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The Forrester Technology Sustainability Framework

The Tech Industry Is Under Scrutiny But Improving

by Abhijit Sunil
August 19, 2020 | Updated: August 25, 2020

Why Read This Report

It's 2020, and the industrial sector can no longer ignore the mandate for environmental sustainability. This is especially true for technology. Organizations that demand customer goodwill and trust are creating sound sustainability strategies and assessing how they can optimize the effects they have on the environment. With lessons from cloud and data center providers, this report examines the current sustainability landscape of the tech sector. It provides a detailed framework for infrastructure and operations (I&O) leaders to analyze sustainability and outlines steps that both technology providers and consumers can take.

Key Takeaways

Investors See An Organization's Environmental Impact As A Risk
Most mega data center owners and providers, including Amazon, Facebook, Google, and Microsoft, as well as content delivery network providers, telecoms, and major colocation players, have become vocal and strategic about their environmental goals. They're aiming to address the negative impacts they've made and attempting to regain customer goodwill.

The Right Framework Is Essential To Properly Analyze Your Firm's Carbon Footprint
Various technology sectors are increasingly overlapping, and cloud computing and digital transformation are touching every industry. Use a systematic framework across the full technology lifecycle and supply chain to analyze your sustainability and measure your carbon footprint.

Innovations Make Significant Progress Possible, But Many Gaps Remain
The cost of green energy is declining, and newer, innovative techniques for data center cooling, efficiency monitoring, and water usage are on the rise. However, challenges around scale and investment capex, fueled by an inability to control supply chains and partner ecosystems, are thwarting the sustainability goals of many smaller enterprises.

The Forrester Technology Sustainability Framework

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Sustainability Is In Vogue, With Technology Front And Center

A growing number of companies of all sizes are embracing corporate responsibility as a core value across many sociological and political dimensions.[1] At the top of everyone's list of values is sustainability.[2] Although this initiative has always been a nice-to-have, in the past, economics overrode it — "green" was more about money than about the planet. A heightened sensitivity to climate change and the human race's impact on it have now flipped that thinking around.

Technology Affects The Environment In Two Ways

The world of information technology has come under scrutiny because data centers have voracious appetites for power and cooling resources. Globally, the rush to cloud computing and colocation services is driving intensive data center buildouts. Technology leaders need to mitigate the ecological risks while taking advantage of the ecological benefits that technology can offer:

1. **Technology as a risk for sustainability.** Data computation, storage, and transfer are the backbone of technology and have a deep impact on the environment. Data center operations are in the spotlight for the enormous amount of energy necessary to power the IT infrastructure as well as cool the facilities. The tech supply chain is also usually environmentally abusive.

2. **Technology as a benefactor for sustainability.** Technological progress has made green energy sources possible; in the past decade, we've seen growth in effective recycling techniques, more efficiency across the information and communication technology (ICT) value chain, and more accurate measurement and reporting of emissions data.

You're Not A Passive Observer

Tech leaders must do their part to save the planet. This responsibility lies not just with technology providers but also with the industries they enable. Tech leaders of all kinds can collectively reduce technology's carbon footprint.

