business benefits for action are already clear.**
- **Few enterprises have taken advantage of these benefits, with just 6% of organizations having implemented a 'mature' sustainable IT strategy.**

Achieving Sustainable IT

Sustainable IT matters, and the Capgemini Group's sustainable IT framework enables teams to overcome their challenges around tooling and knowledge, and to implement IT operations that benefit environment and enterprise.

BREADTH & DEPTH

IT connects the functions in an organization. For this reason, *truly* sustainable IT must cover every aspect of an enterprise's IT operation.

The Capgemini Group uses 'sustainable IT' to describe an environment-focused approach to the design, use and disposal of computer hardware and software applications, and the design of accompanying business processes.

These overlapping considerations are captured in the four pillars of the Capgemini Group's sustainable IT framework (see fig. 11.)

A critical approach is necessary. Organizations that fail to understand and truly deliver on sustainability can – at best – achieve little with their efforts and – at worst – be guilty of 'greenwashing'.

Organizations can ensure a critical, comprehensive approach to sustainable IT by adopting a three-step roadmap that covers **assessment**, **governance** and **implementation** (see fig. 12.)

This ensures organizations have the diagnostic tools needed to align their sustainable IT strategy with their wider sustainability strategy.

Stakeholders are engaged and behavior change is managed by a dedicated sustainable IT team, with support from leaders. Finally, enterprise architecture is shifted to sustainable foundations, by operationalizing sustainable IT initiatives and by making sustainability a key pillar of software architecture.

Fig 11 **The Capgemini Group's four pillars of sustainable IT**

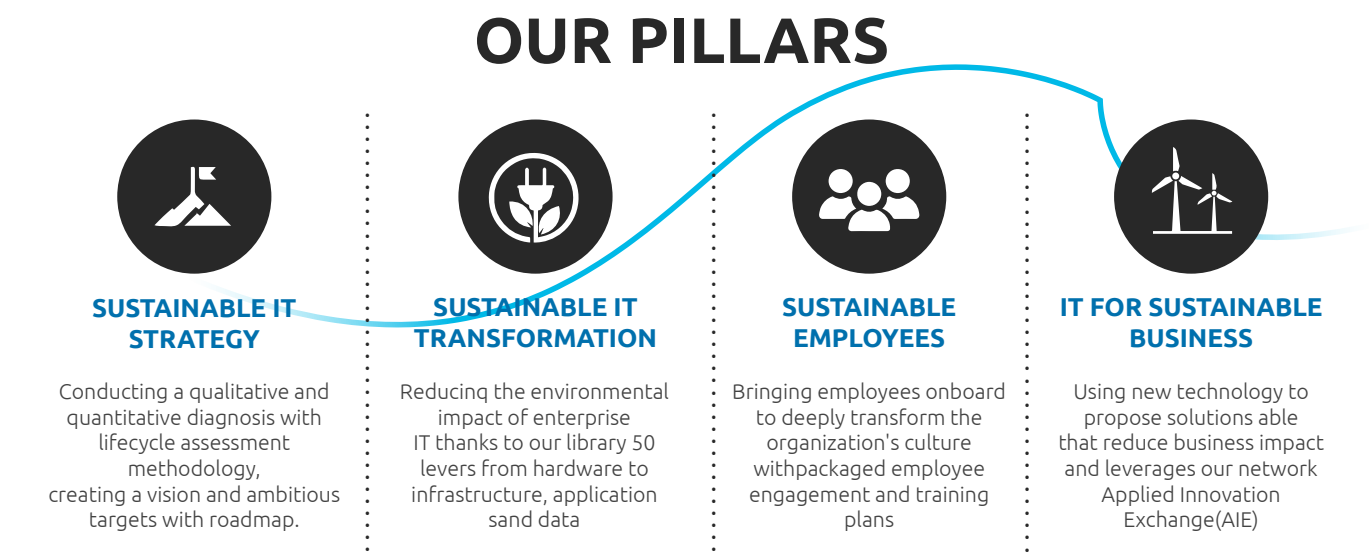
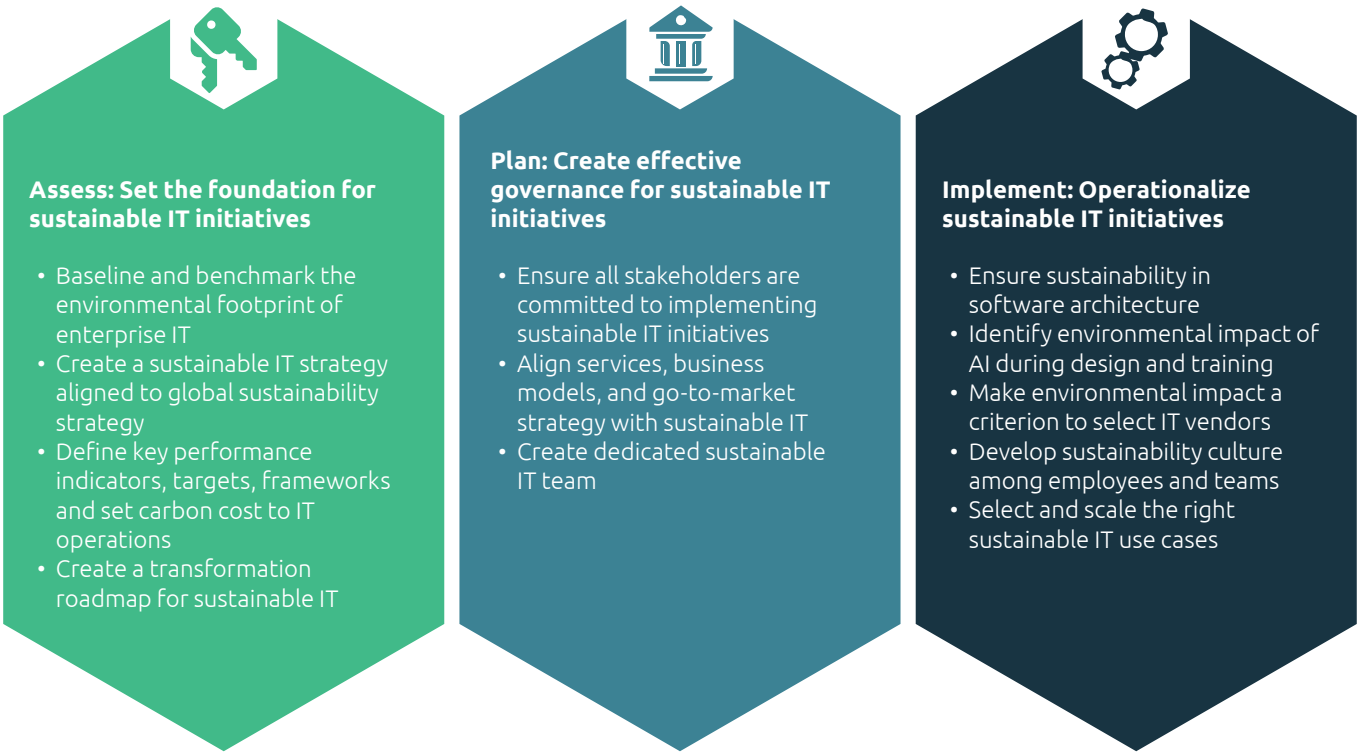


