Hitachi Vantara

RESEARCH REPORT

The State of Data Infrastructure Sustainability

Findings of a global research study by Hitachi Vantara

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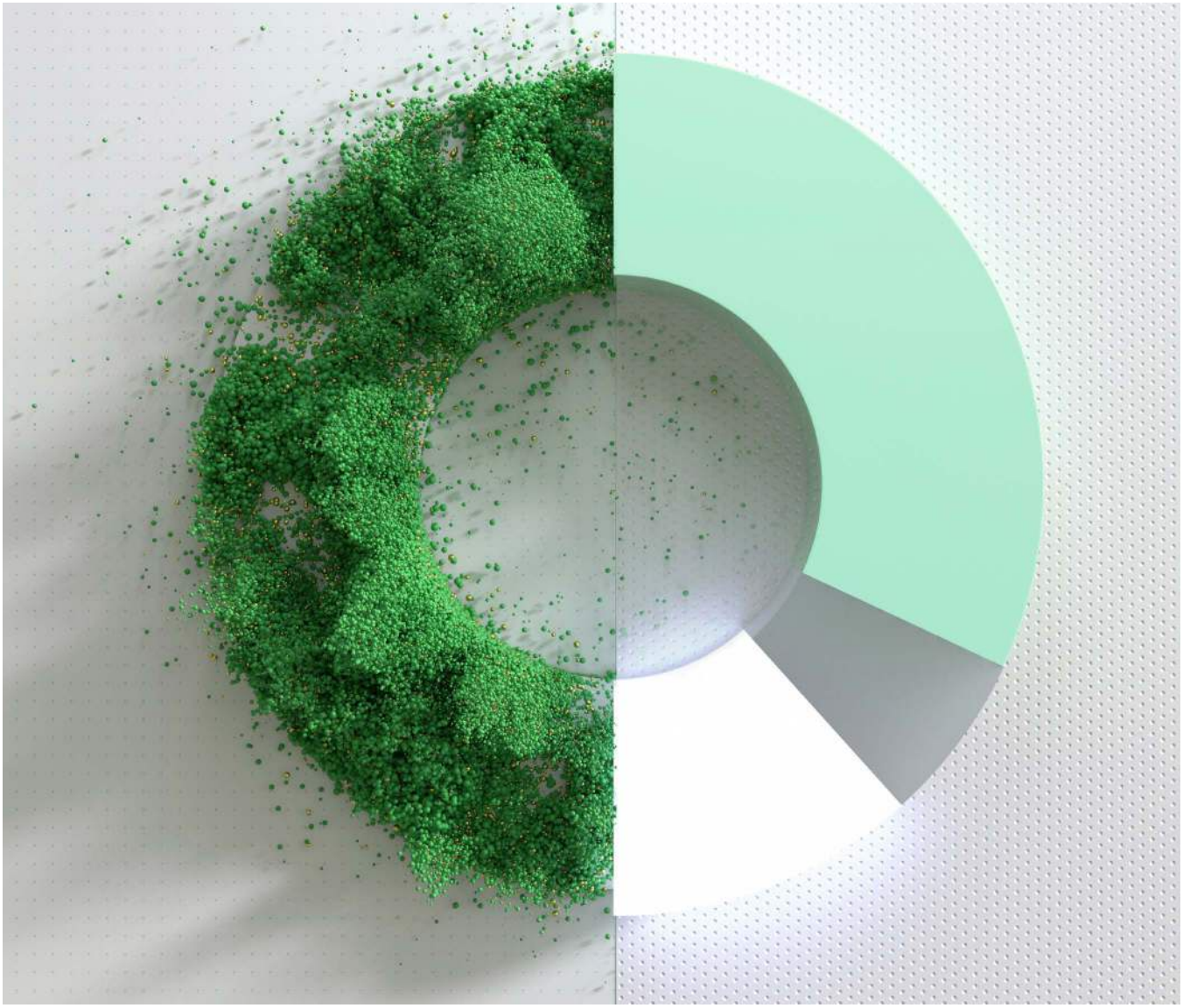


Executive Summary

Sustainability continues to be a priority for businesses worldwide. Yet, while a majority claim their plans are on track, the reality is more complex.

In a recent study among 1,000 global businesses by Hitachi Vantara, the data center is identified as a focal point for decarbonization, though many don't fully understand the impact the data center has on their overall carbon footprint. Additionally, nearly half report cloud migration is the primary approach to reducing data center CO2 emissions. This highlights a common misconception that shifting workloads from data centers to the cloud addresses the problem. As a result, many place a lower priority on approaches such as moving to high-performance data infrastructure, even though this has proven to be more immediate and cost-effective.

The study did reveal there are a growing number of leaders who think differently and recognize that modern data infrastructure is pivotal in driving sustainability forward. Companies that aim to boost their environmental performance would be well-served by pursuing the same infrastructure strategy to stay ahead.

Introduction

Data Center Decarbonization

The New Frontier in Business Sustainability

Data infrastructure often takes a back seat in sustainability discussions among business leaders and policymakers. No mention of data infrastructure was made in recent United Nations Climate Change summit agendas or official policy communiqués. Yet every day, businesses around the world generate, consume, store, process and move massive volumes of data, often with little insight into the energy and carbon footprints of their actions.

The energy demands of data creation, storage, movement and processing are formidable, and growing at an unprecedented rate. Total worldwide data creation more than doubled just over the past three years, 2019-2022, from 41 to 97 zettabytes. And it's forecast to nearly double again by 2026 to 181 zettabytes, according to Statista.

The Information and Communications Technology (ICT) sector now generates an estimated 3.9% of global carbon emissions, putting it ahead of other industries like aviation or chemicals. And that share has grown quickly. According to the International Energy Agency, data centers and transmission networks accounted for just 0.6% of global greenhouse gas (GHG) emissions in 2020.

As emerging next-gen technologies – AI/machine learning, blockchain, the IoT, virtual reality, the metaverse, social platforms, etc. – continue to grow in scale and complexity, data centers will need to accommodate ever larger workloads, increasing energy usage and related carbon emissions. Take deep learning models, for example. According to the Association for Computing Machinery (ACM), the computing resources needed to train these models jumped an estimated 300,000 times between 2012 and 2018. Given the rapid pace of data growth and recent advances in these areas, these impacts will multiply exponentially in the years ahead if left unchecked.

The Cloud Alone is Not the Answer

Against this backdrop, some enterprises have looked to public cloud as a potential solution to their data sustainability goals. Yet the economics of data center decarbonization are complex, with many factors – energy sources, location, technology platform and regulatory environment – influencing energy use and carbon impact.

While hyperscalers can be efficient in the management of their facilities, this is not necessarily the case for the infrastructure that runs their internal and customer applications and

workloads, including servers, storage and networks. Hence, hyperscalers do not solve the problem for their customers. Companies that transfer their carbon emissions to public cloud providers are still accountable for it through their Scope 3 reporting. In a worst-case scenario, this may actually result in moving workloads from a low-carbon-emission country to a high-carbon-emission country[1], making the impact even worse.

Companies that transfer their carbon emissions to public cloud providers are still accountable for the impact through their Scope 3 reporting.

For most enterprises, the answer to data-driven sustainability lies closer to home: in the data center itself. Several use cases show that deployment of more eco-friendly data center infrastructure can reduce carbon emissions significantly more than public cloud providers can. These results can be delivered by controlling various facilities, such as uninterruptible power supplies (UPS), cooling systems and storage infrastructure.

To shed light on how companies are addressing today's data sustainability challenges, **Hitachi Vantara surveyed 1,000 global enterprises across a range of industries** on their data center sustainability strategies and performance. The results, presented in this report, provide an evidence-based roadmap to data center decarbonization, along with actionable insights into best practices organizations anywhere can use to benchmark their plans.

1 In a low-carbon country most of the energy is created by renewable resources (e.g., hydro, wind, solar) whereas in a high-carbon country, most energy derives from fossil fuels (gas, oil, coal, etc.).

The Report is Presented in Four Distinct Sections:

1. **The sustainability imperative:** An examination of the drivers, challenges, responsibilities and solutions.
2. **The data center connection:** Actionable insights on how to develop an eco-friendly data center that both reduces CO2 emissions and energy consumption.
3. **Demystifying the economics of data center decarbonization:** A short primer illuminating this critical, but complex area.
4. **An instructive call to action:** Why the time for business leaders to take action on their own data sustainability initiatives is now.

A summary of the survey methodology and sample demographics, designed and implemented in collaboration with independent market research partners at ThoughtLab, is included at the end of this report.

Section 1

The Sustainability Imperative

Demands for Action are Rapidly Increasing

Regulatory pressures are mounting around the world for companies to reduce their carbon emissions and limit global warming.

The EU has led with its European Green Deal and a raft of measures to improve climate-risk transparency. In the U.S., the Biden Administration has made clean energy a cornerstone of the recently passed Inflation Reduction Act, with a goal to reduce carbon emissions 40% by 2030. While the Securities and Exchange Commission

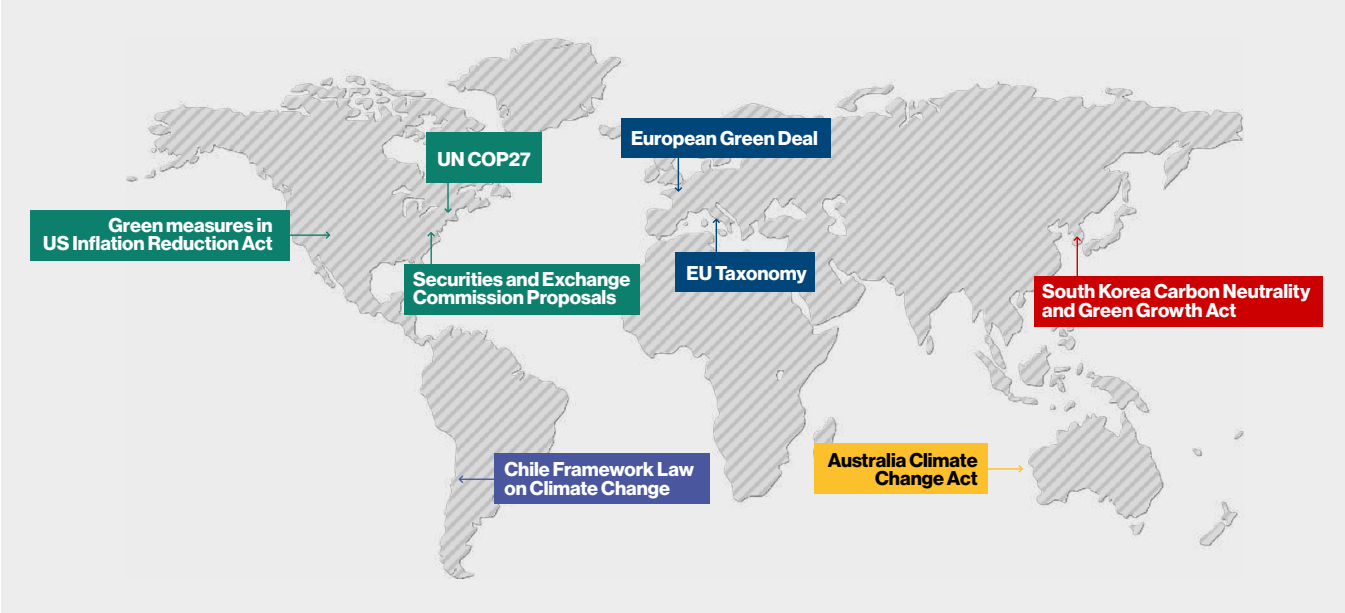


Fig. 1 Pressures rising everywhere

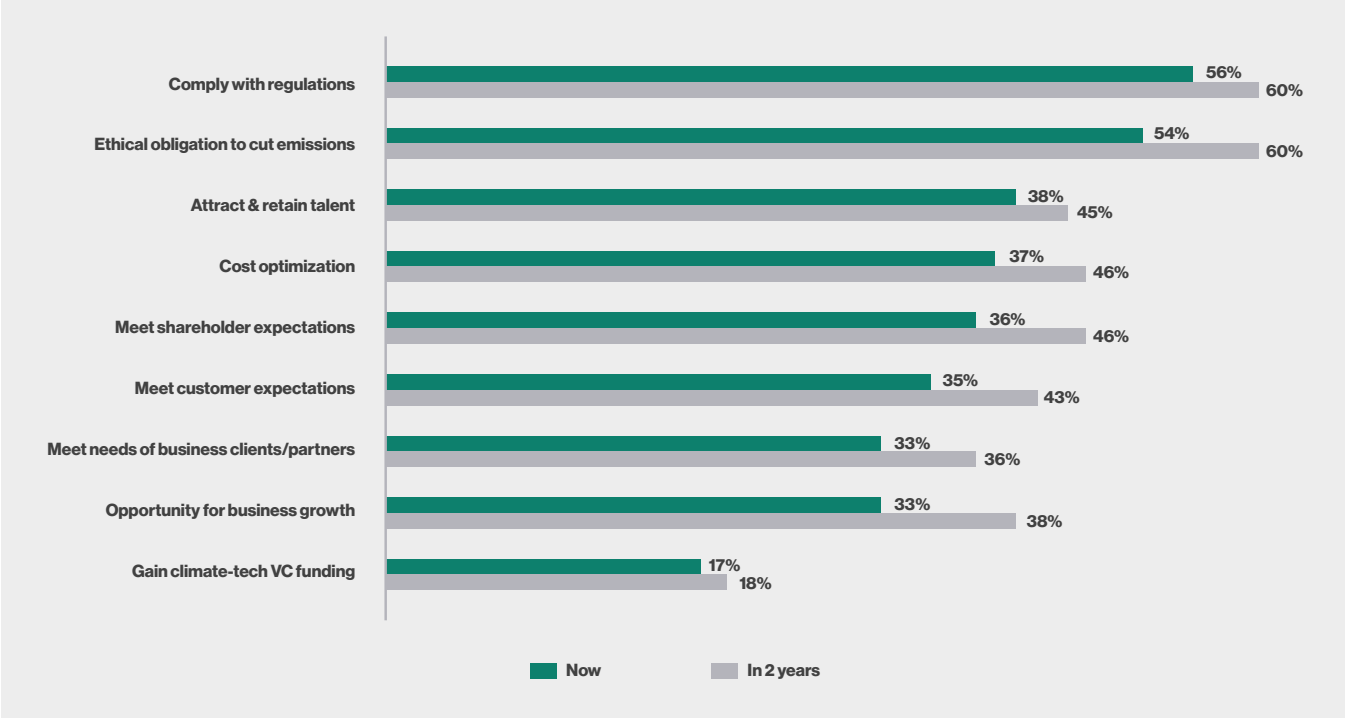


Fig. 2 Drivers of organizational sustainability goals, now and in two years

(SEC) is proposing new rules requiring greater disclosure of GHG emissions and climate-related risks by public companies.