The Right Sustainability Approach Demands A Clear Framework

Technology customers need to understand the lifecycle of sustainable initiatives that vendors should take so they can: 1) use a defined structure to identify opportunities and gaps within their organization's overall sustainability efforts and 2) use a set of standardized reference criteria to compare the sustainability efforts of various organizations and sectors.
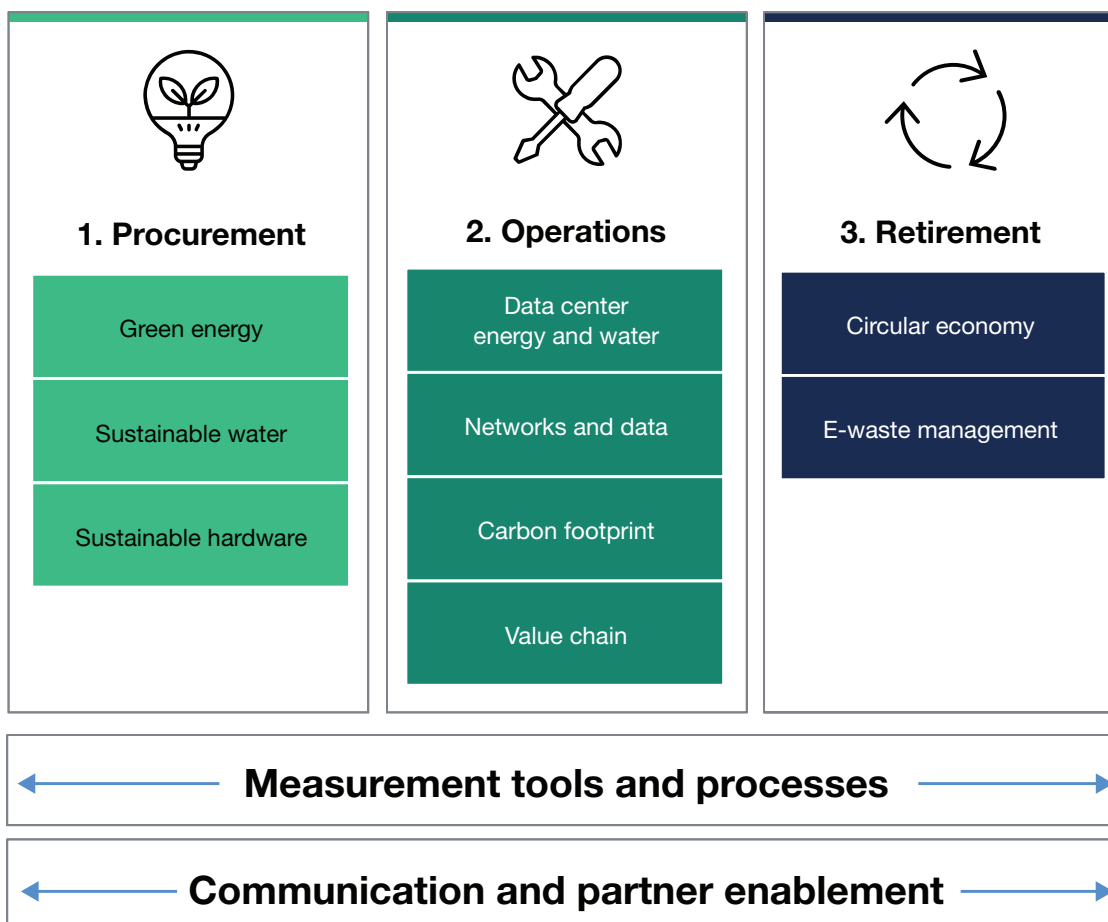
Three Pillars Of Sustainability Complete The Story Within Any Organization

Forrester is introducing an overall framework for analyzing the sustainability story of every organization (see Figure 1). Depending on your position in the tech ecosystem, your sustainability strategies and toolkit will vary; the framework applies to both providers and consumers of technology. It will also help

in assessing the depth and breadth of sustainability efforts as well as optimization opportunities for organizations, such as clean energy procurement as a standalone initiative versus participation in the full circular economy.

FIGURE 1 Forrester's Sustainability Framework Guides You Through The Full Tech Lifecycle

1. Procurement	2. Operations	3. Retirement
Green energy	Data center energy and water	Circular economy
Sustainable water	Networks and data	E-waste management
Sustainable hardware	Carbon footprint	
	Value chain	

Measurement tools and processes

Communication and partner enablement

A Clear Framework Helps Simplify A Complex Carbon Footprint

The measurement of carbon footprints in technology sectors and comparison with other industries is complex, given the overlapping footprints of various sectors. This highlights the importance of a clear framework. Hence, when we look at industry verticals, it's often difficult to make an apples-to-apples comparison. For example, you'll see discrepancies when comparing energy consumption alone with a full lifecycle impact during a fixed period of time.