Fig 12 Three steps to ensure comprehensive IT sustainability



Sustainable IT frameworks in practice

Capgemini used the **four-pillar Sustainable IT framework** to define its own strategy for cabon-neutrality by 2025 and net zero by 2030.

Work on the **assessment** stage of the company's Sustainable IT transformation started in 2020, with an in-depth qualitative and quantitative audit of the company's IT landscape in a pilot market.

Qualitative studies included in-depth interviews with stakeholders, employee surveys and workshops to assess the maturity, strengths and weaknesses of our IT landscape around sustainability. Our quantitative audit included inventory and impact analyses of digital equipment and services, product lifecycle analyses and modelling on our IT carbon footprint.

The output of these studies consisted of a detailed report with 20+ recommendations to lower the company's carbon impact, and a report on our Sustainable IT maturity that identified 100 sustainability strengths and weaknesses across the organization.

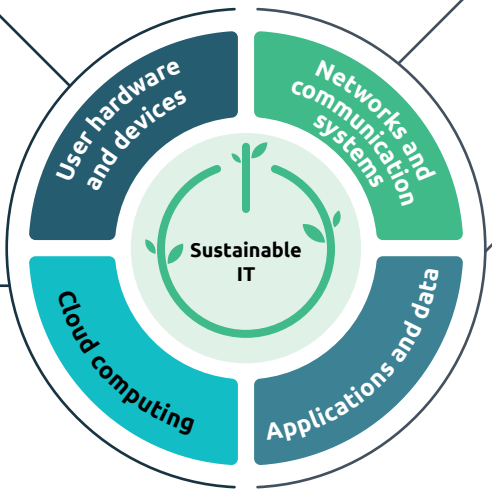
These insights formed the foundations for Capgemini's global strategy to cut carbon emissions across the four pillars of Sustainable IT. The basis of this **plan** is a five-year roadmap focused on 30 sustainability levers, with **implementation** progress monitored via a cross-company dashboard.

POINTS OF FOCUS

With this roadmap in place, organizations can consider and address six IT focus areas as part of their sustainable IT transformation:

1. Procuring hardware and user devices with minimum lifecycle carbon cost
2. Improving employee awareness of device utilization and sustainability
3. Proper disposal, recycling and refurbishment of hardware
4. Utilizing energy certified and auto-off hardware
5. Prolong the lifespan of devices

1. Adopt enterprise cloud solutions
2. Switch to a green cloud architecture and framework
3. Use AI/ML to optimize data center utilization and improve cooling solutions
4. Utilize or shift to public cloud utilizing low carbon grids



1. Deploy edge computing to reduce network transfers
2. Use efficient data transfer mechanisms

1. Ecodesign applications to minimize resource utilization
2. Develop sustainable architectures to rationalize applications, and identify and decouple energy-intensive applications
3. Streamline data architecture and optimize the data lifecycle
4. Design efficient and sustainable AI applications

Environmental disclosure and policy

1. Establish public disclosure and sustainability reporting for IT operations
2. Establish green policies for IT hardware and services procurement
3. Mandate environmental disclosure for IT vendors
4. Advocate circular economy principles for vendors

Governance

1. Assess the environmental impact of technologies and computing hardware
2. Establish and follow lifecycle carbon footprint accounting for all hardware
3. Establish carbon cost of IT operations
4. Develop change management programs and user awareness campaigns
5. Ensure participation of senior technology executives in the organization's sustainability governance

KEY INSIGHTS

- **Effective sustainable IT programs address the full scope of environmental impacts created by IT, from hardware manufacture to disposal, and from software procurement to engineering processes and everyday operations.**
- **Teams can ensure a critical view of their sustainable IT operations via assessment, governance, and implementation exercises that address six key areas: user hardware and devices, networks and communication systems, cloud computing, applications and data, environmental disclosure and policy, and governance.**

The Case for Cloud

Moving IT systems to a private or public cloud-hosted environment offers a fast, straightforward route to sustainable IT, if done properly.

CARBON IMPACT

Microsoft's studies have shown that moving applications from on-premise systems to their Azure public cloud can make IT operations up to 93% more power-efficient, in turn reducing CO2 emissions by up to 98%.

Other research estimates that by moving all applications to the cloud, enterprises could prevent one billion tons of CO2 emissions in three years.[30]

These emission savings are achieved, largely, by sharing energy-efficient computing infrastructure. This, in turn, saves running costs for organizations.

UNDERSTANDING INFRASTRUCTURAL EFFICIENCY

Many enterprises run simple line-of-business software on dedicated or virtualized servers, which waste computing power because of their low rate of utilization. Hosting these applications in cloud environments that share computing power between tenants enables organizations to massively increase their Power Usage Effectiveness (PUE – a measure of the efficiency of computing operations). Scope 1 and 2 emissions – those generated in the delivery of a business' services – are significantly lower, as a result (see fig. 13.)