In Latin America, Chile is a leader in climate legislation, with its Framework Law on Climate Change. Regulators in Asia Pacific, slower to react, are now catching up with new requirements for climate-related disclosures. For example, in March 2022 South Korea introduced the Framework Act on Carbon Neutrality and Green Growth, with the goal of cutting carbon emissions more than 35% by 2030. Australia introduced a Climate Change Act in 2022, as well (Figure 1).

The survey results also highlight the sense of urgency; 56% of respondents cite the need to comply with new legislation or regulations – along with an accompanying ethical obligation to be part of this initiative – as top drivers of their sustainability goals (Figure 2). And they expect these pressures to rise further over the next two years.

Regulatory pressures are mounting around the world for companies to reduce carbon emissions and limit global warming.

At the center of the strong moral obligation expressed by senior managers to address climate change, many firms express a related belief in the importance of shared value creation – that their organizations can do well as they do good. Indeed, a large number believe that a sustainability commitment will help them to attract and retain talent, optimize costs and generate growth. A smaller percentage (17%) also think it will enable them to gain access to climate-tech investment and/or venture capital.

Over the next two years, leaders across the C-suite expect most of these forces to strengthen. Regulatory requirements and ethical obligations will still dominate. But the greatest escalation in sustainability demands will come from key stakeholders – employees, customers, partners and investors – each a unique group senior management can't afford to ignore. Cost optimization will continue to remain a major catalyst for sustainability action and executives will pay increasing attention to its ability to help drive business growth.

Eco-Data Leaders Think and Act Differently

Against this background, firms are taking a variety of actions to address climate risks. The most prevalent include decarbonizing data centers, shifting to alternative energy

Our Eco-Friendly Data Center Maturity Framework

Based on the study results, combined with deep expertise in the space, we created a framework for maturity in developing an eco-friendly data center strategy, incorporating the progress organizations reported across eight key areas of data center design. This framework also distilled viewpoints from academic and research papers on the topic.

These key areas are:

1. Ensuring efficient, energy-saving data management.
2. Modernizing and streamlining processes and applications.
3. Using the latest technologies and tools to drive efficiency and reduce emissions.
4. Setting and tracking goals for decarbonization and measuring results.
5. Developing an implementation plan, budget and team to build an eco-data center.
6. Consolidating and upgrading servers, storage and other infrastructure.
7. Ensuring optimal cooling systems and use of air flow.
8. Working with partners and suppliers with eco-data center expertise.

Using these as a benchmark, respondents were asked to report their progress and apply scores using a scale from 0-4 as shown below:

0—Not considering or not applicable (0 points)
1—Planning: Exploring options, developing plans (1 point)
2—Early implementation: Starting to implement plans (2 points)
3—Intermediate implementation: Midway in implementing plans (3 points)
4—Advanced implementation: Fully implemented plans (4 points)

Respondent breakdown/results based-on our framework:

- **27% Beginners:** largely in the planning stage across these eight initiatives but starting to implement those plans in several areas.
- **19% Implementers:** mostly in the early implementation stage for these initiatives, with a minority in the planning or mid-implementation phase.
- **29% Advancers:** also in early or mid-implementation but leaning more strongly towards mid-implementation than early implementors.
- **25% Leaders:** "eco-data leaders" are those that are most advanced across the eight initiatives.

The lion's share are either mid-implementation or advanced in each initiative.

sources and generally using the latest technologies that help reduce carbon impact.

Given the pivotal role of data center decarbonization, the study helped identify a hierarchy of "eco-data leaders" based-on the progress their companies have made building and implementing an eco-friendly data center (see box, "Our eco-data center maturity framework," above). These leaders realize the dangers of reactive strategies to regulation and instead seek to innovate to stay ahead of regulators and industry competitors.

Our maturity framework reveals that these forward-looking leaders and organizations think differently about sustainability and its role in their businesses. As companies mature into eco-data leaders, they become more advanced in integrating and associating sustainability performance

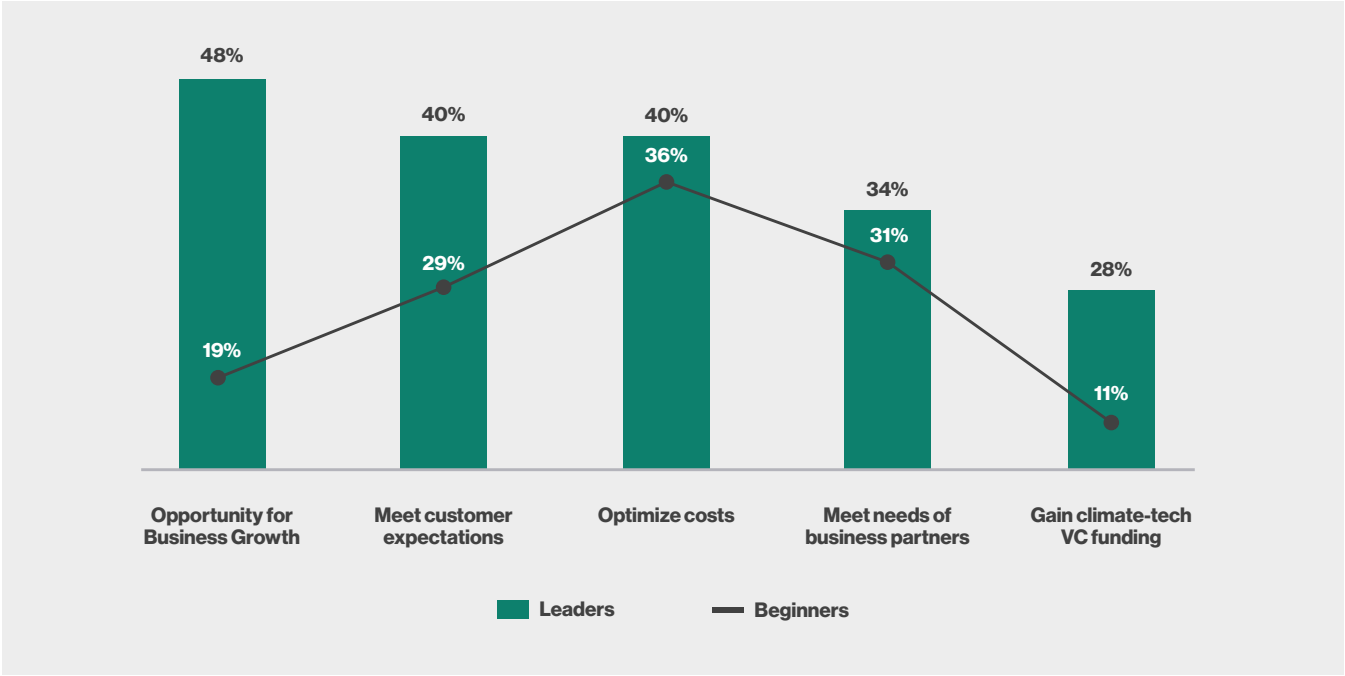


Fig. 3 Eco-data leaders more likely to associate sustainability with value creation

with business outcomes. Notably, eco-data leaders are much more likely to see sustainability as inextricably interwoven with business value, as it presents greater opportunities to grow their business, attract investment, meet customer expectations and optimize costs (Figure 3).

Eco-data leaders also differ from others in how they plan, execute and assign responsibility for their sustainability strategies. They are much more likely to have distributed leadership responsibilities among the top echelons of their organization, where a cross-section of senior leaders is involved, directly or indirectly, in sustainability decision-making.

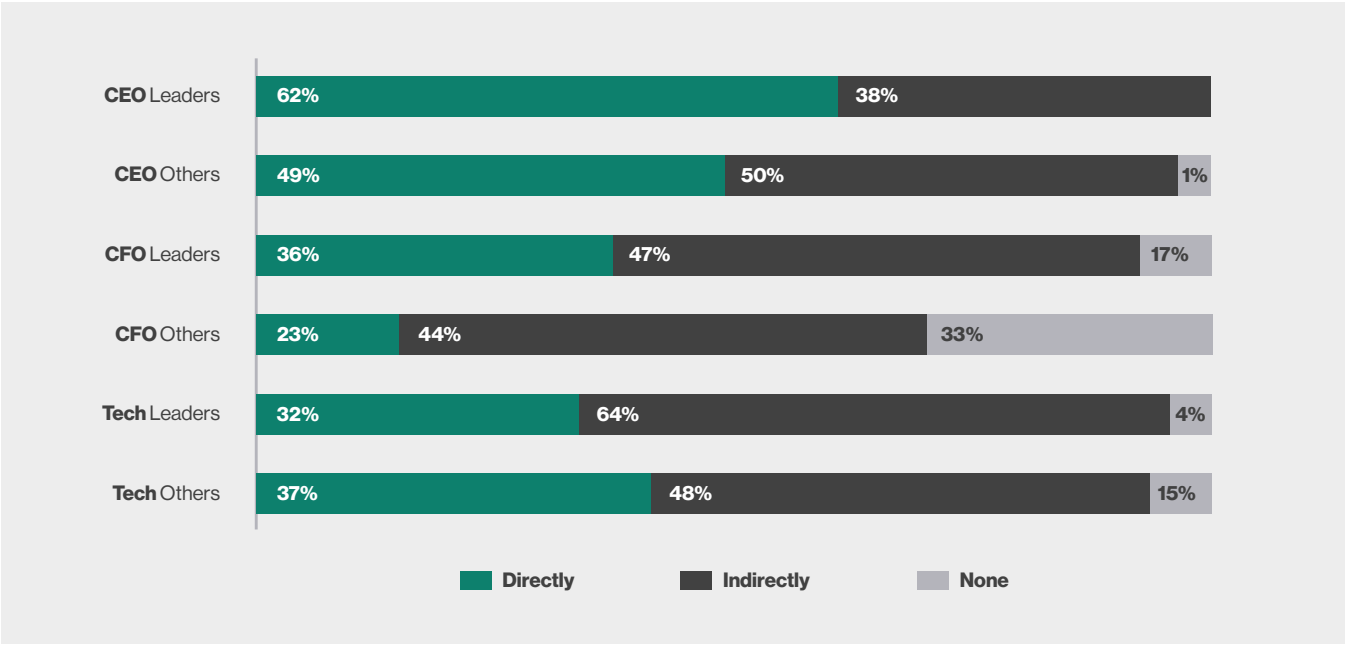


Fig. 4 Allocation of C-level responsibility for sustainability, eco-data leaders vs. others

One key difference is the role of the CEO. In most eco-data leader driven organizations, CEOs are at the vanguard of sustainability programs, underlining sustainability as an imperative for the business. In such companies, 62% of CEOs are directly responsible for sustainability KPIs, vs. just under half (49%) in others, where CEOs are more likely to play an indirect role (Figure 4).

This central role of the CEO means that other C-level execs also have a strong impetus to deliver on sustainability and set the right incentives and managerial cues for the rest of the organization. For example, CFOs in eco-data leading organizations take more direct and indirect responsibility for sustainability performance than in other companies. Similarly, the technology C-suite (CIO, CTO, CDO) is also more likely to have responsibility for sustainability than their counterparts in other companies. In short: for eco-data leading organizations, executive management is more likely to play a role delivering on sustainability outcomes.