Data Centers Are Hot Spots For Energy Conservation

The data center industry has three categories: the hyperscale players, including tech giants like Facebook and colocation vendors; the cloud players, such as Amazon Web Services (AWS), Azure, Google, and IBM, most of which are hyperscalers themselves; and the enterprises that run traditional data centers. Hyperscale data centers operated by colocation providers and cloud players have grown increasingly efficient and gained much lower power usage effectiveness (PUE) ratings due to a variety of factors like standardization, specialized design, and extreme automation, all of which their massive scale and investment capabilities make possible.

Efficiency Gains Offset Extraordinary Data Center Growth

According to the International Energy Agency (IEA), global data center electricity demand in 2019 was about 200 TWh, or around 0.8% of global final electricity demand.[3] Cloud vendors and hyperscalers consume much of this energy, mainly because their numbers have exploded over the past decade.[4] Traditional data centers are far less efficient, but the proportion of total data center workloads is in steep decline, yielding a smaller overall energy profile (see Figure 2). The real testament to efficiency is that overall data center workloads increased by 650% between 2010 and 2019 but overall energy use remained flat.[5]

FIGURE 2 Rises In Efficiency And Hyperscale Are Balancing Data Center Energy Demands
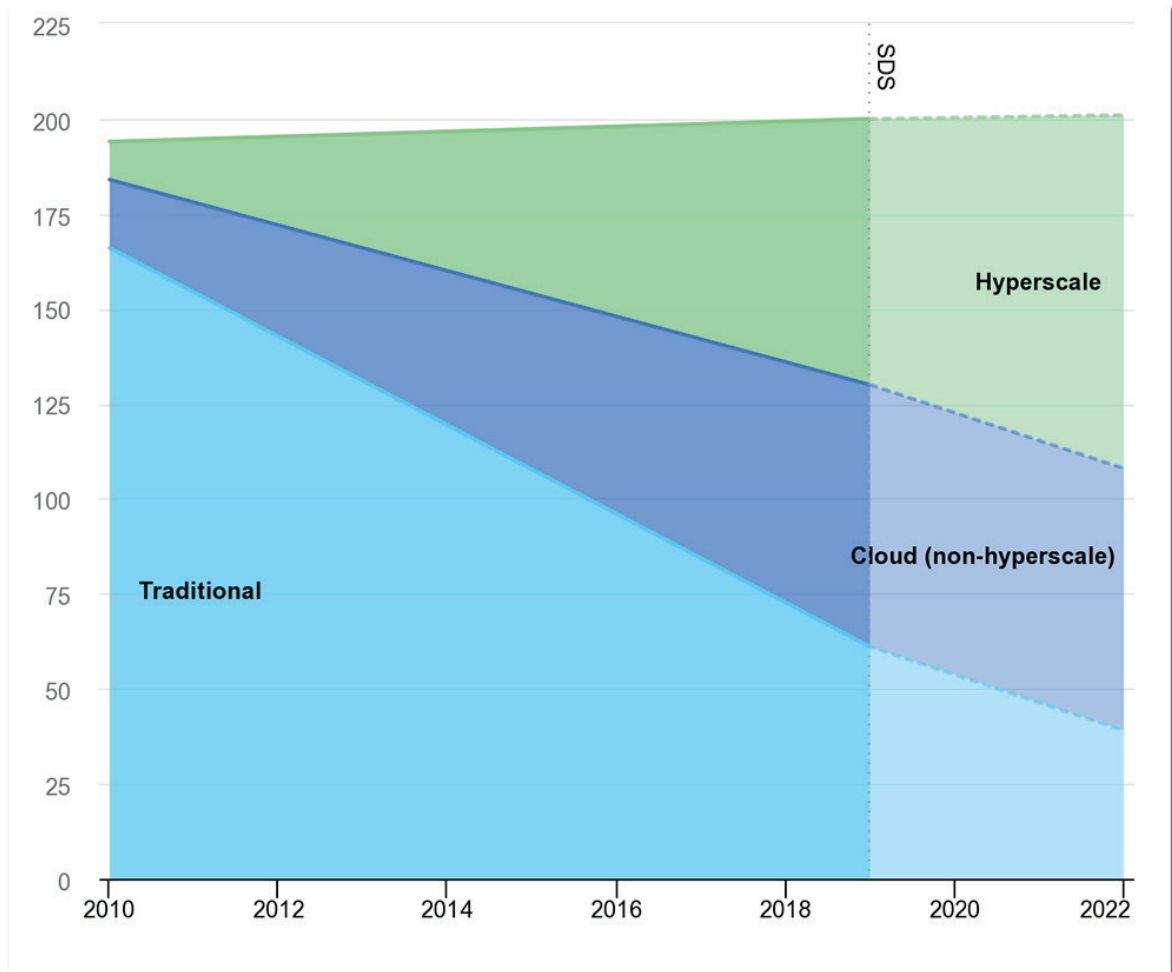
Source: "Global data centre energy demand by data centre type, 2010-2022," IEA, June 4, 2020
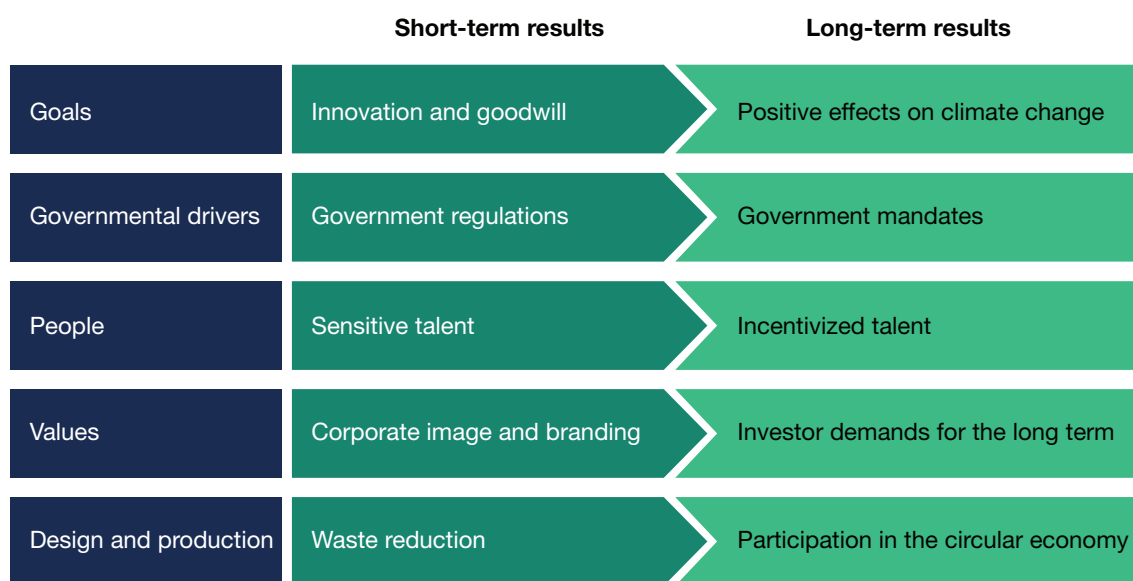
Address Water Usage To Keep These Hot Spots From Boiling Over