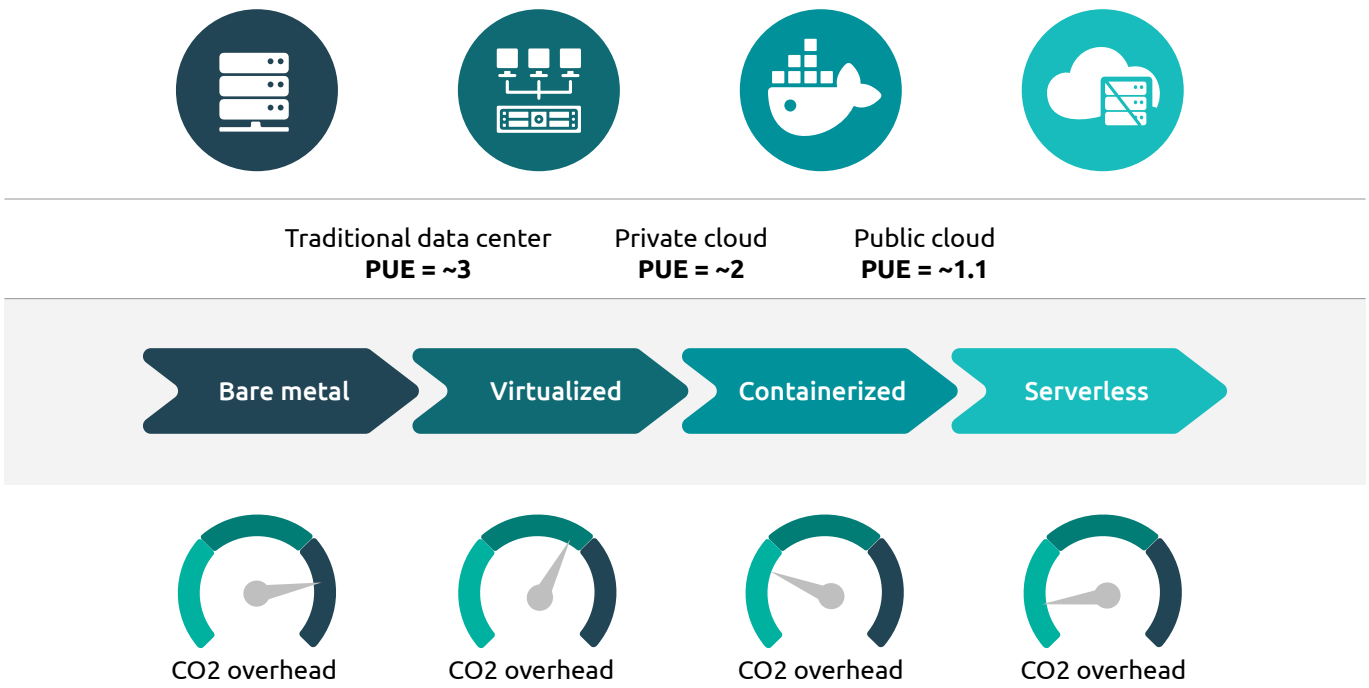
Public, multi-tenant platforms can be dynamically provisioned to ensure tenants' power usage balances with others. This way, each unit accommodates the most possible tenants while remaining performant. Energy usage can be predicted and minimized by the data center provider.

Private cloud systems – where hardware is used by a single tenant only – are typically less energy-efficient than public, multi-tenant systems, as each hardware unit contains spare capacity that could be shared with others.

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."

– LANCE PIERCE,
President, Carbon Disclosure Project, North America

Fig 13 How Power Usage Effectiveness (PUE) and CO2 overheads vary between hosting alternatives



Power Usage Effectiveness (PUE) measures data center energy efficiency. Lower ratings indicate greater efficiency.

Sources: Capgemini Research Institute

FOCUS & SUPPORT

Cloud users have greater visibility over their computer energy usage, boosting their awareness of energy costs and emissions.

This awareness is shared by their cloud provider. As a rule, data center providers are incentivized to monitor and optimize provisioning, performance and PUE wherever possible, to reduce their energy costs.

This includes implementing the most efficient hardware. The largest 'hyperscale' cloud providers use their purchasing power to collaborate with hardware manufacturers to improve hardware design and sustainability. Consideration extends to infrastructure around the data units, including lighting, cooling and conditioning.

Microsoft, for example, assesses PUE across all aspects of its data center operations, applying solutions at a micro level to drive efficiency. These include improved chip design, liquid immersion cooling, and even successful experiments with undersea data centers, as part of their Project Natick.

Once installed, providers ensure hardware is fully utilized throughout its life, thereby earning the greatest possible return on embodied emissions from the manufacture, transport and disposal of each unit.

Microsoft, for example, reuses and repurposes cloud hardware via its 'Circular Center', saving 90% of solid waste from going to landfill.[31] Experiments made during Project Natick saw Microsoft teams cut hardware failure by a factor of eight.[32]

Hardware can be reused for other tenants, and demand for components is lower as a result.

In this way, cloud tenants benefit from economies of scale in terms of hardware performance, financial investment and the carbon cost of manufacture of each component. As a result, cloud computing helps to effectively target scope 3 emissions generated across tenants' IT value chains, beyond their direct emissions (scope 1) and the indirect emissions generated by their use of power (scope 2). These scope 3 emissions are otherwise the most difficult to address.

OPTIMIZING OPERATIONAL EFFICIENCY

It's important to note that power efficiency can vary greatly from one data center to the next, according to the design and hardware choices made at the site.

In its study on the efficiency of cloud computing, Microsoft was careful to note that while 98% reductions in CO2 emissions are possible, this is dependent on "specific server usage, renewable energy purchases made, and other factors"[33] in rehosting. In short, considerations linked to scope 1, 2 *and* 3 emissions.

These "other factors" include optimizing application landscapes when rehosting to the cloud, to ensure systems *can* operate as efficiently as possible in their new location.

In the worst-case scenario, copying energy-intensive software to the cloud will achieve zero efficiency gains, because the unaltered applications will still require significant power on the new shared infrastructure. This must be considered at the 'assessment' stage of the sustainable IT journey (see fig. 12.)

