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Feature

Digital Sustainability for a Better Future

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digital sustainability for a better future

GOOGLE HAS THE GOAL OF ACHIEVING NET ZERO EMISSIONS ACROSS ALL ITS OPERATIONS BY 2030. But the company runs a lot of data centers, data centers create a lot of heat, and so a lot of energy is required to cool them. How can Google, a company founded on energy-gobbling centers, possibly get to net zero?

Google gave this question to DeepMind, its AI subsidiary. DeepMind collected data from various sensors in Google's data centers, including information about temperatures, pressure, power consumption, and cooling-equipment status. It then created a real-time model of the cooling system that enabled it to predict the future temperature and

Digital technologies, when used in the right way, can benefit organizational performance, improve people's lives, and protect the planet.

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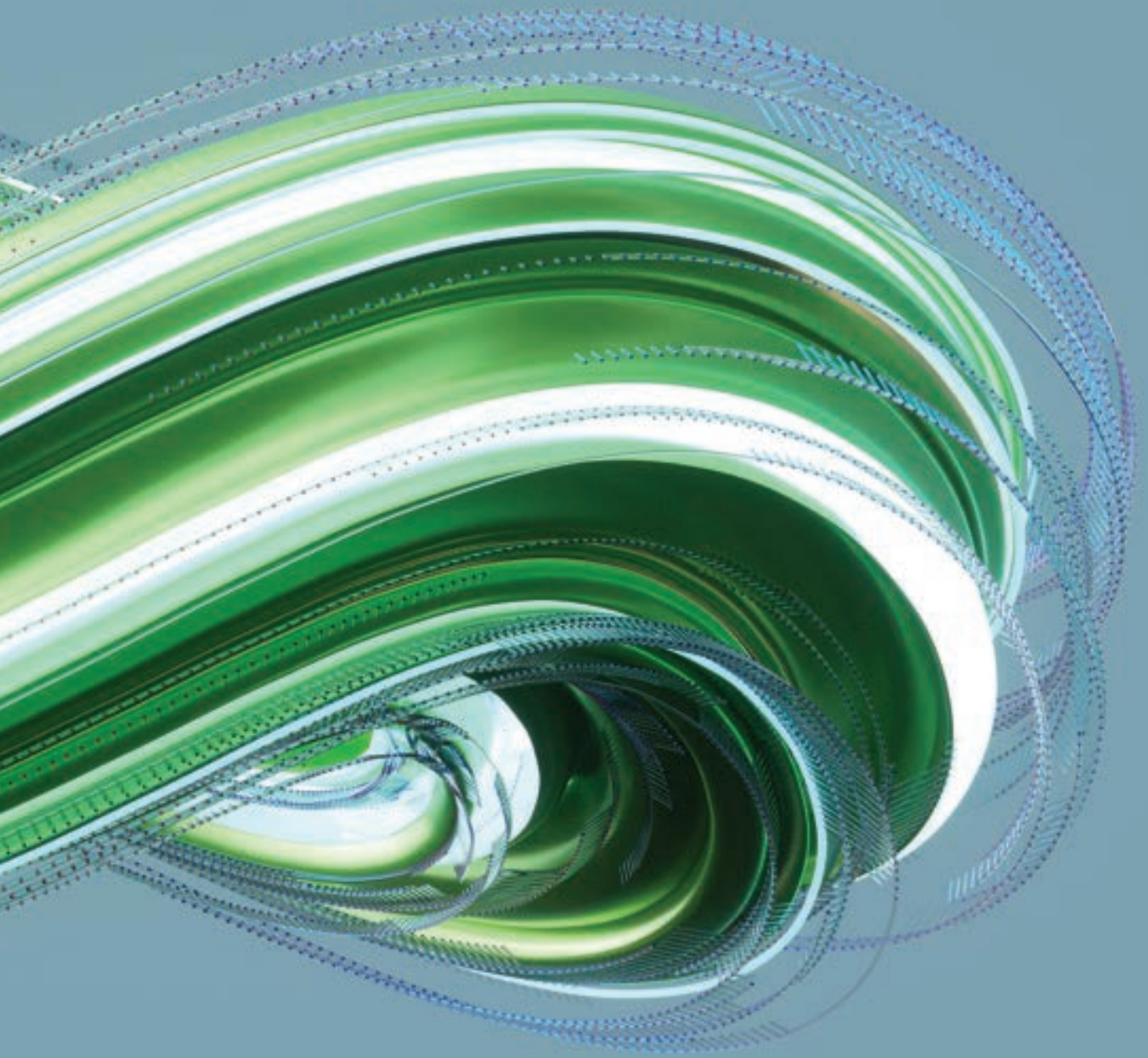