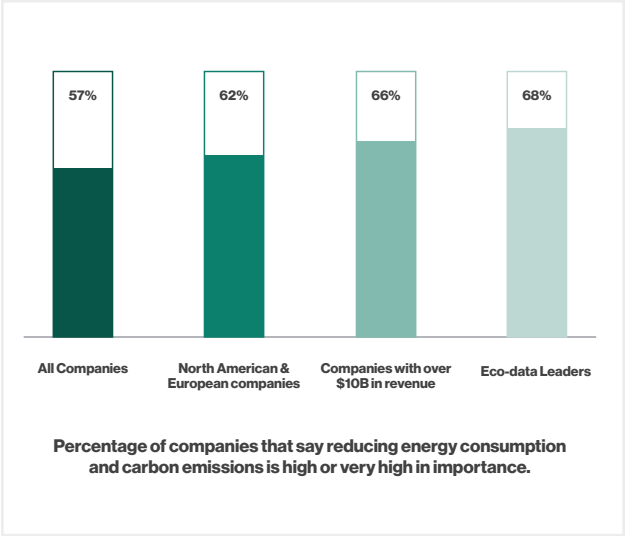


Fig. 5 The sustainability imperative in numbers

Companies are Taking Decisive Action

While their level of focus varies, most firms now have carbon emissions firmly in their crosshairs. About 8 in 10 have established ambitious goals to reduce emissions and many have already made progress against their plans. One is a Nordic manufacturer, whose chief sustainability officer said, "In my organization, we have made drastic changes to achieve our sustainability goals."

Most companies attach high importance to reducing carbon emissions. But there are variations by location, size and maturity. More businesses in North America and Europe see it as highly important vs. those in APAC. With bigger budgets and greater pressure from stakeholders, larger firms also rank reducing carbon emissions higher than do smaller firms. And

The Eco-Data Leader's Edge

68%

68% of leaders – vs. 53% of other companies – assign high or very high importance to reducing carbon emissions and energy consumption in their organization (Figure 5).

27%

27% of leaders report they are ahead of their carbon reduction plans vs. 19% of others.

2036

Leaders plan to achieve carbon neutrality by 2036 and net zero by 2047, several years ahead of others.

51%

51% of leaders see an eco-friendly data center as one of the best ways to decarbonize vs. 27% of others.

eco-data leaders are much more likely to find decarbonization an imperative than others, which explains why they are ahead in their sustainability journey.

Most organizations have set goals for achieving carbon neutrality (a state of net zero CO2 emissions) and even more have done so for net-zero carbon emissions. The latter is a stronger measure that requires a firm to emit no GHG, including methane, nitrous oxide and other hydrofluorocarbons, in addition to carbon dioxide.

Most firms also believe they are on track or ahead of plan to achieve their organizational carbon reduction goals (Figure 6). European and U.S. companies are leading the charge, with firms in APAC playing catch-up. Public sector enterprises are further ahead of plan than others, reflecting their need to serve as role models and meet higher governmental standards (Figure 7).

Again, eco-data leaders are showing the way for the rest. They assign higher importance to reducing energy consumption and carbon emissions, have set more ambitious goals for achieving carbon neutrality and net zero, and they are more likely to be ahead of plan than others.

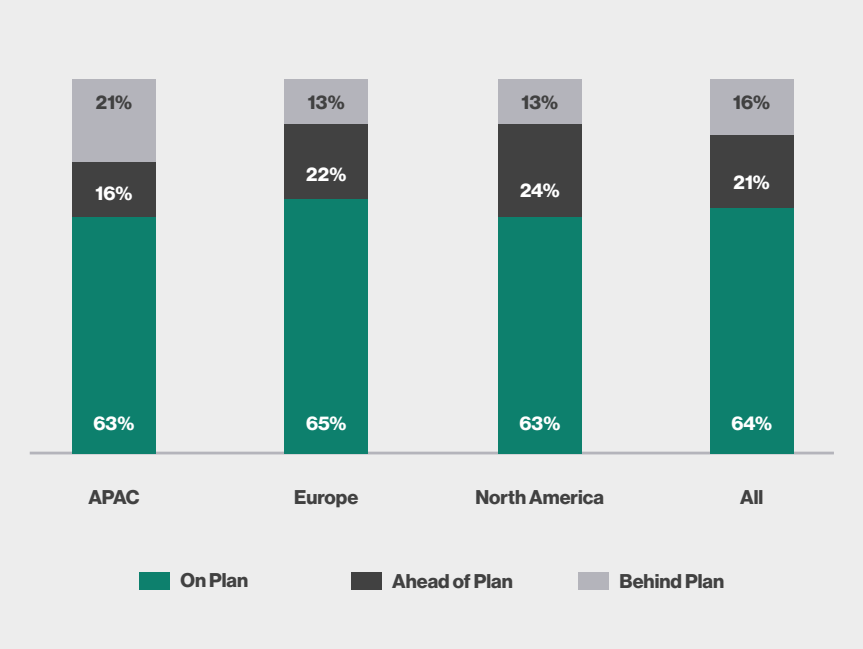


Fig. 6 Progress against carbon reduction goals, by region

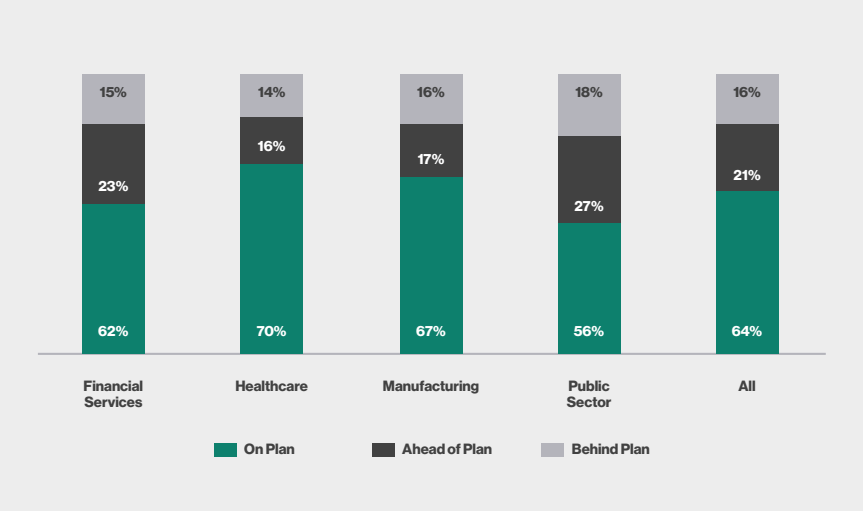


Fig. 7 Progress against carbon reduction goals, by industry

Sustainability Progress: A Closer Look at the Challenges Ahead

While many companies have set sustainability goals and report early progress on their plans, there are still many hurdles ahead, as they take their initiatives to the next level. These fall into four categories (Figure 8).

One of the most vexing areas for executives is **coping with external factors outside their control**. For one, they need to keep up with a rapidly spreading maze of sustainability regulations around the world. For another, they must limit the impact of emissions that are not under their direct control, such as customer use of products and services, which can be difficult to not just manage, but to measure. Sprawling, diverse supply chains – often far-flung across different regions – add to the challenge. European companies are particularly concerned by emissions and assets not being under their direct control (38% vs. 33% of firms in North America and 30% in APAC).

Better information would help, but executives also run into **a second set of hurdles, due to limited access to data**. Many firms cite this as a problem, while others point to a lack of standardized metrics and

Better information would help, but executives cite a second set of hurdles, due to limited access to data. Others point to a lack of standardized metrics and measurement tools even when it is available.

measurement tools even when it is available. Companies in North America and APAC are particularly aware of deficiencies in access to sustainability data (Section 3 of this report examines measurement challenge in more detail).

Sustainability strategies also flounder due to gaps in talent and expertise. Firms say that they do not have sufficient access to needed sustainability skills and talent, a reflection of gaps in local market resource pools, as well as in corporate upskilling and hiring programs. Tapping into outside networks of expertise could help to fill these talent gaps, but firms also struggle to find the right partners and consultants, which is a more acute challenge for firms in APAC.

The final group of challenges revolves around inadequate organizational management. These include the lack of a sustainability strategy and plan, insufficient senior executive support, high costs and limited budgets, and an uncertain business case. As more management teams make sustainability a top priority, these organizational and governance issues should diminish.

Further complicating matters, these challenges morph together as companies make progress in making their data centers eco-friendly (Figure 9). For beginners, the obstacles revolve around "nuts and bolts" issues of compliance, budget, data and resources. For eco-data leaders, higher-order impediments come to the fore, e.g., around making complex technology choices, moving from data to measurement and managing disparate supply chain aspects of sustainability.

Technological, Cultural and Process Changes are Essential to Success

Overcoming these challenges requires a next-level use of technology and fresh thinking. Firms are taking steps to reduce carbon emissions along three broad fronts: harnessing technology solutions, adapting culture and governance and embracing sustainable processes (Figure 10). But for many, it is still a work in progress.

Most companies are **putting the latest technology front and center** in their sustainability plans. The top four steps companies are taking to improve sustainability all involve technology: decarbonizing their data centers; harnessing the latest technology solutions to reduce their carbon footprint; shifting to alternative energy sources; and ensuring energy efficient buildings, plant and equipment.

Harnessing technology to drive sustainable results takes many forms. The VP of data at one U.S. manufacturer reports using technology "to monitor our baseline power usage and anticipate future electrical consumption." A public sector organization in Canada is going one step further; working with sequestration technology, "which has helped to reduce the carbon footprint of our data center," according to their CTO. And the VP of IT enterprise architecture at a Canadian financial services firm said, "We have switched to alternative energy sources and are making sure that our buildings, factories and equipment are energy efficient."

Fig. 8 Main hurdles to achieving sustainability goals

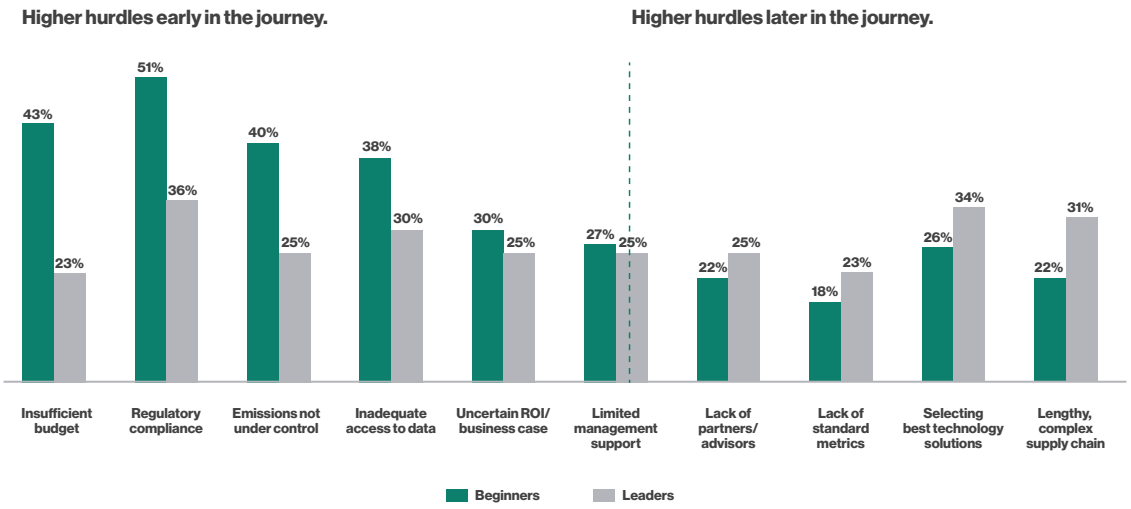


Fig. 9 Hurdles evolve as companies advance sustainability initiatives

These technology-related actions are happening in lockstep with significant cultural changes: creating a corporate culture that embraces sustainability goals and engages employees in the co-creation of sustainability solutions. As the chief data officer of a public sector organization in India said, "Building a culture of awareness regarding carbon emissions has been very fruitful in the reduction of emissions."

To reinforce these **cultural changes**, almost 4 of 10 organizations set a governance framework for assessing, monitoring and managing sustainability. For example, the CEO of an Australian healthcare company noted, "We are using tools and systems to monitor and manage energy usage." He added, "they have been beneficial for us to increase efficiency and reduce emissions."

Many organizations are also using these performance tools in conjunction with data centers. According to the VP of operations of a German financial institution, "The most successful practice adopted by our organization is monitoring and measuring the sustainable performance of data centers and responding appropriately by upgrading servers and other equipment at the organization."

Most organizations are also rethinking their business processes to deliver more sustainable results. These often include adopting circular economy and zero-waste measures, extending the lifecycle of equipment, working with partners and suppliers to ensure sustainable practices and reducing the need for business travel and commuting. For instance, the CTO of an Italian manufacturer says the firm "has been encouraging the circular economy and zero-waste principles by moving towards reusing and repurposing of servers and other hardware in our data centers." According to the CTO, this has helped decrease their carbon footprint.