Rehosting applications *only* means enterprises will fail to achieve their full sustainability potential when cloud-hosting, as the case studies at the end of this chapter demonstrate. In one, migrating to the cloud enabled an organization to reduce their CO2 emissions by 8%. Refactoring their applications reduced their emissions by a further 49%.

Research by the Capgemini Group shows that the more organizations invest in rationalizing their landscape, the greater their savings in terms of emissions.

Organizations have a wide range of architectural, application and data-focused options available to optimize their application portfolio, as captured in the Capgemini Group's sustainable IT 'focus areas' framework (fig. 14.) and explored in more detail below. The relative scope, cost and estimate energy-efficiency benefits of these options are shown in fig. 15.

Fig 14 **Optimization of cloud architecture, applications and data within the Capgemini Group's sustainable IT model**

1. Procuring hardware and user devices with minimum lifecycle carbon cost
2. Improving employee awareness of device utilization and sustainability
3. Proper disposal, recycling and refurbishment of hardware
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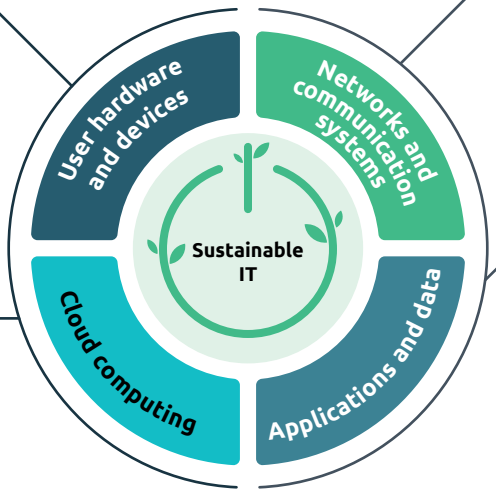

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Rehosting [5% greater efficiency]

Rehosting is a minimum-level effort option when moving application servers, databases and operating systems to the cloud, whereby each element is updated to meet the requirements of the new cloud infrastructure.

In some cases, rehosting is the only option available to organizations, especially when moving Commercial Off-The-Shelf (COTS) applications not designed for cloud. It's possible to reduce the cost and power consumption of these systems by using dev/test environments that schedule systems to automatically shut down for specified periods.

Refactoring [30% greater efficiency]

Moving application environments to the cloud landing zone and adapting applications to leverage Platform as a Service (PaaS) components makes it possible to achieve efficiency gains *without* making substantial changes to software architecture.

This option is feasible when software technology and architecture is able to run 'natively' on Platform as a Service systems, such as Azure App Service, Azure Container Instances or in a Kubernetes environment. Teams can develop applications in technologies they're familiar with, operating within a semi-shared infrastructure that automatically scales up or down based on application load.

Revising & Rebuilding [30-80% greater efficiency]

Application architecture is an important factor in determining software power consumption and resource utilization, and IT teams' ability to tune both factors. Microservices architectures, for example, can be used to apply innovations like containerization and serverless computing – both of which improve operational efficiency.

Containerization enables teams to move workloads to more energy-efficient locations. Compute-intensive workloads, for example, can be relocated from a middle-efficiency private cloud to a high-efficiency public cloud, like Microsoft Azure. In this way, containerization offers similar efficiency gains to refactoring.

Serverless architectures offer even greater efficiencies, by allocating cloud resources to applications only when those applications are required, to save both capacity and energy usage. This provides an optimal model for most line-of-business applications that do not require heavy computational workloads.

Serverless applications are easier to scale out and scale in, as they use a programming model that allows the underlying platform to add more instances quickly when demand increases.

Replacement [80% greater efficiency]

Many COTS applications can be replaced with lighter-weight SaaS applications that offer similar functionality and run on shared infrastructure. Access to these services is usually charged on a per-usage basis, thereby offering scalable costs and up to 80% greater efficiency.

Microsoft's Azure App Service allows teams to focus on developing and operating applications without needing to handle the operating system and infrastructure beneath.

Teams can operate several web applications in the same environment, maximizing utilization of their reserved capacity.

Examples of Microsoft **serverless solutions** include:

- Logic Apps and Power Apps: No-code/low-code solutions for creating integrations, workflows and internal applications.
- Power Automate: A cloud RPA (Robotic Process Automation) tool to automate repetitive manual computing tasks.
- Azure Functions: A 'Functions-as-a-Service' programming model for writing application and system logic, whereby users only pay for the seconds in which logic is executed.
- Azure Container Apps: These applications leverage the power of containerization and serverless models, while remaining cloud-agnostic. This way, teams can allow platforms to take care of infrastructure and operations, while applications scale automatically according to load.
- Azure Container Instances: For workloads involving batch jobs that are scheduled or triggered externally, container instances can be used to utilize minimal resources for the shortest period, instead of running the workloads on dedicated infrastructure.
- For more advanced use-cases, teams may build semi-serverless environments using Azure Kubernetes Services (AKS), Kubernetes Event-Driven Autoscaling (KEDA) and Container Instances-based scale-out nodes for addressing abnormal increases in load.