pressure in each data center up to an hour in advance. Armed with these insights, the cooling system could optimize its operations to proactively manage changes in temperature. These actions included adjusting cooling equipment settings, such as fan speeds, pump pressures, and valve positions, to match the predicted cooling demand.

Further, DeepMind's system, with its neural networks and reinforcement learning, could continually learn and adapt. By analyzing new data and adjusting its model, the AI improved its predictions and recommendations over time, causing a 40 percent reduction in energy used for cooling. This continuous learning allowed the system to adapt to changing conditions, such as fluctuations in server load or weather, and ensure that it remained maximally efficient across many different scenarios.

Moving toward a sustainable economy is perhaps the biggest societal and organizational challenge of our time. Digital technologies are useful for many aspects of sustainability, such as reducing greenhouse gas emissions, safeguarding biodiversity, increasing recycling, preventing deforestation, and supporting sustainability objectives across value chains. While the role of digital technologies in supporting this transformation cannot be underestimated, the mechanisms through which this advance occurs remain underexplored.

We see this gap as a missed opportunity. By their very nature, digital technologies are well suited for visualizing, improving, and scaling processes—and, by extension, for achieving greater and faster sustainable impacts. Embracing digital technologies in sustainability efforts can empower us to make data-driven decisions and innovations that lead to a greener, more resource-efficient world, aligning our technological advancements with our environmental responsibilities.

THE PROMISE OF DIGITAL SUSTAINABILITY

One reason why business leaders have not paid attention to the intersection of digital technology and sustainability is that they seem noncomplementary. Companies have used digitization largely for economic benefits, such as reduced costs, increased revenues, or enhanced agility, and have paid relatively little attention to environmental impacts. Sustainability, by contrast, is concerned with benefits for the environment—for example, by phasing out waste or lowering greenhouse gas emissions—and companies often underestimate digital technologies as potential enablers. Despite these biases, a 2022 cross-industry study found that 40 percent of executives believe that digital technologies can have a positive effect on their sustainability agendas.[1]

We believe that digital tools can boost organizational performance, and, if used in the right way, can also help to protect the planet and improve people's lives. We refer to this combination as digital sustainability, which we define as the use of digital tools and technologies to improve environmental sustainability in addition to, or, in some cases, at the expense of, organizational performance.

To be sure, the impact of digital technologies on sustainability is not always positive. Digital pollution accounts for an estimated 4 percent of global greenhouse gas emissions, which is larger than the aviation industry's share.[2] Digital technologies themselves must become more responsible and sustainable.

Yet digital technologies can play an important role in achieving sustainability. Consider how digital technologies have enabled the ongoing electrification of the transportation sector; how smart-city concepts use digital technologies to enable more efficient use of space and resources; and how the agricultural sector is drawing on spatial data and smart sensors to improve the use of land, water, and pesticides. In fact, the World Economic Forum and Accenture estimate that digital technologies can reduce global greenhouse gas emissions by up to 20 percent.[3] Further, a study by PwC estimated that 70 percent of the UN Sustainable Development Goals targets could be achieved by using emerging technologies such as AI, blockchain, and Internet of Things (IoT).[4]

While business leaders have concentrated primarily on how digital tools and technologies can enhance profitability, they have yet to fully explore these resources' potential in advancing sustainability. Our research finds that both objectives can be achieved via three broad mechanisms: seeing better, acting better, and scaling better. Let us examine them in turn.

SEEING BETTER

One way in which digital tools and technologies can help is by proving clarity, visibility, and transparency about sustainability impacts. As one supply chain executive at Philips put it, "I think that getting transparency across the whole value chain is critical, because transparency is not only there for sustainability; it also enables you to improve your performance."