Technology

- Use latest technology solutions (49%)
- Decarbonize the data center (46%)
- Shift to alternative energy (46%)
- Ensure energy-efficient plant and equipment (36%)

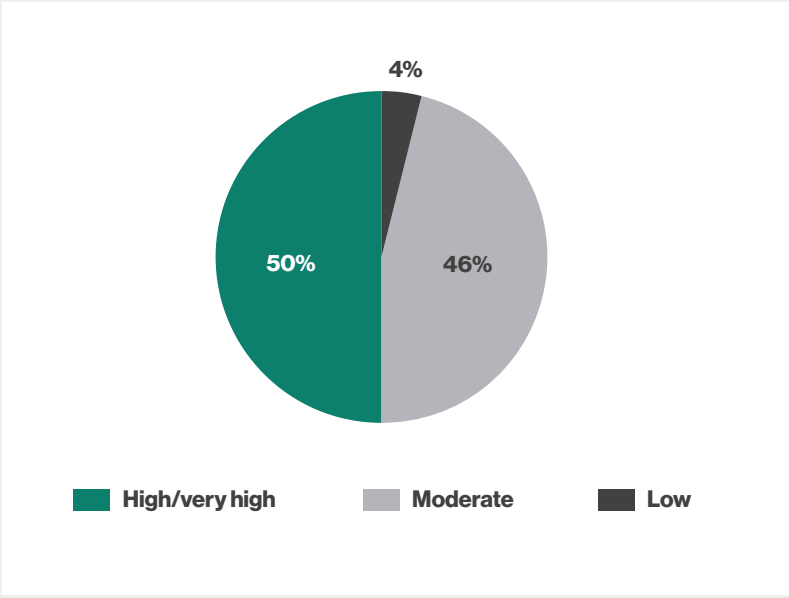
Adapting culture & governance

- Create a supportive corporate culture (38%)
- Monitor and manage performance (37%)
- Engage employees in co-creation of solutions (32%)

Embracing sustainable sources & process

- Circular economy measures (34%)
- Lifecycle of equipment (28%)
- Work with partners on sustainable practices (27%)
- Reduced business travel (16%)

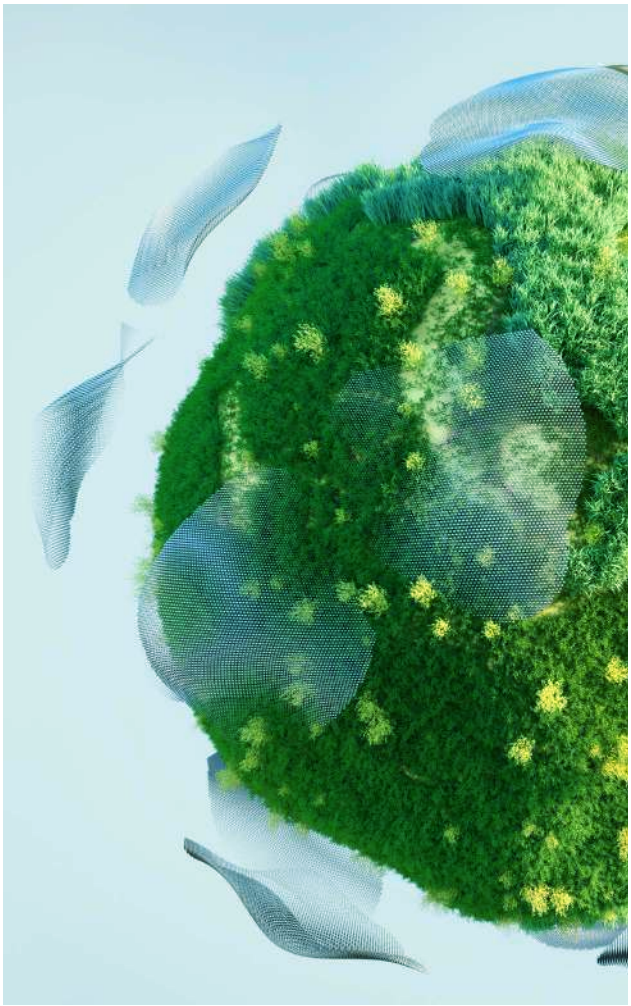
Fig. 10 Steps companies take to reduce their carbon footprint



Respondents saying eco-data centers are high or very high priority.

- 58% of CEOs
- 59% of Firms with >$10B in revenue
- 62% of Eco-data leaders
- 60% of North American firms

Fig. 11 Priority given to creating eco-friendly data centers



Crucially, senior executives are becoming more aware of how important eco-friendly data centers are in improving sustainability. Half of respondents reported that creating an eco-friendly data center is a high priority. 61% of eco-data leaders said decarbonization of the data center is by far the number one step they are taking to reduce their carbon footprint. The chief digital officer at an Australian public sector organization put it succinctly, reporting "Our primary objective is to create an efficient data center."

Executives recognize decarbonizing their data centers is not an easy task. In fact, 39% said it's the area their organization needs the most help.

Yet at the same time, executives recognize that decarbonizing their data centers is not an easy task. In fact, this is the area where organizations need the most help, cited by 39% of survey respondents. A similar percentage (37%) need help in using the latest technology solutions to reduce their carbon footprint.

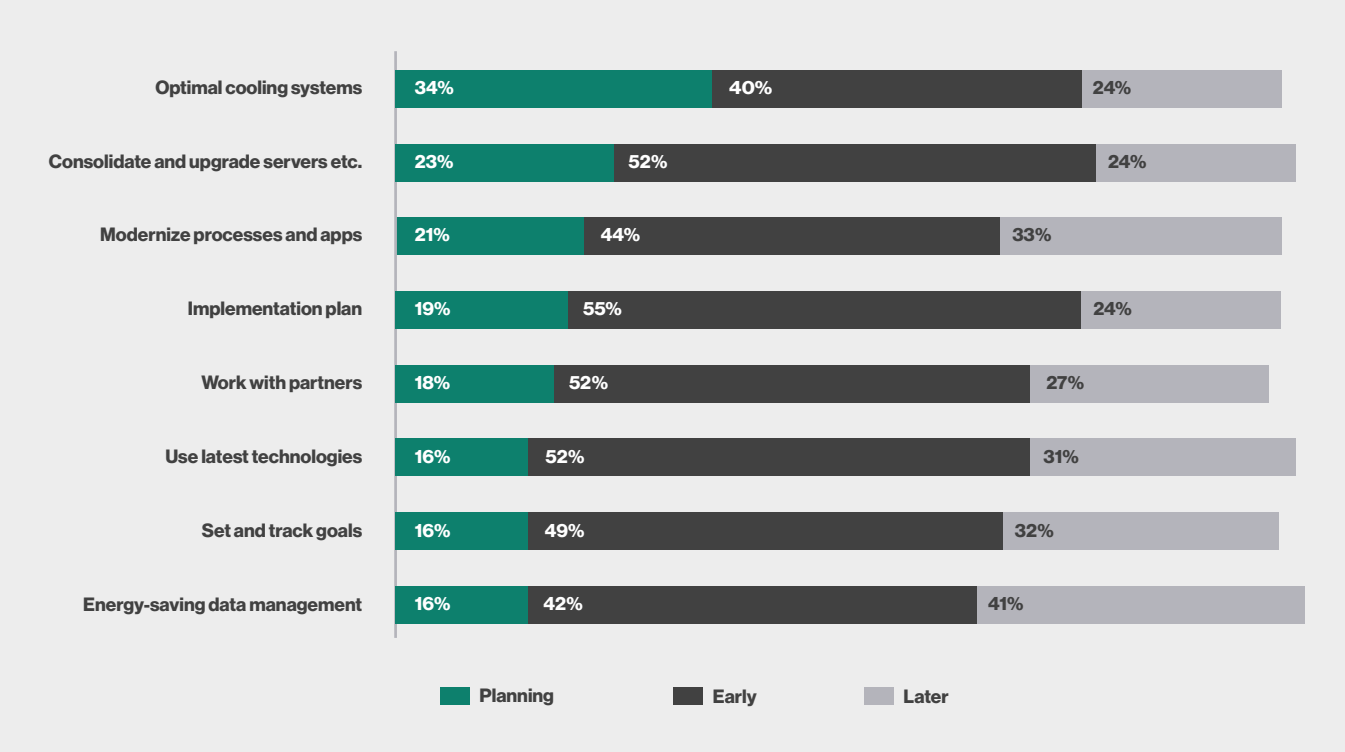


Fig. 12 Progress on initiatives to design/implement eco-friendly data center (current stage)

Section 2

The Data Center Connection

Data Centers are Becoming a Focal Point for Sustainability Efforts

The VP of data at a Nordic healthcare provider spoke for a growing number of senior leaders across industries, noting, "We designed our data center with our ESG (environmental and social governance) objectives in mind." Over half (51%) believe that developing an eco-friendly data center is one of the most effective ways for an organization to reduce its overall carbon footprint.

Half of all respondents also attach a high or very high priority to creating an eco-friendly data center – with eco-data leaders more strongly on the high priority side – while only a fraction ranks it low (Figure 11). Respondents from North America and firms with revenue over $10B also lean towards high priority. Almost six in ten CEOs also ranked it as a priority for their organizations.

Executives cited several factors driving their data center decarbonization imperative. One main reason, according to 24% of respondents, is mounting regulatory pressures, e.g., the European Commission's new data reporting requirements for data centers. Added urgency is coming from the exponential data growth, driven by AI, blockchain, VR/AR, the IoT and a host of other data-dependent next-gen technologies. Almost a third say that the huge growth in their data volumes also contributes to their growing carbon footprint.

Respondents also understand that modernizing data centers without taking sustainability into account is no longer an option. Only 10% say that decarbonization is a secondary consideration when modernizing their data centers. For chief sustainability officers, that figure is just 3%.

Interestingly, while many companies prioritize data center (DC) decarbonization, many don't appreciate the full impact the DC has on their carbon footprint. For instance, only one-third say developing an eco-friendly data center is one of the most effective ways for their organization to reduce its overall carbon footprint.

Part of the problem is that leaders across the C-suite are not fully aware of the impact of data center modernization to achieving overall sustainability goals. CEOs and CIOs appear better informed; 43% and 41%, respectively, say eco-friendly data centers are one of the most effective ways to reduce their carbon footprint. In contrast, only 22% of CFOs – and surprisingly, only 25% of Chief Sustainability Officers – express agreement.

These disparities around data centers underscore the need for greater knowledge sharing and involvement of leaders across the C-suite.

Data Center Modernization is a Work in Progress

About one-quarter of organizations did not take decarbonization into account when they built their current data centers. This is one reason most organizations are still in the planning or early implementation stage of an eco-friendly data center (Figure 12). However, a sizable number have already moved to the later stages (intermediate or advanced implementation), with the highest degree of progress reported for energy-saving data management (41%) and modernization of processes and apps (33%).

The next two years will be critical, with many moving from planning and early implementation stages to intermediate or advanced eco-friendly data center implementation (Figure 13). The most progress will continue to be made in energy-saving data management (66%) followed by modernization of processes and apps (64%).

Eco-data leading companies are at the forefront of this movement. In two years, about nine in 10 will be in these later stages of implementation, leaving a widening gap between these more progressive companies and all others (Figure 14). For example, 94% of leaders expect to be at an intermediate or advanced stage in consolidating and upgrading equipment (vs. 48% of others).

Large companies with +$10B in revenue can see the biggest cost savings from becoming eco-data center leaders.

Organizations have a strong incentive to bridge these gaps, with data indicating that becoming an eco-data leader can fast track sustainability results. While other companies saw a rise in their data center's carbon footprint over the last two years, eco-data leaders experienced a slight decrease.

What's more, eco-data leaders expect their data centers' CO2 emissions to fall over 3X faster than other firms. This kind of progress does not always require drastic steps. According to the VP of engineering of a Spanish public sector organization,

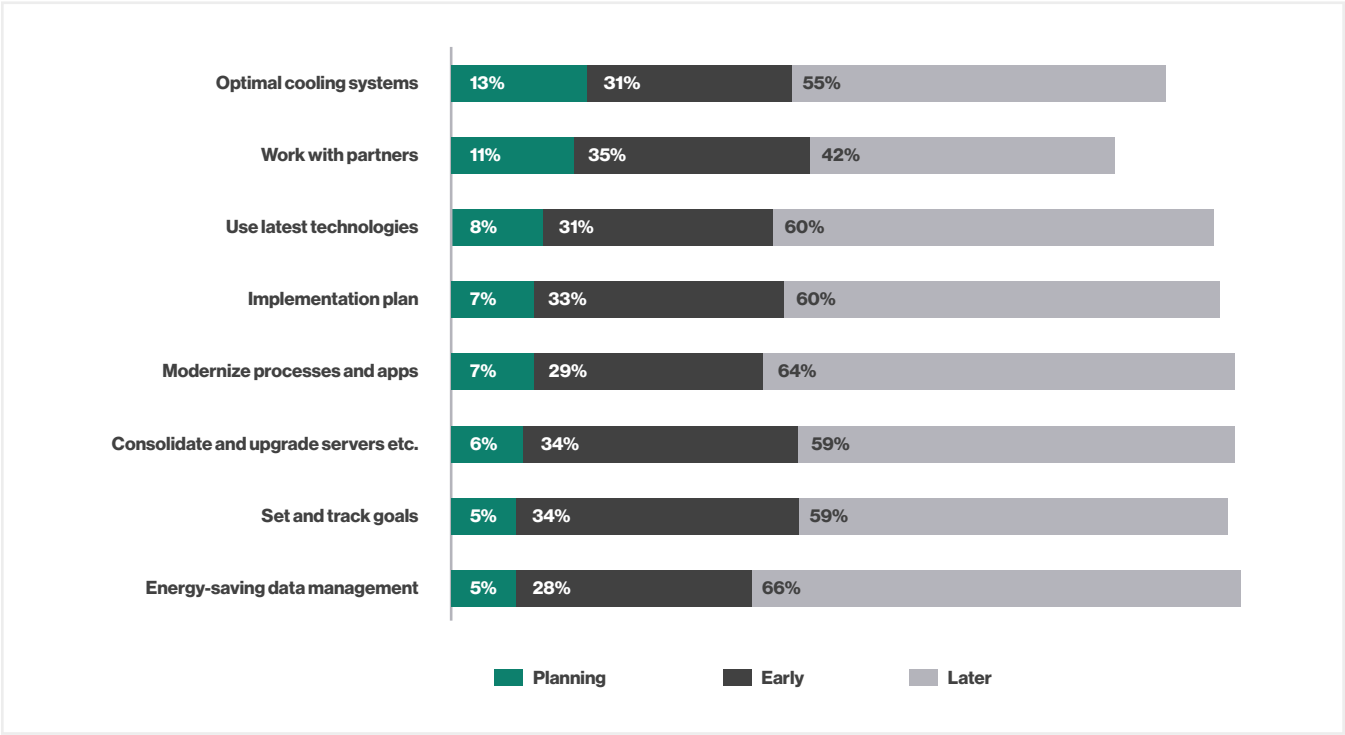


Fig. 13 Progress on initiatives to design/implement an eco-friendly data center (in two years)