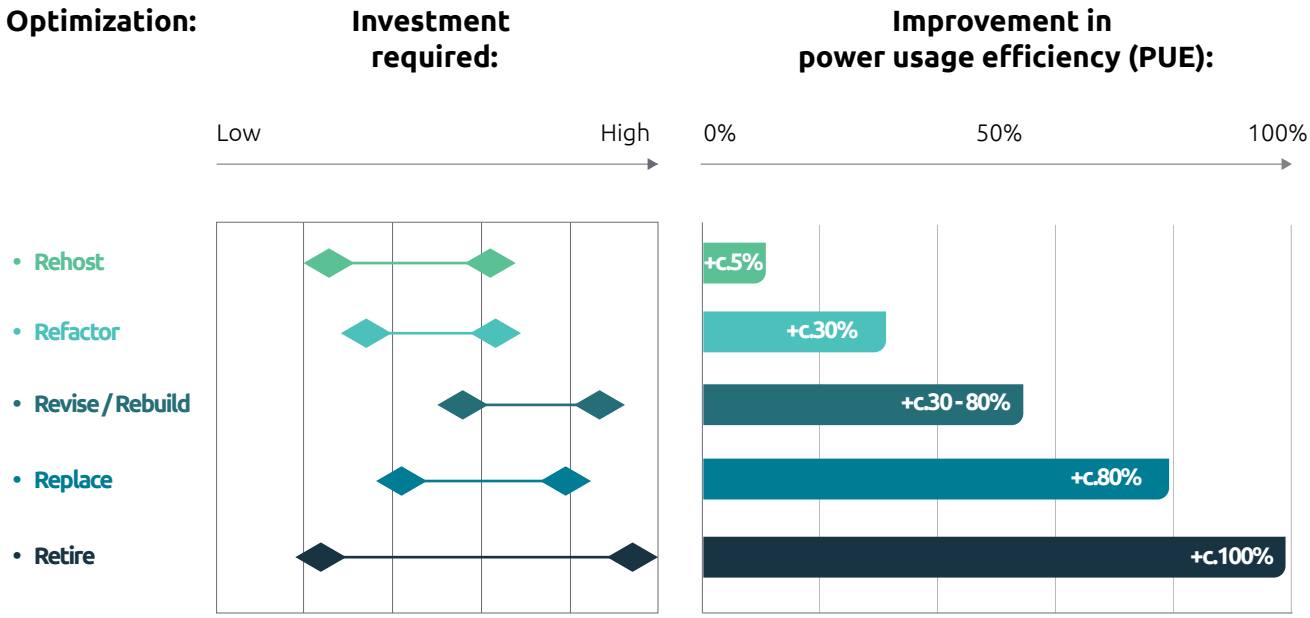
Serverless models also support **data storage**, for which Microsoft offers:

- Azure Cosmos DB: A scalable object data-store for non-relational data, with the option of a purely serverless model or an auto-scaling semi-serverless model.
- Azure SQL DB: A serverless model that scales up and down based on application workload.
- Azure Storage (Azure Blob Storage and Azure Files): These solutions provide scalable solution files and non-relational tabular data, and teams pay only for actual storage used at a given time. This removes the need to plan storage capacity, and users may attach a Content Delivery Network (CDN) to provide smart caching of files that are publicly available and distributed to a global audience.

Retirement [100% greater efficiency]

Migration to cloud offers an opportunity to assess whether heritage applications are still required, and whether their functionality is offered by other applications in the new landscape. Successfully retiring systems, that are switched off and do not consume resources anymore, demands careful planning and a change management approach that extends beyond IT.

Fig 15 **Comparing the scope, cost and impact of each optimization covered in this chapter**



PLANNING FOR SUSTAINABILITY

To achieve maximum sustainability, teams must first understand the full lifecycle of carbon emissions from across their existing IT landscape. With this information, they can select their target cloud infrastructure and choose the relevant optimization exercises for their applications (see fig. 16.)

As part of the 'assessment' stage of the sustainable IT model, the Capgemini Group offers a range of tools to understand and visualize clients' carbon footprint lifecycle, including CO2 emissions from buildings, shipping, system usage, and the reuse of all technology devices, including servers, printers and desktops.

The Capgemini economic Application Portfolio Management (eAPM) suite, for example, offers the ability to calculate and analyze the system energy usage of applications depending on their underlying server structure. With this information, organizations can select their target cloud infrastructure and choose the relevant optimization exercises for their applications (see fig. 17.)