To get a sense of this concept, consider something more mundane: energy use in your own home. Suppose you wish to reduce its environmental impact. Where do you start? Your appliances probably have an energy rating, but even if you know what it is, it provides very little insight on usage. For most of us, our carbon footprint is a black box. We would like to reduce it, but we simply don't have the data to know what to do. Fortunately, newer smart meters are providing real-time information on household energy consumption that can be visualized on mobile apps, allowing us to make better, more informed decisions about our energy usage and resulting in lower bills and reduced environmental impacts.

Today, more than 1,000 companies with a combined value of $16.4 trillion have signed net zero pledges between 2025 and 2035.[5] While it is relatively straightforward to address scope 1 and 2 emissions—the ones in the direct control of the company—scope 3 emissions, those that occur within the wider supply chain, are much harder to tackle. Most supply chains today are so extensive, global, and fragmented that companies have difficulty untangling and understanding them. But if we wish to address sustainability across the full value chain or identify where the biggest emissions occur in a logistics network, we need full transparency. Many companies we have spoken with that track their supply chains find that the Pareto principle holds true: 20 percent of the suppliers are responsible for 80 percent of negative environmental impacts, in terms of both pollution and ethical misconduct.

Several companies are actively working on measuring their scope 3 emissions. For instance, Firmenich, a global leader in flavors and fragrances, introduced the PATH2FARM digital traceabil-

ity initiative in 2021. This effort monitors the social and environmental impacts of Firmenich's raw materials and offers customers access to the company's database, providing complete end-to-end transparency in the supply chain. BASF launched a similar project in 2022 called Seed2Sew. It utilizes blockchain technology to trace the fashion value chain from cotton seeds all the way to ginning, spinning, knitting, and manufacturing.

Or consider Tony's Chocolonely, a Netherlands-based producer of ethical chocolate. The company has a dual social-environmental focus: It wishes to eliminate slavery along the chocolate supply chain and also reduce its environmental impact. When Tony's found huge gaps in information along the supply chain to assess impacts, the company set up a cloud-based platform called Beantracker that monitors the movement of cocoa beans from plantations in West Africa to factories in Europe. Beantracker grounds its sustainability goals by ensuring that its cocoa beans are ethically sourced and free from association with slavery or unfair labor practices, and by enabling them to assess the environmental impact of transportation and production.

But visibility into global supply chains is only the first step. The next is using digital analytics tools, often augmented with AI, to analyze vast amounts of information that support better decisions and predictions. Beantracker enables Tony's to be smarter about social and environmental impacts. When it measured its environmental impact across the chocolate value chain, it uncovered an interesting finding: The largest source of greenhouse gas emissions did not come from the farming of the cocoa pods, or the transportation of the beans, or even the manufacturing process. Rather, it came from the cows that contributed the milk powder for the chocolate. Armed with this knowledge, Tony's can work to mitigate the impact; for example, it has introduced a line of vegan chocolate into its product range.

Moreover, Tony's shares its insights with partners, including suppliers, retailers, and some competitors, so that they can work collectively on improving sustainability along the entire chocolate value chain. They also use GPS satellites and drones to map the size of the farms producing cocoa pods. Tony's compares the GPS data with the output it receives from the farmers. By measuring the output against data from typical yields, it can identify anomalies, such as when too many pods are being supplied from a particular farm. This may signal that farming is happening in protected areas, that deforestation is occurring, or that pods are being stolen from neighboring farms. When anomalies are identified, Tony's sends people to investigate. In cases where yields are below expected levels, they implement coaching programs to help farmers make better decisions about their plantations.

ACTING BETTER

Once a company analyzes data about sustainability benefits, it can make decisions toward greater sustainability. Specifically, digital tools and technologies can improve three broad categories of action. First, they can reduce the need for physical resources; second, they can reduce the negative impact of physical resources; and third, they can offer improved environmental services.

Many negative social and environmental impacts come from the need to source, produce, transport, maintain, and dispose of physical resources. If you can avoid the need for physical resources entirely, these impacts can be eliminated. Several different digital technologies can facilitate this outcome.