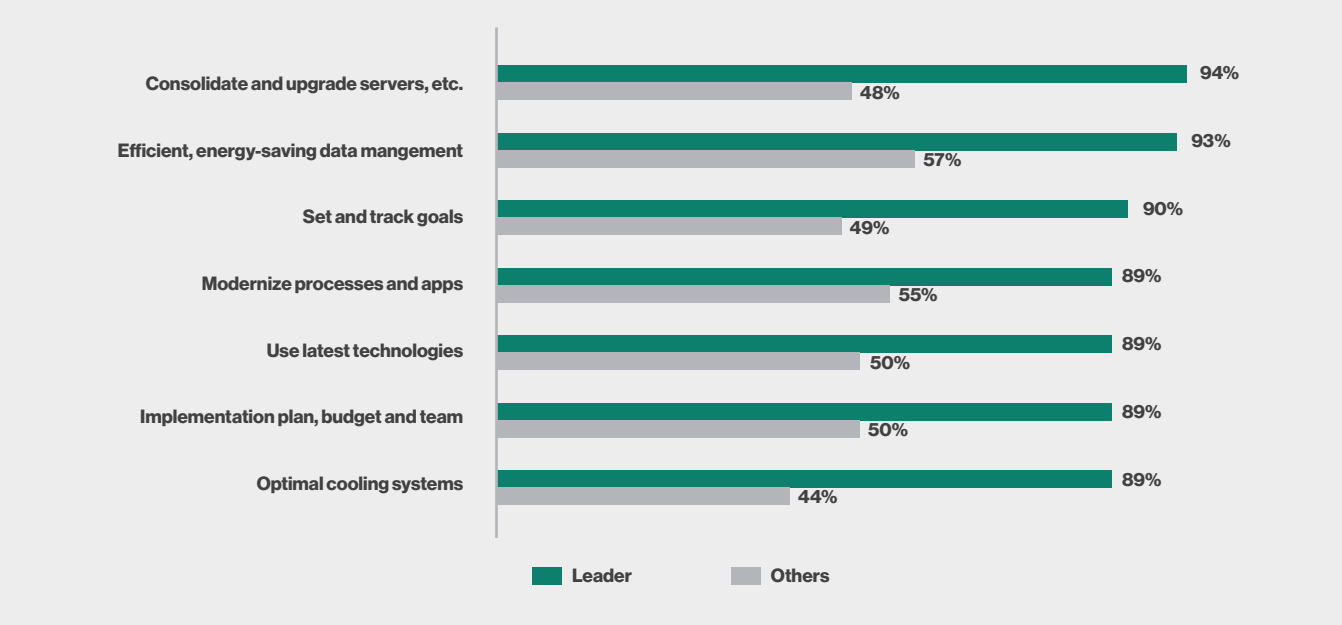
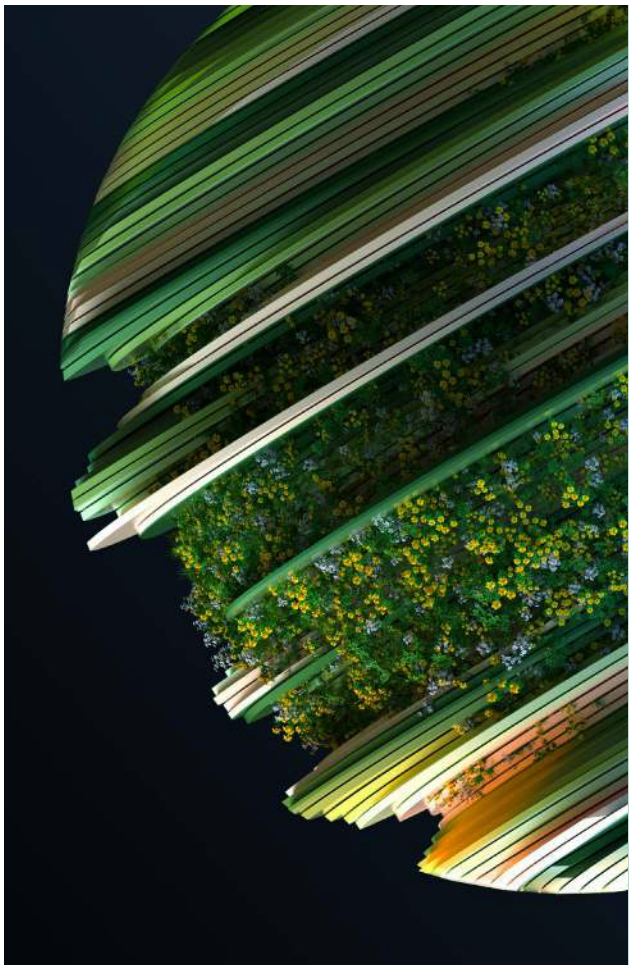


Fig. 14 Organizations expecting to be at intermediate or advanced implementation stage in two years



"Frequently tracking and limiting the energy use in our data center has been the most efficient way to lower our emissions."

Because of the scale of their business – and the higher level of priority they assign to eco-friendly data centers – large companies (+$10B revenue) can reap the biggest cost savings from becoming eco-data leaders. Indeed, the research revealed annual data center operating costs of $9.8M for large eco-leading organizations. In contrast, other companies of similar size spent about $20.2M – more than 2X as much.

Companies are Using a Range of Data Center Efficiency Tools and Strategies

Respondents report looking to a broad arsenal of options to reduce the energy consumption and carbon footprint of their data centers.

Migrating data to the cloud is the most common, a measure taken by 45% of respondents (Figure 15). According to the CIO of an Australian financial firm, "By migrating to the cloud, we have reduced our energy consumption and waste significantly. It has also resulted in efficient asset management and helped increase overall efficiency." The chief digital officer of an Indian healthcare provider agreed, noting, "Shifting data to public cloud platforms has proven to be the most effective and energy-efficient method to reduce our carbon footprint."

Highlighting Misperceptions about the Impact of Cloud Migration on CO2 Emissions

This data point highlights a common misperception about moving to the cloud, which many see as a simple panacea to the challenge. Though others, e.g., the VP of data at a Chinese manufacturer, question if it just "shifts the load of extra emissions to the service provider."

The reality is more complicated. For one thing, the green credentials of hyperscalers and co-location centers are often based on purchases of green certificates that allow them to offset their use of fossil-fuel-based energy. For another, customers may not measure their CO2 emissions in the public cloud, creating a perception they lowered them by shifting to the cloud. However, from a regulatory viewpoint, organizations are still accountable for their broader public cloud carbon emissions under Scope 3 of the GHG Protocol. What's more, moving to public cloud means limiting their ability to reduce emissions using more eco-friendly technology that might otherwise be under their own control in a private cloud implementation.

The research further highlights these conflicting views, with more than half of firms (52%) stating they are reducing their DC carbon footprint by moving workloads to the cloud. While a slightly smaller number (45%) say moving to public cloud just shifts the impact to their cloud provider.

Eco-data leaders have a greater awareness of the impact on sustainability, with 66% reporting they include questions about vendors' sustainability practices in RFPs for data center storage, services and equipment, vs. just 35% among others. This is evident in this response from the CIO of a U.S. public sector organization, who said "Identifying

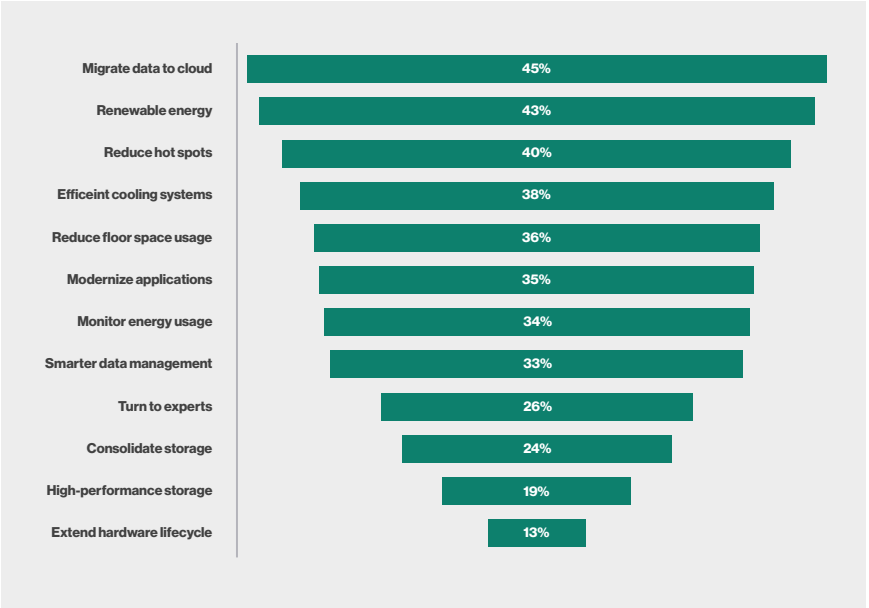


Fig. 15 Steps taken to cut data center carbon emissions and energy use

cloud providers with the highest safety rating, combined with the ability to reduce carbon emissions, has been at the forefront of our strategy to reduce carbon emissions from our data centers."

Using renewable energy is the second most common initiative, taken by 43% of organizations. For example, the CFO of a US financial institution is investing in "renewable energy sources like solar technology to reduce the firm's use of fossil fuels and leave a smaller carbon footprint." The CFO of a healthcare organization in the Nordics said the firm lowered its carbon footprint by using renewable energy while optimizing processes with more energy-efficient technologies. And an Indian manufacturer is recycling its waste in combination with using alternative energy sources.

Reducing hot spots. The chief digital officer of a German manufacturer explains the value of this approach: "Since it reduces heat output and consequently energy use, data center hot-spot reduction has shown to be the most efficient way for minimizing carbon footprints." The VP of operations of a UK public sector entity agreed: "Eliminating data center hot spots has been the most effective strategy for reducing our carbon footprint."

In addition to these top-level actions, companies are taking significant steps to **optimize the data center environment**, including:

- **Efficient cooling systems:** Along with efforts to reduce hot spots, keeping the entire DC cool often consumes more power than any other component. So it's not surprising 36% of companies report implementing more efficient cooling systems. For instance, the CTO of a public sector organization in India installed "best-in-class cooling systems" in server rooms to keep harmful emissions to a minimum, reporting the approach "has been quite effective."
- **Turning to experts:** About one-quarter of firms have turned to external service providers with greater expertise in the space. The chief digital officer of a Canadian public sector entity said, "Our data center's carbon footprint has greatly decreased as

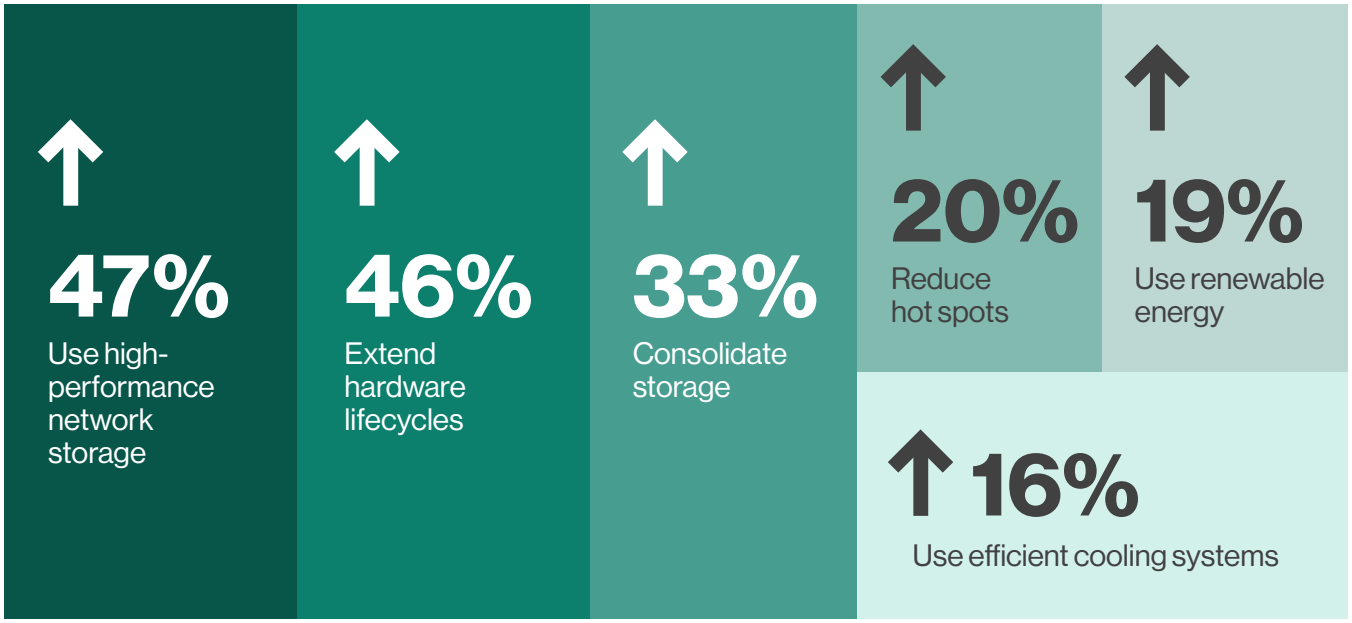


Fig. 16 Fastest-growing ways to cut data center carbon footprint and energy use (respondents expecting growth in next two years)

a consequence of outsourcing to companies with superior knowledge of reducing carbon emissions," adding, "It has aided us in more effectively observing sustainability laws."