Water and electricity consumption have the highest environmental impact in data centers; water is used to generate electricity as well as for cooling in the data center. According to some studies dating back to 2017, the amount of energy dedicated to cooling a data center can be up to 40% of its total energy use.[6] However, QTS, a major colocation player, has told us that due to recent advances, only 20% to 30% of its power goes into cooling.[7] Sourcing sustainable water sources is an important green energy initiative; a few large hyperscalers have begun to promote their water usage effectiveness, and cloud and infrastructure vendors like IBM have set water conservation goals. Lenovo has tracked, monitored, analyzed, and published water withdrawal and wastewater discharge data since 2009.[8]

Data Center Customers Are Demanding More Sustainable Approaches

Factors that evolve over time dictate the ROI for sustainability and the primary drivers for sustainability initiatives (see Figure 3). For the most part, the desire for goodwill and corporate responsibility are the forces behind current initiatives; enterprises get few direct monetary rewards to be green or to attain sustainability goals. However, a Forrester Analytics survey found that 42% of global security decision makers said they're highly or extremely concerned about the potential risk of climate change and the potential impact it could have on their organization.[9] The Forum for Sustainable and Responsible Investment reported that environmental, social, and governance (ESG)- focused assets in the US grew to $12 trillion in 2018, a 38% increase over 2016.[10] Akamai reported a 30% to 40% increase in requests for information about sustainability between 2018 to 2019.[11] Major colocation providers are revealing that most customers do have green building standards and requirements.[12] Furthermore, many regional governments have strict requirements that firms must meet just to get a building permit. Few parts of the world are ignoring the benefits of green buildings, making sustainability a standard for real estate development.