Fig 16 Planning for cloud optimization, to maximize sustainability

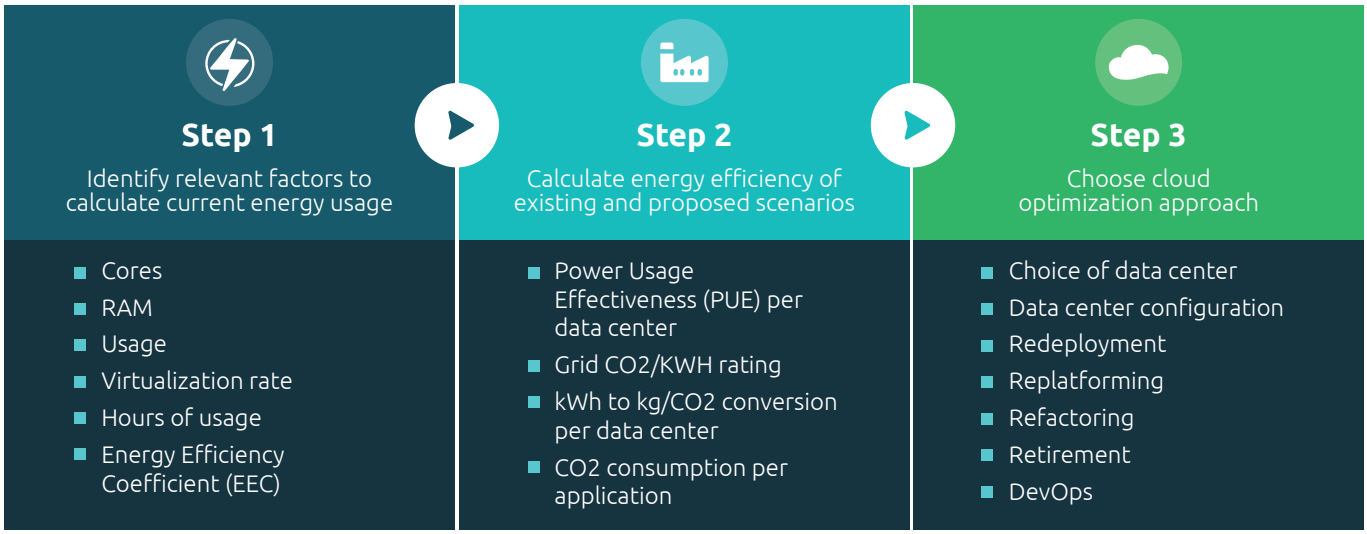
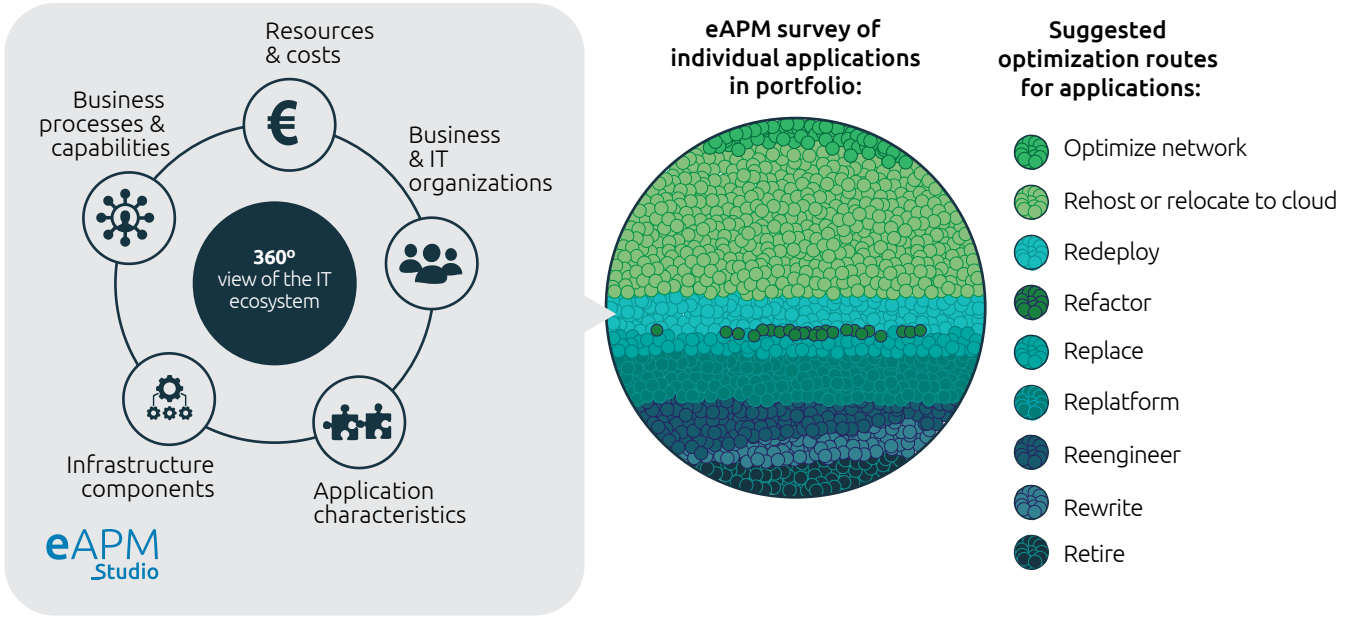


Fig 17 How the Capgemini Group's eAPM suite automatically assesses optimization routes for individual applications, to improve operational efficiency and system sustainability.



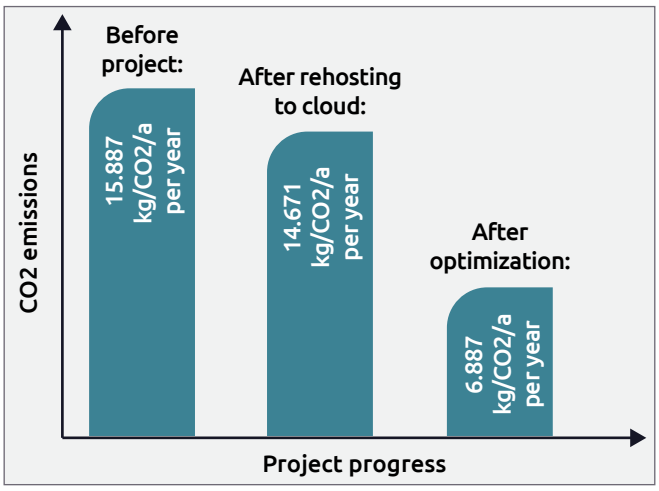
ONGOING OPTIMIZATION

Optimization shouldn't be a one-time exercise. By applying DevOps practices to shorten development cycles and implement changes quickly, IT teams can ensure system energy usage is continually minimized in their new cloud environment.

Emissions-monitoring applications can also play a key role. Microsoft's Emissions Impact Dashboard, for example, uses Power BI to provide teams with accurate data on the emissions generated by their use of Azure cloud and Dynamics systems.

Several hyperscale providers offer AI solutions to monitor and optimize cloud-hosted workloads on an automatic basis. Microsoft's Azure Monitor and Application Insights system is one example, providing an easy-to-use dashboard for tracking and solving abnormal resource consumption on Azure.

SUSTAINABLE IT IN ACTION



CASE STUDY:
Automotive Manufacturer

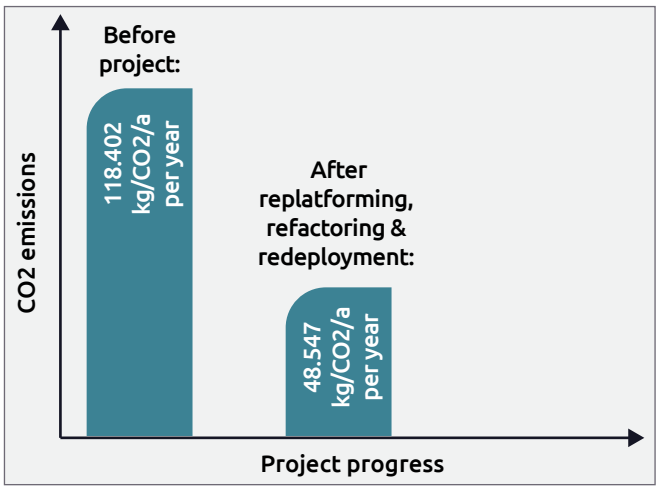
Optimizations:

- Applications moved to public cloud system; applications transformed and containerized.
- Applications refactored to open-source shared services; API consolidated.

Results:

- CO2 emissions down 8% following move to cloud (from 15.887 kg/CO2/a to 14.671 kg/CO2/a).
- CO2 emissions down a further 49% following optimization (from 14.671 kg/CO2/a to 6.887 kg/CO2/a).