When digital equivalents replace physical assets, a dual benefit often results: cost reduction and decreased impact on the environment. Digital twins are good examples of this pattern. They can allow the digital simulation of a product or component to predict its process and performance under various conditions through its design and life cycle. For instance, Tesla creates a digital simulation of every car it sells, using data collected from sensors on the vehicles, which are uploaded to the cloud. This digital twin enables the company to predict where faults and breakdowns are most likely to occur. Doing so, they reduce their costs of maintenance, avoid recalls, and at the same time improve customer experience.

From a sustainability perspective, oil-field services company Baker Hughes advances the digital twin concept by combining simulated data from the digital twin with actual performance data from the physical object, obtained from sensors and inspections, to form what it calls a digital triplet. This digital triplet can extend the life of its products and improve the accuracy of predictions while reducing the need to build physical prototypes. It can also help achieve safety and sustainability targets: The company can use its digital oil-field technologies to monitor and ensure worker health, safety, and environmental protection. For example, remote monitoring powered by computer vision and sensor data quickly and accurately detects corrosion and potential leakages, and AI-enabled predictive analytics help identify and prevent equipment failures that could harm workers and the environment.

Beyond digital twins, other examples of dematerialization, such as additive manufacturing and 3-D printing, can benefit the environment in multiple ways. They can reduce waste in the manufacturing process, build products with less material, and reduce the logistical costs and impacts of getting products to customers. In addition to products, physical processes can be replaced with digital alternatives, in the form of digital process automation. Moving

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paper-based processes to online formats can reduce the need for paper, workforce, and transportation infrastructure.

Digital technologies need not reduce or eliminate physical resources to boost sustainability. They can also help reduce the environmental impact of physical objects that need to be used. They can contribute to greater efficiency, eliminate waste, reduce the need for travel, and encourage recycling and reuse.

The city of Geneva, for instance, introduced an innovative smart-parking system in 2017 to alleviate traffic congestion and enhance productivity for its residents and visitors. Prior to this system, studies revealed that 20 percent of city traffic was composed of vehicles circling in search of parking spaces, causing increased fuel consumption and emissions. Geneva's smart-parking solution incorporates a sophisticated network of sensors embedded beneath parking spaces, high-resolution cameras, precise GPS mapping, and a user-friendly consumer app. Now, with the help of this integrated technology, drivers can access real-time information about available parking spots, pinpointing the nearest and most convenient option. This efficiency boost not only saves drivers valuable time but also reduces the environmental impact of vehicle emissions caused by unnecessary idling and constant searching for parking.

Remote maintenance systems offer another example. They were already expanding across much of the industrialized world before COVID-19, and the pandemic only accelerated their adoption. These systems utilize sensors and analytics to forecast component or product failures, enabling timely repairs or replacements. Such repair or replacement often requires a technician to travel to the site of the problem. But now, to avoid the need to travel, organizations are deploying remote maintenance systems, sometimes involving augmented-reality systems.

For instance, liquid-packaging giant Tetra Pak uses virtual-reality headsets to enable teams of technicians to conduct complicated maintenance tasks on its food-and-beverage packaging lines in hard-to-reach locations, such as Yemen. A general technician wears the headset, which links to a specialist who can walk the technician through the fix. These systems reduce the downtime of the equipment and reduce environmental impact and cost by eliminating the need for the specialist to travel.

Lengthening the useful life of physical resources normally contributes to financial and sustainability benefits, via lower cost of ownership and a reduced need to produce replacements. This includes digital technology products, which too often have a limited life span. If the average useful life of a smartphone or a laptop can be extended by a year, both lower replacement costs and reduced environmental impacts will result, as will beneficial reuse of technology components through recycling and modularity.

Digital technologies can also help to extend the life span of other physical resources, thus reducing physical waste. Medical technology company Philips has designed imaging products that are circular, in the sense that its components can be repurposed and reused. The company is converting other elements from hardware to software so that they can be updated, rather than replaced. Technology tracking is also part of Philips' strategy. When it knows the location of a product, the company can arrange for it to be returned, refurbished, and redeployed, thus extending the product's life span.