FIGURE 3 Factors That Evolve Over Time Are Dictating Sustainability ROI

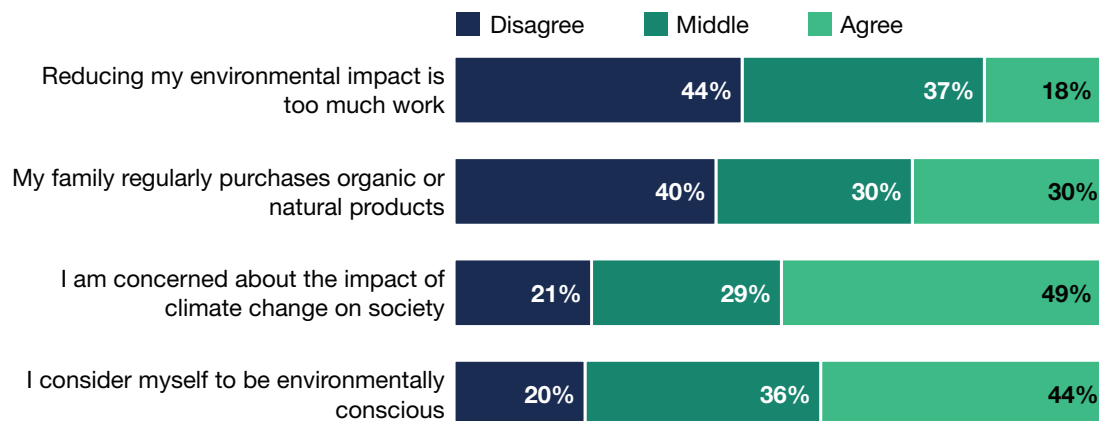|	Short-term results	Long-term results
Goals	Innovation and goodwill	Positive effects on climate change
Governmental drivers	Government regulations	Government mandates
People	Sensitive talent	Incentivized talent
Values	Corporate image and branding	Investor demands for the long term
Design and production	Waste reduction	Participation in the circular economy

Brand Distinction And Scrutiny Drive Short-Term Missions

In the short term, organizations use distinct sustainability messaging to implement strategies that distinguish them from their peers in the value they offer their customers. A strong environmental awareness strategy boosts employee satisfaction with the organization, signals goodwill to customers, and attracts talent that's increasingly sensitive to climate change concerns. Forrester survey data reveals that close to half of respondents (4,594 US online youths ages 12 to 17) said they're concerned about the impact of climate change on society (see Figure 4).[13] This age group will shortly be in the workforce, bringing with them strong views on the environmental impacts of their career choices. According to colocation providers, this trend is already manifesting itself in their customer negotiations.

FIGURE 4 Young People Are Concerned About The Societal Impacts Of Climate Change

"Please indicate how strongly you agree or disagree with the following statements about environmental consciousness."

Legend: Disagree · Middle · Agree

Statement	Disagree	Middle	Agree
Reducing my environmental impact is too much work	44%	37%	18%
My family regularly purchases organic or natural products	40%	30%	30%
I am concerned about the impact of climate change on society	21%	29%	49%
I consider myself to be environmentally conscious	20%	36%	44%

Base: 4,594 US online youths (ages 12 to 17)
Source: Forrester Analytics Consumer Technographics® North American Youth Survey, 2019 (US)

Climate Change And Goodwill Dictate Long-Term Business Benefits

Although the effects of climate change on consuming and creating data aren't yet under the same spotlight as they are in the steel and plastics industries, this issue will gain prominence in the coming decade. All the major cloud service providers — Amazon, Google, and Microsoft — plus other leading-edge tech companies, including Apple, claim they've either achieved carbon-neutral status or are close to doing so.[14] Investors and customers see the environmental impact of an industry as a potential risk in the long term, putting businesses at the mercy of inevitable government policies.