57%
lower total CO2 emissions



CASE STUDY:
Chemical Manufacturer

Optimizations:

- Applications moved from existing data center to hyperscale data center.
- Application portfolio rehosted, refactored and redeployed.

Results:

- CO2 emissions down 58% following application rehosting, refactoring and redeployment (from 118.402 kg/CO2/a to 48.547 kg/CO2/a).

58%
lower total CO2 emissions (extrapolated)

KEY INSIGHTS

- **Migrating applications to the cloud is among the most impactful ways for enterprises to advance towards sustainable IT, being up to 93% more energy-efficient than on-premise computing.**
- **With the right infrastructure and renewable energy source, it is possible to reduce IT operational emissions by up to 98% using cloud systems.**
- **To maximize the sustainability of their cloud setup, IT teams must assess and optimize the operational efficiency of their application landscape and IT practices, as both have an outsize impact on power consumption and resource utilization, and therefore emissions generated.**

Energy Innovation: Microsoft Azure and Vattenfall

This paper has shown how cloud-hosting can offer an impactful way for organizations to make their IT operations more sustainable, by minimizing power consumption and waste. For maximum sustainability, cloud data centers should be powered by renewable energy. Microsoft is leading the charge in this area. The Swedish state-owned energy company Vattenfall is one of Europe's largest producers and retailers of electricity and heat and are determined to enable fossil-free living within one generation. Together with partners, Vattenfall is taking on the responsibility to find new and sustainable ways to electrify transportation, industries and heating.

CLOUD FOCUS

Microsoft's data centers are an important focus area in the company's efforts to drive carbon, water, waste and ecological sustainability across five pillars of its business – employees, operations, policies, products and services, and customers and partners.

Having achieved carbon-neutrality in 2012, Microsoft aims to be carbon negative by 2030 – then, by 2050, to have removed its historic emissions entirely. To do this, the organization aims to eliminate scope 1 and scope 2 emissions – those generated from business activity and from the power it uses – from its operations by 2025. The organization aims to cut half of its remaining scope 3 emissions by 2030.

Fig. 18 shows some of the company's achievements to date.

ZERO CARBON

As part of its drive towards carbon-negativity, Microsoft is working to implement 100% renewable energy sources for its data centers by 2025, alongside its other buildings and campuses.

Much of this renewable power will come from new wind, solar, hydroelectric and blended power projects, made possible by Microsoft's stewardship of the computing power requirements of thousands of customers.

These projects will be complemented by local community initiatives on renewable energy education, reflecting Microsoft's 100/100/0 vision to ensure that 100% of the electricity we consume, 100% of the time, is matched by zero-carbon purchases, by 2030.

Fig 18 **Microsoft's achievements around CO2 emissions, to date**

580,000	21m	1.3m
tons of scope 1, 2 and 3 emissions removed	tons of CO2-equivalent emissions saved by suppliers	tons of carbon removal earmarked for future removal

Sources: Microsoft: 'Building a more sustainable future together', 2021

AZURE AND VATTENFALL AB

Microsoft's three new data centers in Gävle, Staffanstorp and Sandviken, Sweden, are at the leading edge of the company's campaign on carbon emissions.

In 2019, Microsoft partnered with Swedish energy provider Vattenfall AB to power Microsoft´s new datacenters in Sweden, and to develop a 24/7 energy-matching solution that tracks consumption, generation and storage data for Vattenfall's renewable energy sources, in real-time. This provides Vattenfall AB with a clear indication of the renewable energy required to meet Azure users' demands at any time.

Having initially been used for Microsoft's data operations in Sweden, Azure customers across that country are now also able to access this power-matching solution. It is the first commercial application of its type offered by a hyperscale provider and offers a unique level of sustainability transparency.

Today, organizations typically purchase renewable energy via a Guarantee of Origin (GO) or Renewable Energy Certificate (REC). These entitle the buyer to access renewable energy over an extended period, according to average rates of production and consumption.

Under this arrangement, energy providers are unable to balance renewable energy demand with supply, because they lack detailed information on customers' fluctuating energy needs. With Microsoft's 24/7 power-matching solution, the energy provider – Vattenfall – has access to this data on an hourly basis.

Azure customers can, in turn, ensure that their data center activity is being served by 100% renewable energy around the clock, with hour-by-hour visibility and accountability for climate impact reporting.

MAXIMIZING IMPACT

In this way, Microsoft's Swedish data centers offer the pinnacle of hosting sustainability, blending market-leading efficiency with 'true' renewable power.

This breakthrough innovation has significance for now and the future.

Microsoft anticipates that the 24/7 energy-matching solution will drive market forces around renewable energy. Armed with accurate information on customers' renewable energy demands, Vattenfall AB and other energy providers can make informed investments into new renewable energy sources. This will incentivize many to invest in energy storage solutions that enable them to 'release' energy at moments of anticipated high demand. Customers can better understand how purchasing GOs and RECs reflect their actual renewable energy usage. Both factors should drive regulatory change around renewable energy markets.

> *Our efforts go well beyond procurement because we recognize that simply adding more renewables is insufficient. We are innovating ways to enable utilities to on-board increasing amounts of renewables in an effective and efficient way, so more people can benefit from renewable energy."*
>
> **– MICROSOFT 2020 ENVIRONMENTAL SUSTAINABILITY REPORT**

KEY INSIGHTS

- **Maximum sustainability for cloud-hosting can only be achieved where data centers are powered by renewable energy sources.**
- **Microsoft has invested more than a decade in driving down CO2 emissions from its Azure data centers, as part of its vision for net-zero by 2030.**
- **Microsoft's new data center region in Sweden reflects the company's focus on renewable energy innovation. Azure users in the country have access to a groundbreaking 24/7 energy-matching solution that ensures all cloud computing is served by renewable energy from energy company Vattenfall AB.**

Conclusion: The Next Step

Too few enterprises understand the impact that their IT systems have on our environment. To reduce that impact, sustainable IT must become part of the way forward for enterprises across the globe.