- **Consolidating storage:** A similar percentage has taken steps to consolidate their storage footprint. This technique can be very effective, according to the VP of Infrastructure of an Indian manufacturer, who said, "We have consolidated our storage and decreased the number of servers in our data centers, which has greatly lowered our data centers' carbon footprint."

Fastest Growing Tools and Techniques

Over the next two years, organizations plan to take more steps to optimize data center energy usage. The biggest jump will be in the use of **high-performance network attached storage (NAS)**, which allow data storage and retrieval from a central location. Among respondents, 27% plan to use them, up from only 19% today (Figure 16). The chief data officer of a major U.S. manufacturer, which already uses a high-performance network storage system, reports NAS helps "to decrease energy consumption and carbon emissions from our data centers." The chief digital officer of a U.S. government organization reported an even larger emissions reduction by combining high-performance network storage with home-grown compression technology.

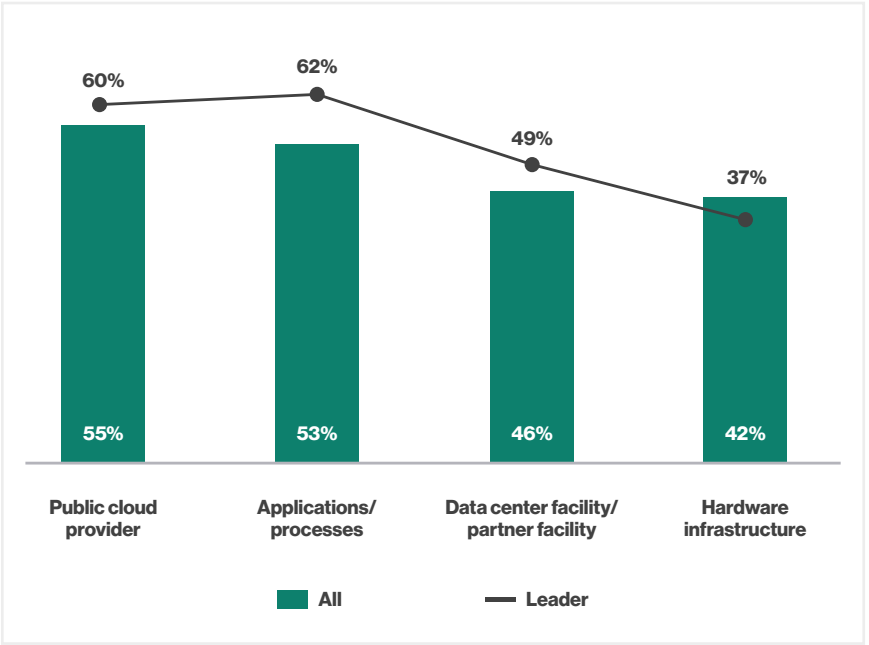


Fig. 17 Data center decarbonization areas of focus

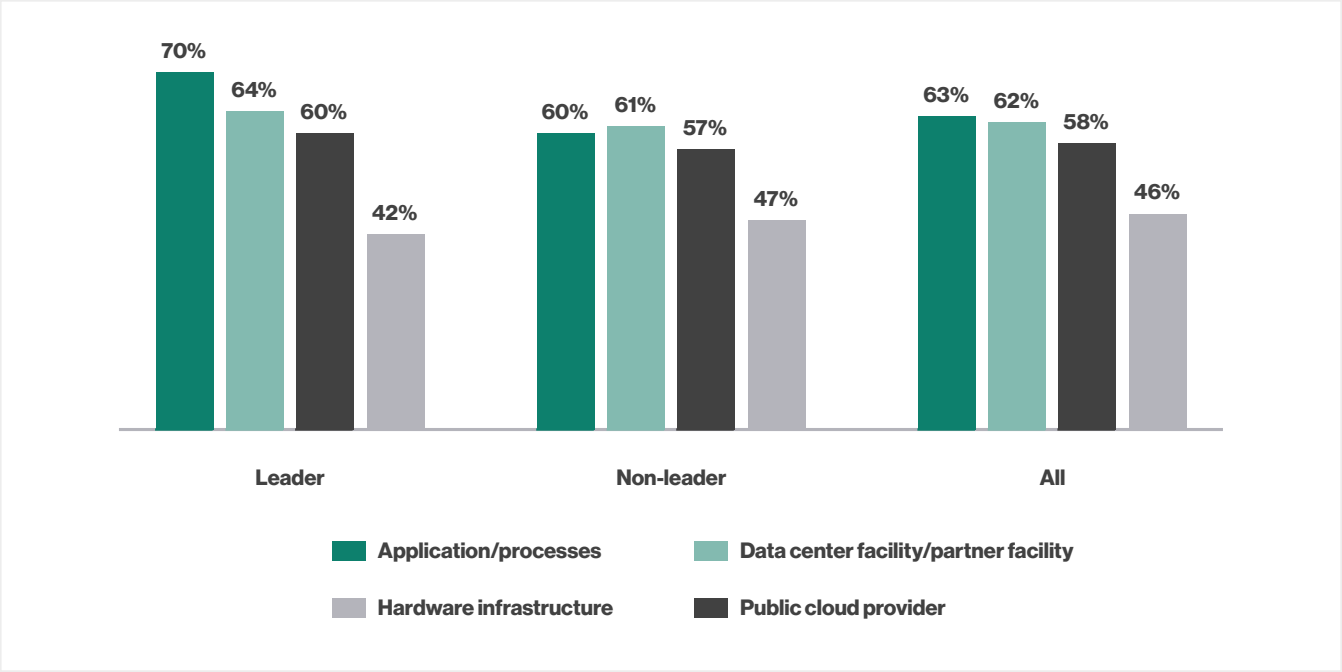


Fig. 18 Data center decarbonization areas of focus over the next two years

Another strategy expected to climb is **extending hardware lifecycles** of storage controllers, disks and front-end ports. The VP of data for a U.S. public sector organization seeing good results from this approach said, "Reducing the number of servers by consolidating and extending hardware life by preventive maintenance has helped us to reduce our carbon footprint." The VP of platform technology at a Canadian healthcare company taking a similar approach noted, "We try to use our hardware for a longer duration of time, to avoid harmful carbon emissions."

Consolidating storage and reducing the number of servers will also gain strong traction. The chief digital officer of a Canadian healthcare firm said, "We're focusing on consolidating storage and reducing the number of servers in our data centers and moving to the cloud to reduce our carbon footprint." An Australian financial firm added they are using the same method of combining network storage with the cloud to achieve the best results.

A Multi-Prong Approach to Reducing Carbon Impacts and Costs

To decrease carbon impacts and costs, companies must act on multiple fronts, across hardware, applications and facilities (Figure 17). To date, the area on which the most firms are focusing is public cloud providers, followed closely by modernization of applications and processes, data center and partner facilities and hardware infrastructure.

Overall, eco-data leaders tend to target more areas than others, with a concentration on apps, processes and strategies that can have a significant impact both on-prem and in the cloud.

As previously indicated, many companies report plans to recalibrate their efforts over the next two years, shifting emphasis to modernizing apps, processes and data center facilities, and away from public cloud providers. For eco-data leaders, the focus will continue to be on apps and processes, but data center facilities will jump ahead of public cloud providers as they strive to take their decarbonization strategies to a higher level (Figure 18).

Making Progress Controlling Data Center Costs

These innovative data center strategies and solutions are enabling companies to mitigate rising costs and emissions from escalating data volume, velocity and complexity. As a result, despite high energy prices, data center costs have only risen modestly. Yet, the results are still mixed, showing there is an urgency for companies to find ways to do better.

On average, firms have seen total costs climb 2% over the last fiscal year, with an increase of 2.85% over the next. European and North American firms have seen similar 1.6% increases, while in APAC the upturn was significantly higher (3.3%), partly due to reliance on imported energy.

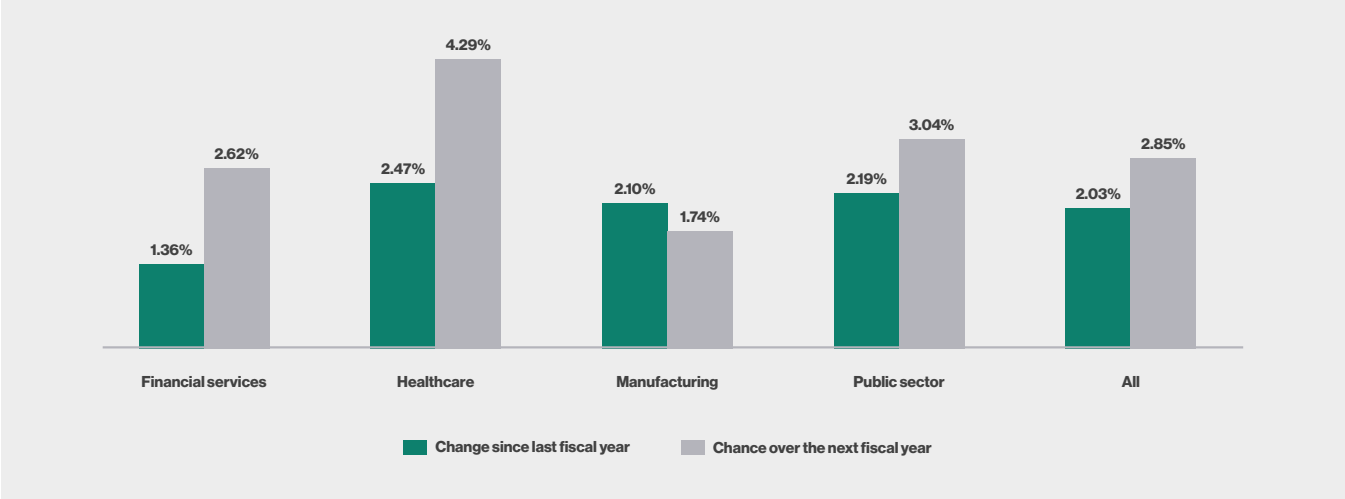


Fig. 19 Change in average annual data center costs, by industry

Manufacturing and healthcare industries, on average, experienced larger jumps in annual data center costs than financial services. What's more, healthcare firms expect costs to surge by 4.29% over the next fiscal year (Figure 19).

However, cost performance is mixed, and averages can conceal stark differences. Over the last fiscal, total costs grew up to 20% for 37% of companies but shrank up to 20% for 12% of them. For 46%, total costs stayed the same (Figure 20).

Over the next year, costs will divide even further. Totals are expected to grow up to 30% for 43% of companies while decreasing up to 20% for 19%. Total costs will stay the same for a lesser number (32%).

Measurement Remains a Key Challenge

The eminent scientist Lord Kelvin reportedly said, "If you can't measure it, you can't improve it." Kelvin's dictum remains true today when it comes to optimizing data center energy usage and carbon footprints. Although they have made significant progress, decision-makers continue to find measurement frustrating.