Sustainable IT Approaches Continue Through The Full Tech Lifecycle

The approach that an organization should take depends on which steps in the framework make sense for each industry, vertical, and individual organization priority. We've already seen various efforts across the three pillars of the framework: procurement, operations, and retirement.

Procurement: A Good Strategy Sets The Stage For Sustainable Technology

Procurement of energy, water, and sustainable raw materials is the first pillar of your sustainability journey. This phase is not only the easiest to implement but also among the most visible to your customers. With a good strategy, energy procurement can yield cost savings that you can pass on to customers and partners.

› **Green power puts more green in your pocket.** Utility companies are exploring opportunities in the ICT space and increasing this focus in 2020. If your organization has a strategy for sustainability and green energy for the long term, meaningful partnerships can guarantee cost benefits. Skybox Data Centers in Houston has partnered with utility company NRG to provide a 100% renewable wind energy supply contract.[15] Several colocation players and hyperscalers, such as Digital Realty, Equinix, Google, Microsoft, and QTS Data Centers, have long-term contracts and are also among the top purchasers of green energy.[16] In 2018, Apple (1.3 billion kWh) and Google (10 TWh) procured 100% renewable electricity for their data center energy consumption.[17]

› **A green edge to your network multiplies energy improvements.** Edge computing and the internet of things (IoT) are expanding technology's value beyond the data center and even beyond cloud.[18] As these devices can number in the thousands within a given enterprise, the resource demands multiply as well. Thankfully, many of these devices have low power requirements by design. As you pursue a connected, instrumented enterprise, ensure that you're using the lowest power you need to perform any given task. Rolling out power-hungry equipment to the edges adds up to excessive aggregate impact.

› **Green raw materials propagate to end products.** Technology providers need to understand the impact of their supply chains. If a storage vendor sources components manufactured in an environmentally destructive manner, its products aren't green, regardless of its own manufacturing processes. There's no exoneration for a buyer for any environmental sins within the complete supply chain, right down to the sand used to make the silicon base for semiconductors.[19]

› **Green transport reduces carbon footprint and saves money.** Making technology is one thing, but getting that technology from one place to another is yet another dimension of the full carbon footprint. Consumerism has everyone expecting rapid delivery of goods, but fast delivery imposes a heavy burden on the planet. Smarter planning for delivery of physical goods allows for transport that makes less of an impact; this might be rail versus air, for example. It's also cheaper — standard five-day delivery is far less expensive than guaranteed overnight delivery.

Operations: Optimization Improves Your Firm's Long-Term Technology Energy Profile

Optimizing infrastructure and operations to be sustainable can be complex but also presents the most opportunity among initiatives that organizations undertake. These opportunities will vary significantly with each geography and industry. However, scale plays an important role in the changes you can make. To optimize operational efficiency:

› **Move as much as possible to the cloud to exploit energy at scale.** In an Energy Star model case study, a single 84-blade server rack installed in an enterprise data center required 28 kW of electricity and needed about eight tons of cooling per rack.[20] This illustrates how operating smaller embedded data centers can be detrimental to energy efficiency. On the other hand, cloud operators utilize their massive scale for adopting large-scale efficiency innovations. In 2014, the Natural Resources Defense Council's report on data center efficiency stated that average server utilization remained static at 12% to 18% between 2006 and 2012, while hyperscalers could achieve 40% to 70%.[21] Higher utilization is more efficient.

› **Optimize consumption with active hardware and software management.** Server and storage virtualization are important pillars in the energy efficiency of a data center. Virtualization and newer infrastructure models such as hyperconverged infrastructure help optimize server workloads and thus energy consumption. Akamai's 2019 sustainability report stated that because of a combination of hardware and software optimization techniques tuned for more efficiency, its net power usage had risen only 9% since 2015, although its platform capacity had increased 182%.[22]

› **Drive desirable behaviors with an internal value chain.** This includes how an organization works as well as its management philosophies. Firms must embed sustainable attitudes within the workforce, too. As organizations empower more line-of-business managers to make procurement decisions, they need to make their overall sustainability goals clear from the top down. This also plays a key role in e-waste generation.