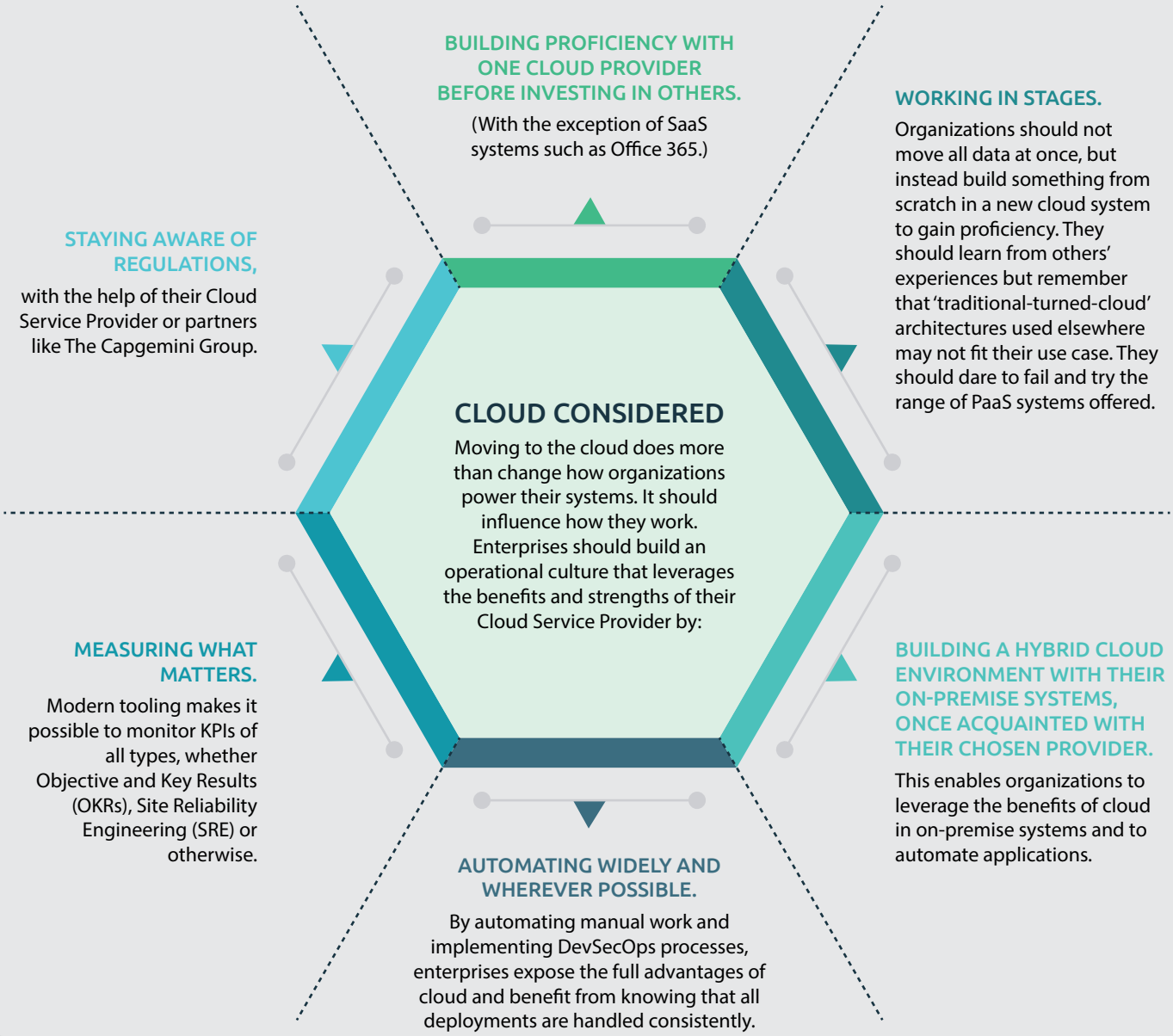
In this paper, the Capgemini Group has set out four pillars for sustainable IT; a three-step roadmap for building sustainable IT operations; and six key focus areas to help enterprises accelerate their sustainable IT journey.

In turn, this paper makes the case that one of those focus areas – moving to the cloud – offers a highly effective route to sustainable IT, when implemented under the correct conditions (see fig. 19.)

For more than a decade, the Capgemini Group has supported organizations to build cloud environments and workloads and migrate systems to the cloud, and in turn help realize the benefits that cloud offers to enterprises and our environment.

This work will become ever more important as we drive towards a net-zero future.

Fig 19 Key cultural considerations for enterprises moving their IT operations to the cloud



SUSTAINABLE IT & THE CAPGEMINI GROUP

Sustainability is a key pillar of the Capgemini Group's strategic ambitions, and we are committed to helping organizations to achieve their net-zero objectives. Sustainable IT is the first block of our Group sustainability framework, with which we support organizations to:

- Understand the significance of IT systems and operations on their sustainability agenda.
- Develop a holistic view of what they can achieve regarding IT and sustainability – including using smart technologies, and by moving from a net-zero strategy to green product and service experiences.
- Initiate or accelerate their cloud journey
- Engage every employee in sustainable IT.
- Build sustainable IT into operations, using an MVP to define project scope, achieve results quickly, understand outcomes and iterate for success.

To kickstart your Sustainable IT journey, our experts can deliver a comprehensive overview of your IT sustainability maturity via an in-depth qualitative and/or quantitative study. This will empower your team with a clear understanding of your sustainability status today, and quick wins and next best steps for your organization.

TO EXPLORE THE ELEMENTS OF SUSTAINABLE IT COVERED IN THIS PAPER – INCLUDING CLOUD – BOOK YOUR SUSTAINABLE IT WORKSHOP WITH THE CAPGEMINI GROUP TODAY

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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 325,000 team members in more than 50 countries. With its strong 55-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 2021 global revenues of €18 billion.

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Further reading

Capgemini: Sustainable IT: Why it's time for a Green revolution for your organization's IT [Click here]

Capgemini: Sustainability Evolution: Will your organization turn disruption into opportunity? [Click here]

Capgemini: Environmental Sustainability Performance Report, 2020/2021 [Click here]