Beyond their impacts on physical resources, digital technologies can also provide new solutions and business models to increase the positive impact an organization may have on the world. For example, over the past decade, German chemicals giant BASF has invested heavily in digital tools and technologies across its lines of business to enhance efficiency, improve information flow, and find new sources of revenue. At the same time, it has pioneered the adaption of its products and processes to reduce negative impacts on the planet. However, these two streams—digital and sustainability—operated separately within the organization.

digital technologies both enable seamless connectivity and provide the infrastructure required to scale sustainable solutions

Today, this structure is changing. In its agriculture business, BASF is combining satellite and sensor data with digital analytics to maximize outcomes that benefit both the planet and farmers' bottom lines. Satellites scour the fields looking for dry areas, weedy areas, sandy areas, and so on. Sensors gather information about the soil and the air and the conditions of the animals or plants. These extensive datasets are meticulously analyzed and processed by sophisticated algorithms, which are designed to make crucial decisions about when and where to apply water, fertilizer, and herbicides. Unlike the decision algorithms of the past, which might have been geared primarily toward cost reduction or yield maximization, the current focus has shifted. Now, the emphasis is on optimizing profits while minimizing the ecological footprint, aligning agricultural practices more closely with sustainability goals.

Restor, recognized as the largest network of restoration and conservation sites across the globe, exemplifies how digital technologies can advance environmental interests. Its map-based, open-source platform integrates real-time data and high-resolution satellite imagery to identify areas with potential for ecological restoration. For instance, the platform can help identify deforested regions that could benefit from reforestation projects. Its users, including restoration practitioners, NGOs, businesses, scientists, and governments, can also learn about native tree species suitable for restoration in specific areas. Moreover, Restor collects data from various restoration projects globally, promoting transparency in restoration activities and enabling well-informed decision-making. This ecosystem connects practitioners, funders, volunteers, and decision mak-

ers, fostering a collaborative approach to ecological restoration on a global scale.

Google's Environmental Insights Explorer showcases how advanced data analysis and modeling capabilities can aid cities in their sustainability endeavors. This platform measures municipal emission sources and conducts in-depth analyses of environmental data. As a result, urban planners, policy makers, and environmental advocates gain valuable insights into their environmental impact and can identify effective strategies to make informed and sustainable decisions. For instance, a city might use this tool to understand the sources of air pollution and devise plans to reduce emissions from transportation or industrial activities.

By harnessing real-time data, advanced modeling techniques, and innovative digital platforms, companies can revamp their business models to protect the environment. Digital technologies not only optimize operational efficiency but also empower companies to make well-informed decisions that contribute directly to a more sustainable and ecologically conscious approach. As a result, companies are better positioned than ever to introduce innovative solutions and strategies that drive meaningful change, leading to a future where environmental concerns are met with strategic and effective business responses.

SCALING BETTER

Once we discover ways of acting better through innovative digital sustainability approaches, we face the challenge of scaling these solutions. The power of digital technologies lies in their capacity for rapid and extensive dissemination.

However, the responsibility for scaling digital sustainability should not remain confined within organizational boundaries. In today's interconnected world, the path to achieving scalable and sustainable solutions often leads us to the realm of multistakeholder and cross-sector collaboration. Here, the principles of cooperative competition, or "coopetition," come to the forefront, as organizations, industries, and even competitors join forces to address pressing sustainability challenges. Open data and open-source tools can catalyze these collaborative endeavors, unlocking the potential for collective action and transformative change on a global scale.

Tony's Chocolonely has taken a remarkable approach by sharing with industry competitors the valuable insights obtained through its Beantracker system. Embracing the spirit of coopetition, the company introduced an innovative platform called OpenChain, aimed at fostering collaboration among various chocolate manufacturers. In a bold move, Tony's Chocolonely decided to openly share its knowledge and expertise concerning ethically sourced chocolate, effectively giving away its hard-earned insights. This act of knowledge-sharing facilitates the exchange of information and best practices and has the potential to create a ripple effect, benefiting participating companies and contributing to broader sustainability goals within the industry.