› **Tailor standardized configurations for your business to save energy.** The right refresh cycles, phasing out less energy-efficient legacy infrastructure in favor of more modern infrastructure, can help with adoption of new innovations. Many cloud vendors tweak the cooling metrics in data halls to use as little energy as possible. Energy Star estimates that data centers can save 4% to 5% in energy costs for every 1°F increase in server inlet temperature.[23]

Retirement: The End Of Your Technology Lifecycle Starts At The Beginning

An effective circular economy strategy closes the loop on the sustainability journey of an organization by optimizing for energy usage, operations, and recycling. To complete this circle requires more than just attention to recycling and waste management efforts — you'll need a deliberate strategy throughout the procurement and design phases of your business, infrastructure, and operations.

› **Buy equipment with its inevitable disposal in mind.** Put specific design considerations in place for deconstructing, reusing, remanufacturing, and minimizing waste.

› **Avoid energy waste with proper design.** A key component of sustainability is designing products and assembling systems that are dependable. Designing for dependability ensures that products get optimal use, extending a system's life to its maximum potential with minimal environmental impact.[24] Several hyperscale data center operators are taking action on this already.[25]

› **Give technology an afterlife with a circular economy.** In 2017, Google reported that 18% of newly deployed servers were remanufactured machines and 11% of the components it used for machine upgrades were refurbished inventory.[26] It also resold more than 2.1 million units into the secondary market for reuse by other organizations. Many third-party technology recyclers also help in IT asset upcycling. More than half of Hewlett Packard Enterprise's (HPE) environmental impacts relate to customers' use of products, with another third resulting from the supply chain.[27] Finding the right refresh cycle and e-waste management techniques are critical at this step.

Other Novel Approaches Can Enhance Your Sustainable Goals

In addition to the standard approaches to increasing data center efficiencies and procuring green energy and truly green products, several innovative approaches have been taking shape to help — and more will follow.

› **AI and machine learning add informed feedback to your process.** Many data center providers and colocation players are experimenting with AI techniques to forecast the PUE of their facilities and dynamically optimize their data centers in real time. Google reported saving up to 40% on its data center cooling bill, which equated to a 15% reduction in overall PUE overhead, by utilizing AI made by DeepMind.[28] The solution works by training a system of neural networks with different operating scenarios and parameters within the data center.

› **Waterside and airside economizers save cooling energy.** Waterside economizers eliminate the need for compressors and use the evaporative cooling capacity of a cooling tower to produce chilled water. At optimally cool outside temperatures, organizations can use them instead of chillers. In addition to providing cooling redundancy, waterside economizers can provide significant reduction in costs.[29] An airside economizer distributes outside air directly to the servers; instead of being recirculated and cooled, the exhaust air from the servers simply vents outside. This is particularly advantageous in cooler and non-humid regions.

› **Unorthodox power and cooling solutions can offer surprise savings.** Many innovative cooling mechanisms are developed by hyperscalers, which have more control over the environment and applications they need to run within each of their data center facilities. One example is Facebook's StatePoint Liquid Cooling (SPLC) system, developed with Nortek Air Solutions, which uses water instead of air to cool data halls.[30] In comparison with previous indirect cooling systems, Facebook anticipates that the SPLC system will reduce water usage by more than 20% for data centers in hot and humid climates and by almost 90% in cooler climates. In 2018, Facebook said its operations had achieved 75% renewable energy and are on track to meet 100% in 2020.

› **Natural cooling may be an option.** Over the past decade, many data center operators and several hyperscalers have considered relocation or expansion to cooler environments like Canada, Iceland, or the Nordics to take advantage of air- and water-cooling opportunities. However, data gravity and latency issues make such movements impractical for many use cases. To balance this, Microsoft recently tested an underwater data center model, reasoning that because more than half of the world's population lives within 120 miles of the coasts, building data centers in the water will address latency issues as well.[31] This is experimental, but it's worth following.