Despite the need to control costs from growing data use, 34% of firms – 41% for smaller firms with $500M-$1B in revenue – do not currently measure the annual operating costs of their data centers. Reflecting best practice, 77% of eco-data leaders measure costs, compared with 63% of others. Over the next

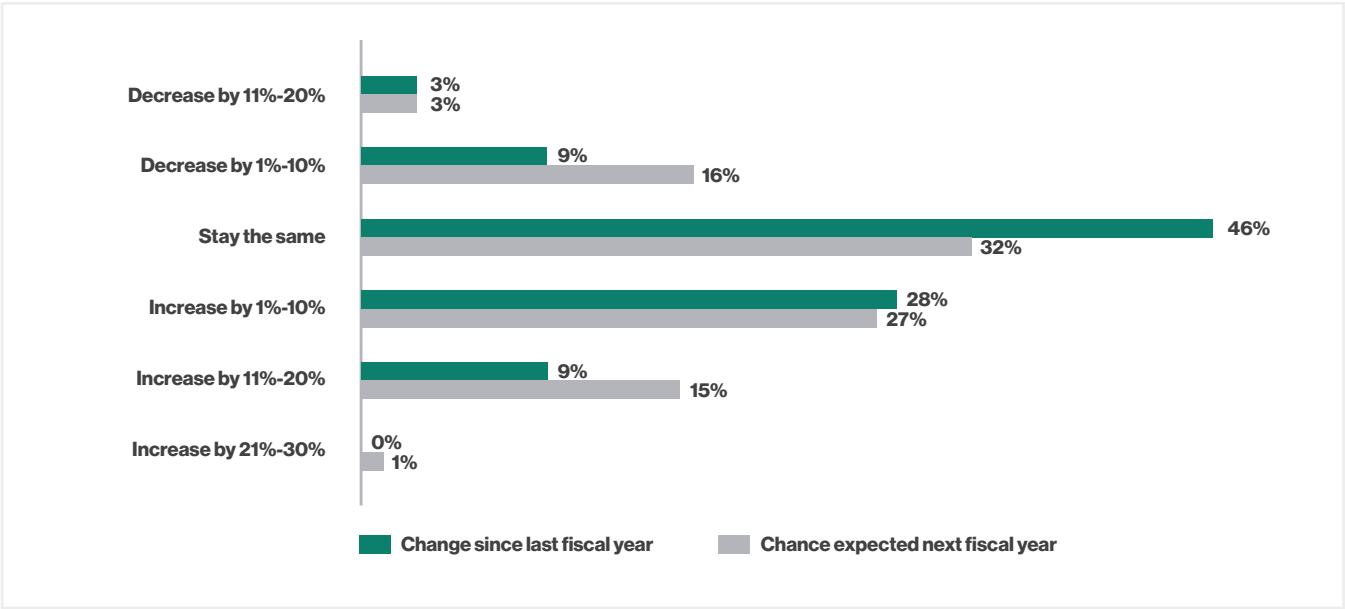


Fig. 20 Change in annual data center costs, all firms

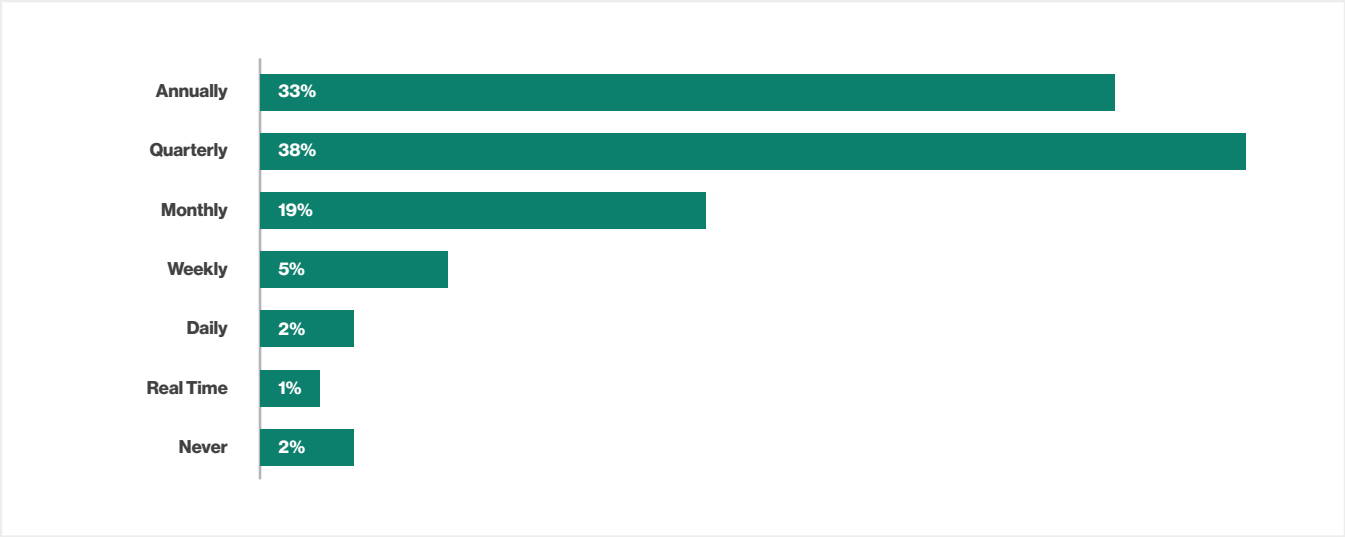
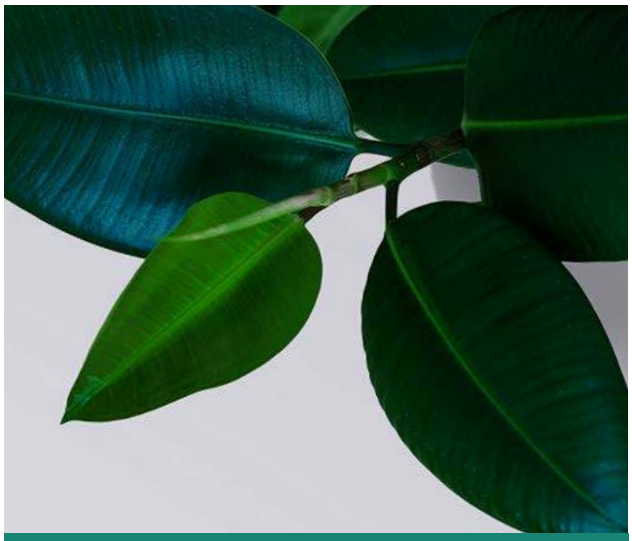


Fig. 21 Frequency in measuring carbon footprint of data center



Eminent scientist Lord Kelvin reportedly said "If you can't measure it, you can't improve it." His dictum remains true today when it comes to optimizing data center energy use and carbon footprints. But businesses continue to find measurement frustrating.

two years, the number of eco-data leaders doing so will rise to 83%; for others it will increase to 73%.

Firms most often measure their data center carbon footprints quarterly (38%); 33% do so annually and 19% monthly. Only 8% have moved to real-time, daily or weekly measurement (Figure 21). Companies expect moderate improvement in the frequency of measurement over the next two years, with quarterly rising to 42%, monthly to 22% and high-frequency (real-time, daily or weekly) to 11%. Eco-data leaders are 3X as likely as other companies to use high-frequency measurement today and will stay well ahead in two years.

When measuring GHG Protocol impacts, companies remain largely focused on Scope 1 direct emissions (from on-premises), with 87% measuring these impacts. More than two-fifths of this number (41%) measure the more complex Scope 2 (indirect emissions from power plants) emissions, while 26% measure Scope 3 emissions (other indirect emissions from vendors such as co-located and public cloud providers). The relatively low proportion measuring Scope 3 emissions points to a broader issue of perception; many companies believe that moving to the public cloud reduces their carbon emissions, but most are not measuring those emissions that are on co-located and public cloud providers (i.e., Scope 3 emissions). The extent of scope measurement appears to be largely driven by regulatory requirements, suggesting a missed opportunity for firms to get ahead of the game. As would be expected, more eco-data leaders (37%) measure Scope 3 impacts than others (23%).

Section 3

Demystifying the Economics of Data Center Decarbonization

Data Center Decarbonization: A Multifaceted Problem

When measuring their data center's energy use and carbon footprints companies need to consider many factors – regardless of whether they are on-premises, co-located or in the public cloud. Without a holistic view of the energy supply chain, it is hard for enterprises to make the right choices regarding technologies and locations, which hampers progress toward meeting net-zero goals.

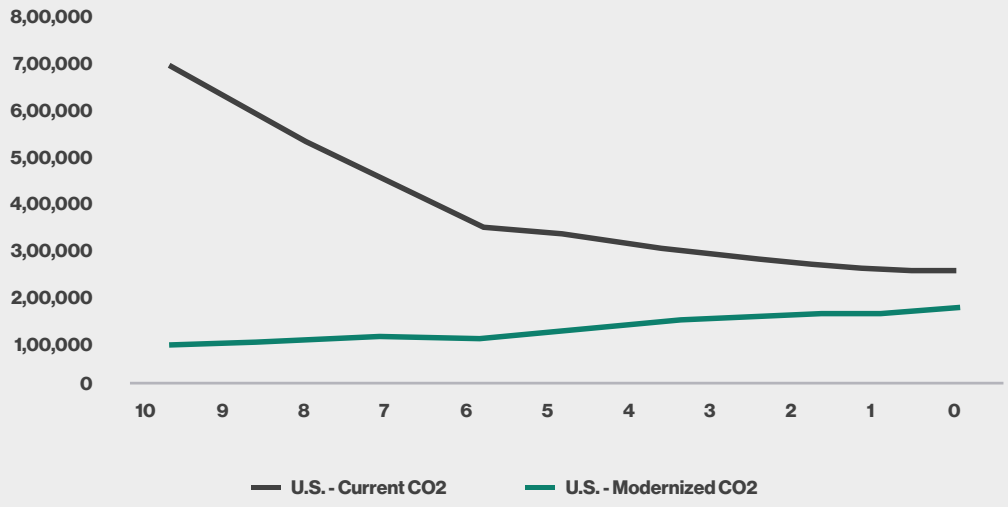
Data centers are large users of electricity (and potentially other natural resources such as water, depending on the type). According to the U.S. Department of Energy, data centers consume "10 to 15 times the energy per floor space of a typical commercial building." Energy is required for data storage, data workloads and compute instances and data center IP traffic. Energy is also required for power cooling and ventilation systems – accounting for around 30% of energy consumption – and to run the facility (e.g., the building) itself.

In addition, data centers generate energy demands through their use of external telecommunications networks for Internet traffic. Older data centers were often configured without reference to heat distribution, meaning hotspots can lead to extra demands on cooling systems and increased energy costs. The implication is that many aspects of the data center – its age, usage of modern storage and networking technologies, space usage and configuration, cooling systems and degree of application modernization, to name but a few – will shape its energy use and associated carbon footprint.

Location Matters

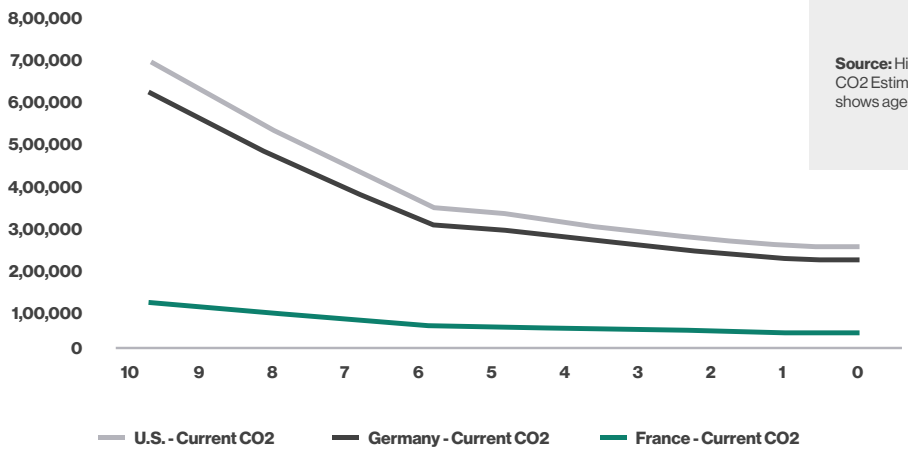
Data center location also matters – greatly, in some instances. Efficiency differs across regions, with power usage effectiveness (PUE) scores (a widely used measure of efficiency) generally being lowest (most efficient) in Europe and the U.S., and highest in Latin America and Africa. More importantly, the energy mix and associated carbon footprint can vary radically by location. For example, Germany makes greater use of fossil-fuel based power, compared with France, where nuclear is more prevalent. California has a much higher use of renewable sources compared with other U.S. states, where fossil fuels are far more dominant.

Location also exerts an influence at the micro level, with on-premises data centers located close to offices generally making less use of Internet traffic and telecom infrastructure compared with more distant public clouds. Russell Skingsley, Hitachi Vantara's CTO and global VP of technical sales, explains: "If you have your data center very close to your office,



Source: Hitachi Vantara Data Center CO2 Estimator – Note: Horizontal axis shows age of data center in years. The black line shows the pre-modernization CO2 emissions of a data center of a given age. The green line shows the estimated carbon emissions after modernizing a data center of a given age.

Fig. 22 Data center CO2 (lbs.) emissions, modernized vs. non-modernized, over 10 years (U.S. estimates)



Source: Hitachi Vantara Data Center CO2 Estimator – Note: Horizontal axis shows age of data center in years.

Fig. 23 Data center CO2 (lbs.) emissions estimations by country/data center age

the Internet communications are probably only one or two telecom switches away from your office. So, when you are pumping data in and out through emails and file transfers, the loads on these switches are very small. But if you suddenly switch to a data center 400 miles away, the energy use and carbon emissions shoot up."

Estimating the Carbon Impact

How much difference do these factors make to data center carbon emissions? The Hitachi Vantara Data Center CO2 Estimator provides estimates based on age, location, available capacity and array capacity splits. For example, a data center with five-year-old storage infrastructure in the U.S. with 4,999 TB of capacity is estimated to generate 336,090 lbs. of CO2; with the latest modernization technologies this can be reduced 65% to 117,632 lbs. For a data center with 10-year-old storage infrastructure, the gains are even more dramatic from modernization, with CO2 emissions falling from 718,804 lbs. to 90,795 lbs. of CO2, an 87% reduction (Figure 22).

Assessments by Hitachi Vantara for clients have consistently shown that eco-friendly storage infrastructure delivers substantial environmental and business benefits, with a recent assessment showing that the enterprise's data center could achieve a 96.5% reduction in its energy bills, and a 35% reduction in its associated carbon footprint, with estimated annual savings of $1.4M.

Geographic location also makes a big difference for a similarly specified storage infrastructure. While current (pre-modernization) carbon emissions from the storage infrastructure are broadly similar for U.S. and German data centers, they are strikingly lower for data centers in France, a reflection of the energy mix in that country which relies much more heavily on nuclear energy than on fossil fuels (Figure 23).