Digital technologies enable different stakeholders to connect and communicate, no matter how diverse and dispersed. In 2019, Schneider Electric introduced the Schneider Electric Exchange, a dynamic open platform geared toward sharing IoT-driven solutions for energy management and automation. The exchange seeks to foster collaboration among a diverse array of stakeholders—including customers, partners, developers, experts, innovators, industry professionals, and sustainability advocates—to address critical sustainability and efficiency issues. Among other benefits, it promotes community-driven challenges asking for solutions across a wide spectrum of topics, such as optimizing energy consumption in data centers, enhancing building energy efficiency, and refining industrial automation processes. Moreover, Schneider Electric Exchange provides the resources and support required for scaling solutions, thereby amplifying their impact.

Such collaborative networks are not limited to the corporate sector. For example, Wildlife Insights is a cloud-based platform that provides the largest database of camera traps in the world. The platform is the product of a partnership of the World Wide Fund for Nature (WWF), Conservation International, the Smithsonian Conservation Biology Institute, the Wildlife Conservation Society, the North Carolina Museum of Natural Sciences,

the Zoological Society of London, Map of Life, and Google. It addresses the pressing need in wildlife conversation to map, share, and process wildlife data, all of which enable conservationists to better understand changes in wildlife population and provide better protection as a result.

In addition, digital platforms help promote a circular economy by facilitating the exchange, sharing, and recycling of goods. These platforms can connect individuals and businesses to exchange used items, reducing the need for new production and minimizing waste. Too Good To Go, for example, is an app that connects consumers with local restaurants and grocery stores to purchase surplus food at a discount before it goes to waste. This initiative not only reduces food waste but also raises awareness about the environmental impact of food disposal.

Scaling sustainability solutions requires organizations to look beyond their organizational boundaries to collaborate with actors they do not normally collaborate with, even direct competitors, to enable industry-wide shifts toward sustainability.

The Holy Grail 2.0 initiative brings together more than 160 organizations across the fast-moving consumer goods (FMCG) value chain to address better management, sorting, and recycling of plastic packaging. Only 14 percent of all plastics are currently recycled, and the vast majority end up in landfills. Yet the complexity of the challenge and the large number of stakeholders involved—the chemical industry, materials suppliers, transformers, end producers, customers, cities for waste collection, recyclers, and regulatory institutions—call for systemic solutions. The Holy Grail initiative implemented as a first step digital watermarks on the consumer packaging of its members to enhance the sorting of plastic waste. The imperceptible codes, which are as small as a postage stamp, are printed all over the packaging. High-resolution cameras installed at sorting units can then easily detect and decode this information, significantly enhancing the precision of plastic-waste sorting.

Catena-X has similar goals. This groundbreaking industry collaboration within the automotive sector seeks to streamline complex processes, optimize resource usage, and promote transparency. A standout achievement among its endeavors is the development of an innovative and standardized digital battery passport. This tool is poised to revolutionize the battery industry by ensuring strict compliance and transparency. It aligns well with forthcoming regulations aimed at curbing carbon footprints and emissions limits, setting the stage for a more sustainable and eco-conscious future. For instance, imagine a scenario in which an electric vehicle's battery carries a digital passport. This document contains a comprehensive record of the battery's life cycle, from production to recycling. It details critical information, such as materials used, manufacturing processes, energy consumption, and even carbon emissions, associated with its creation. This wealth of data empowers manufacturers, regulators, and consumers alike to make informed decisions that not only comply with regulations but also promote greener, more responsible practices within the automotive industry.

As these examples show, digital technologies both enable seamless connectivity and provide the infrastructure required to scale sustainable solutions. From fostering circular economy platforms to powering blockchain-enabled transparency, digital tools offer dynamic pathways for businesses to navigate collaborative landscapes and scale their positive impact.