Recommendations

Save The Planet — And Save Money In The Process

Although goodwill benefits have traditionally drive sustainability initiatives, the right partnerships, strategic planning, and a systematic analysis with a framework will help achieve other benefits, including financial ones. You can directly cascade these benefits to your customers. Executive buy-in for making concrete decisions and developing an environmentally responsible corporate culture is the start. Technology leaders should:

› **Use a framework to investigate where their organization has the most impact.** A systematic approach and communication style are essential in every strategy, and the framework we lay out for sustainability helps with that goal. More important is ensuring that the figures on green energy consumption and emissions that your partners provide are accurate and determining which elements they contribute within the sustainability ecosystem. For example, a sound green procurement strategy is only part of an overall initiative that extends all the way to the possibilities of effective waste management, management principles, and water usage.

› **Enable partners and customers to share their initiatives.** A key opportunity for enterprises is to demonstrate how your own sustainability initiatives help drive those of your customers, who will likely have their own sustainability goals. This not only serves as a differentiator but will also generate trust in long-term investments. Customers have historically shown a willingness to pay a premium for a well-differentiated product when evidence is abundant that it applies to their goals. This means engaging in clear and transparent communication about your sustainability targets, the regulations you're tracking, and your own service providers' initiatives.

› **Consider colocation and hyperscale opportunities to reduce carbon footprints.** Larger cloud hyperscalers use their scale to efficiently spread their resources over sizable areas to achieve much higher PUEs. They're also able to forge long-term, cost-effective partnerships with green energy suppliers, thus enabling access to cost guarantees, and to employ more innovative techniques to energy management and a circular economy. With the continuous evolution in data center interconnections and network connectivity, organizations can mitigate some level of latency requirements for certain workloads, making cloud migration a viable option in addressing environmental impact. Various subscription-based models also mean less equipment to own and refresh at the end of a lifecycle.

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› **Foster an atmosphere for internal innovation.** No two industries — indeed, no two organizations — will have the same opportunities and challenges when it comes to being environmentally responsible and sustainable. Create an environment where employees and internal leaders are motivated to find sustainable solutions for the various operations they oversee. This will inspire internal projects and initiatives that may lead to optimized processes. At many organizations, these initiatives eventually serve as valuable key differentiators from competitors. Bake the philosophies of circular economy and design for dependability into every product line and process.

› **Create an effective sustainability team.** A dedicated sustainability team can help generate substantial internal and external impact. Most of the industry leaders in sustainability initiatives that we interviewed have a dedicated sustainability team that actively looks across the organization for optimization opportunities and people with the power to effect change. With the right framework, these teams can be instrumental in making recommendations to senior leadership on a practical sustainability roadmap, thereby empowering decision making. This also ensures continuity and accountability for various initiatives. Such a team can also help communicate externally with customers, media, and stakeholders about an organization's thought leadership initiatives.

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Supplemental Material

Survey Methodology

The Forrester Analytics Consumer Technographics® North American Youth Survey, 2019 (US), was fielded from May to July 2019. This online survey included 4,594 respondents in the US, ages 12 to 17. For results based on a randomly chosen sample of this size, there is 95% confidence that the results have a statistical precision of plus-or-minus 1.5% of what they would be if the entire population of US online youth (defined as those online weekly or more often) had been surveyed.

Forrester weighted the data by age, gender, income, region, and broadband adoption to demographically represent the US online youth population. The survey sample size, when weighted, was 4,594. (Note: Weighted sample sizes can be different from the actual number of respondents to account for individuals generally underrepresented in online panels.) The programming language herein reflects the survey respondent base for each question. Bases for specific questions have

been changed in published data for increased clarity. Therefore, the base in published data may not match the base language in this document. Dynata fielded this survey on behalf of Forrester. Survey respondent incentives included points redeemable for gift certificates.

Companies Interviewed For This Report

We'd like to thank the individuals from the following companies who generously gave their time during the research for this report.

Akamai	Lenovo
Cyxtera	NTT
Digital Realty	QTS
HPE Financial Services	

Endnotes

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