The Impact of Regulation

The policy and regulatory framework in different regions/countries will affect the economics of data center decarbonization. Regions vary in their approach to investment in fossil fuels vs. renewables which shapes the energy options available and the associated carbon emissions. They also have different regulatory reporting requirements, such as the need to report Scope 1 (direct emissions from owned/on-prem resources), Scope 2 (indirect emissions from power plant producing electricity) or Scope 3 (other indirect emissions from vendors, e.g., co-located and public cloud providers). Data sovereignty and privacy regulations can also affect the economics of decarbonization, for example, by requiring certain types of data to be segregated or duplicated in different jurisdictions.

The bottom line: enterprise IT decision makers must carefully calibrate their data center footprints, understand the economics of decarbonization and make the right strategic technology choices to achieve their ESG and net-zero goals. Sequencing it correctly is crucial. Hitachi's Skingsley suggests, "Small, medium and large data centers should start by implementing their own green practices, first to lower energy consumption with eco-friendly data center products, and then compensate with carbon offsets. This will lower energy costs as well as minimize the need for carbon compensation, which saves them money. Next, they can focus on starting the journey towards 100% renewable energy, from wind, solar and other sources."

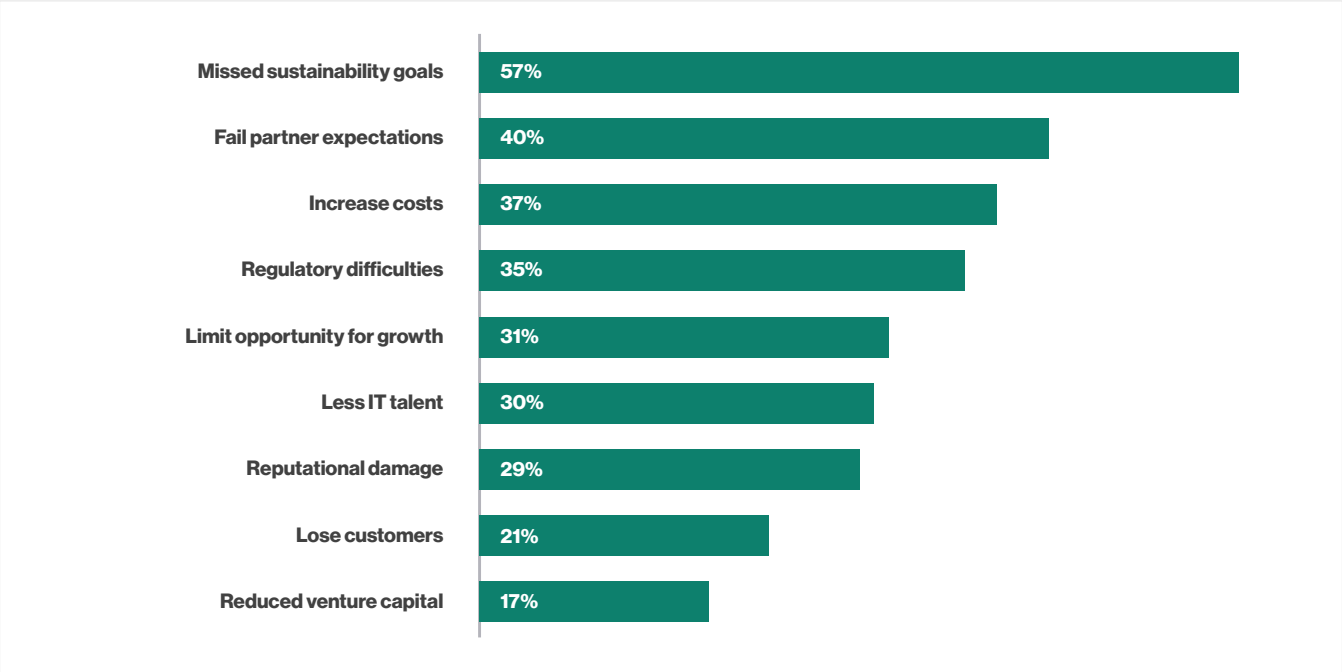


Fig. 24 Negative impacts of failing to decarbonize data centers

Section 4

The Time to Act on Data Center Decarbonization is Now

The societal and business imperatives for data center sustainability have never been greater. Top management teams recognize the importance of their ethical and societal obligations to achieve net-zero goals to their employees, customers, partners and investors. And that companies that are ahead in their sustainability journeys enjoy an array of benefits, including lower costs, accelerated growth and happier customers and employees.

Due to the exponential growth and critical role of data in creating competitive advantage, data centers play a pivotal role in achieving ESG objectives. Organizations worldwide are taking decisive steps to decarbonize and are aware of the painful consequences of not doing so. Respondents said running afoul of regulatory obligations, missing stakeholder expectations, impaired business performance and damaged reputation are just some of the potential negative impacts from failing to act (Figure 24).

The stakes are high, and failure is not an option. Management teams would be wise to act now to accelerate their efforts to decarbonize their data centers. Not simply to unlock major savings in energy consumption and address their regulatory obligations to shrink their carbon footprint. But to be a part of a growing global movement to power good that will benefit people everywhere for generations to come.

Calls to Action

While many hurdles still remain, our survey of 1,000 firms across industries worldwide shows that rapid progress in data center decarbonization is possible with the right strategy, data and technology. Business leaders can get started today by applying the following guidelines for success:

- **Get the basics right:** Data center sustainability leaders must master the basics, making sure they have detailed plans and roadmaps in place, resources allocated and senior level buy-in across the global enterprise.
- **Move at the speed of innovation, not regulation:** Too many firms allow strategy to be dictated by the pace and direction of regulation, at the risk of falling behind technical and competition change. Eco-leading organizations must put innovation at the forefront of their data center strategies, using progressive solutions and shaping the regulatory frontier itself.
- **Measure far and wide:** To get to net-zero, firms must take a broad view of emissions across their entire IT estate, including edge, on-prem, off-prem and Internet communications. Including elevating carbon reduction strategies and tools to both the application and geographic landscape.
- **Make data center sustainability a team effort:** Make sure your entire C-suite understands the benefits and sequencing of data infrastructure decarbonization. Look to outside experts to help map options using the most modern hybrid strategies and technologies, including on-prem, near-cloud, public cloud and application modernization.
- **Leave no data center decarbonization stone unturned:** Look beyond the obvious and consider ALL options at your disposal and being used by your peers. From reducing hot spots, installing energy efficient cooling, consolidating storage, extending hardware lifecycles and deploying high-performance, energy efficient network storage. Sustainability is bigger than any single solution. It's about changing the cultural mindset.
- **Think beyond the cloud:** While it can help, the answer isn't simply shifting the burden to cloud providers. Companies that transfer workloads to cloud providers are still accountable for the carbon emissions through their Scope 3 reporting.

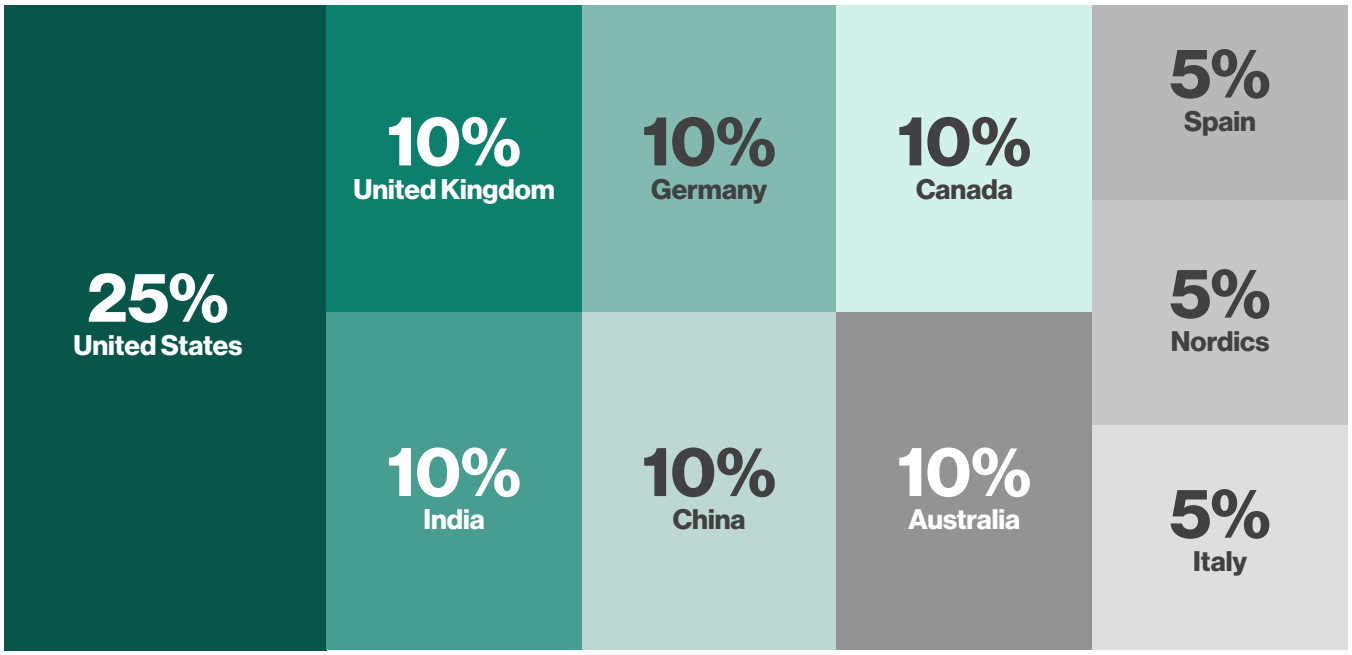


Fig. 25 Distribution of respondents by region

Appendix

Research methodology and sample demographic profile

In the first quarter of 2023, working in collaboration with ThoughtLab, Hitachi Vantara conducted a survey of 1,000 leading companies in 10 countries. The study covered key regions of the world, including the U.S. and Canada; UK, Germany, Spain, Italy and the Nordics in Europe; and India, China and Australia in Asia Pacific (Figure 25). Survey respondents were screened to ensure they were knowledgeable about their organization's data center and its energy consumption.

Firms surveyed were equally distributed across four industries (Figure 26):

- **Financial services:** including banks, payment services, capital markets firms and insurance providers.
- **Healthcare:** including providers, payors, medical research firms, benefits management and medical device/technology suppliers.
- **Manufacturing:** including industrial and consumer manufacturers, automakers and energy companies.
- **Public sector:** including city/county, state/provincial and national/federal government.

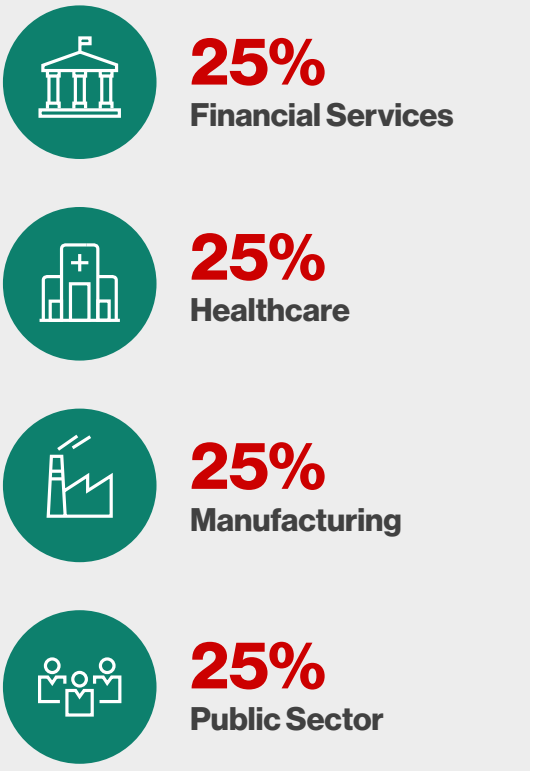


Fig. 26 Distribution of respondents by industry

Respondents were also broadly distributed across organization size, measured by revenue (Figure 27).

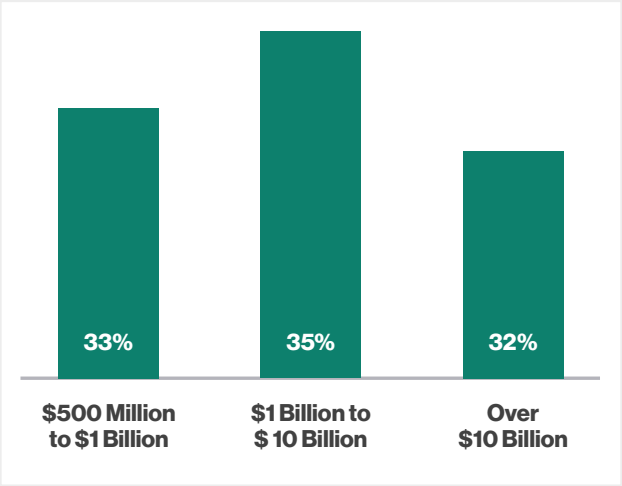


Fig. 27 Distribution of companies by revenue size

Respondents were asked the percentage of their data center workloads across three platforms: on premises, co-located and public cloud. On average, surveyed firms run half their workloads on-prem, 29% in co-located facilities and 21% public cloud (Figure 28).

Fig. 28 Average percentage of data center workloads by platform

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Hitachi Vantara, a subsidiary of Hitachi, Ltd. (TSE: 6501), turns data-rich businesses into data-driven ones. For more information, please visit hitachivantara.com.

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