THREE MODELS FOR DIGITAL SUSTAINABILITY

While digital sustainability offers many benefits, few organizations are actively pursuing it. The reason for this reluctance is mostly practical: Organizations have separate groups to manage digital technology and sustainability, and these silos get in the way of generating combined value. Therefore, organizations must bridge these silos, and that is never a simple task. The report-

Components of Digital Sustainability

Companies and organizations must pursue digital sustainability on three fronts

	SEE BETTER	ACT BETTER	SCALE BETTER
Sustainability Challenge / Opportunity	•Opaque value chains •Hard-to-measure scope 3 emissions •Hidden environmental violations	•Improve resource efficiency •Reduce waste •Offer improved environmental services	•Speed up solutions •Provide benefits at scale
Digital Enablers	•Earth observation technology •AI and advanced analytics •Blockchain •Cloud/Edge computing	•Digital process automation •Internet of things •Digital twins •Extended reality •3-D printing	•Artificial intelligence •Cloud computing •Digital watermarks •Additive manufacturing at scale
Digital Sustainability Outcome	•Relevant data collection •Uncover hidden root causes •Planning accuracy •Improved decision-making and foresight	•Optimization of processes and services •Increased resource efficiencies •Value creation from waste products	•Share and spread learning •Collaborate inside and outside organizations •Gain momentum for scaling change
Examples	•BASF Seed2Sew •Firmenich PATH2FARM •Tony's Chocolonely Beantracker	•Baker Hughes Digital Triplet •BASF Smart Agriculture •Philips Circular Initiative •Smart City Geneva	•Tony's Chocolonely OpenChain •Catena-X •Schneider Electric Exchange •FMCG Holy Grail initiative

Digital Sustainability Maturity Assessment

Take this test to evaluate your organization's readiness for digital sustainability

Digital Sustainability Maturity Category	Considerations	ANSWER ON A 1-5 SCALE 1: Strongly disagree 2: Disagree 3: Neutral 4: Agree 5: Strongly agree
See better	• Digital technologies give us clear visibility into our sustainability impacts across our organization. • We can track sustainability effects across our extended value chain, including scope 3 emissions. • We conduct advanced analysis of our sustainability impacts based on data we collect. If the total for this category is 8 or below, you need to enhance the visibility of your supply chain.	SUBTOTAL |
Act better	• We have replaced many of our physical objects with digital alternatives. • We have replaced many of our physical processes with digital alternatives. • We have programs to reduce the negative sustainability impacts of our technology portfolio. If the total for this category is 8 or below, you should refocus your digital sustainability efforts on reducing costs, limiting risks, and finding new sources of value.	SUBTOTAL |
Scale better	• In our organization, digital and sustainability teams work closely together. • We have been successful at taking digital sustainability pilots and rolling them out at scale. • We have included partners, such as suppliers and customers, in our digital sustainability efforts. If the total for this category is 8 or below, you need to create the framework conditions for building digital sustainability at scale.	SUBTOTAL |
Digital Sustainability Maturity Score	If the total is 25 or less, you have a digital sustainability problem. If it is between 26 and 34, you are at a moderate level of digital sustainability, with room for improvement. If you are above 34, you are at a high level of digital sustainability.	SUBTOTAL | TOTAL |

ing lines of digital and sustainability teams often do not intersect except at the very top of an organizational chart. To simplify matters, we have identified three different models for managing digital sustainability, each with advantages and disadvantages.

Outsourcing | In an outsourcing model, the digital and sustainability teams remain separate entities but coordinate to work with external parties to manage the portfolio of digital sustainability projects. The teams focus on their respective strengths and limit coordination with each other across functions to infrequent exchanges.

A Danish wind-energy product manufacturer, NordicEcoWind (pseudonym), pushed a digital sustainability agenda from the top team, driven by a passionate CEO. However, while both digital and sustainability were core pillars of the company's strategy, the teams that managed each part had few points of intersection. Instead, they worked with external vendors to find appropriate solutions, such as implementing advanced data analytics to optimize energy efficiency, exploring renewable energy innovations, and developing environmentally conscious supply chain solutions.

This approach has the advantage of avoiding the turf wars that often arise when teams work across silos. It also can benefit from the experience of external vendors. However, it adds complexity to projects: Many parties need to work together, because the expertise often resides primarily with the external vendors, and mechanisms for knowledge transfer may be limited, or the company may lack a robust learning culture. Consequently, the approach may hinder the company's ability to scale these initiatives beyond individual projects. The insights and expertise gained from these external partnerships often remain compartmentalized and make it challenging to propagate a cohesive and sustainable digital sustainability strategy throughout the entire organization.

Two hats | In a two-hat model, an organization focuses on both digitization and sustainability and brings the two together. While the two functions do not formally merge, they work hand in hand and rotate leadership among different officials—chief sustainability officer, chief digital officer, or chief innovation officer—for different projects. Project teams combine people from various departments for the duration of the project, after which they return to their home functions.

Firmenich pursues a two-hat approach. Its chief digital officer has the dual responsibilities of leading the company's technological innovations and contributing to its environmental, social, and governance efforts (e.g., PATH2FARM). He works closely with the head of sustainability on these initiatives, and they both have strong support from the management team and board.

The two-hat model promises tight coordination and alignment between the technology and sustainability groups, but it can run into difficulties when attempting to align different groups' competing interests, priorities, and incentives.

Ingrained | An ingrained model seeks to imbue digital sustainability within the organizational culture by empowering and incentivizing all employees to further digitization and sustainability simultaneously. These models are almost always supported by very

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strong commitments from the CEO and other leaders within the executive team, who mandate that digital sustainability is included within processes, projects, compensation, and bonus targets. These organizations typically leverage the power of digital technologies not only to improve financial performance but also to advance environmental goals.

Philips has integrated digital sustainability targets into many of its processes and key performance indicators. Employees are required to sign an annual document attesting to the principles of sustainability. The company measures and publicly reports environmental impacts and links individual performance bonuses to sustainability targets for many of its leaders. Sustainability is centralized, but champions in other departments, including Digital, advocate for the company's sustainability agenda. Representatives from Sustainability and Digital are required to review all of the major business projects to ensure that they are compatible with organizational objectives.

The ingrained model aspires to embed digital sustainability within the company by fostering a culture of continuous improvement and cross-functional collaboration. It not only facilitates the exchange of ideas and best practices but also opens avenues to identify novel opportunities that can enhance both sustainability and business performance. However, this approach comes with its own challenges. It necessitates providing more advanced training to employees in both sustainability and digital domains to ensure that they have the knowledge and skills to contribute effectively. Additionally, it can complicate the decision-making process for employees who must consider multiple additional criteria, including sustainability, in their day-to-day responsibilities. Nonetheless, this holistic approach to sustainability often leads to enhanced innovation and stakeholder engagement, and long-term value creation.

EXPAND ALONG ALL THREE FRONTS

As we have demonstrated, bringing together a company's digital and sustainable transformation strategies can result in a positive outcome for the environment, in addition to benefiting or, in some cases, hindering organizational performance. While many aspects of digital sustainability can lead to reduced costs, such as digital process automation and dematerialization, some initiatives may result in additional expenses or lower revenues. Tony's Chocolonely accepts the added cost of using digital monitoring equipment to assess environmental impacts across its value chain. Philips acknowledges that extending the life span of its medical equipment may come at the expense of selling new units. These organizations are willing to shoulder a range of economic performance impacts in pursuit of greater sustainability.

We have articulated three ways in which digital technologies can support sustainability objectives: by providing visibility and transparency, by actively improving outcomes, and by expanding benefits across organizations and industries. Different digital technologies can enable each of these objectives. While digital sustainability is still an emerging concept, the examples we have reviewed illuminate the path ahead. (See "Components of Digital Sustainability" on page 58.)

The three strategies should not be adopted piecemeal. Real improvements depend on pursuing *all three approaches*. Organizations that use digital technologies to improve their ability to see better and implement programs to reduce harmful impacts, yet fail to expand these initiatives, end up with a fragmented array of pilots and proofs of concept, few of which attain the scale needed to achieve real benefits. At the same time, organizations that focus on action and scale yet lack the visibility and transparency to fully understand the root causes of sustainability issues often focus on areas that do not address their most material issues, and risk overlooking important areas of potential improvement. Thus, organizations need to expand their digital sustainability efforts to all three focus areas. (See "Digital Sustainability Maturity Assessment" on page 59 for an assessment tool designed to help pinpoint digital sustainability gaps and needs.)

Considering the multitude of environmental problems we face, we must quicken the pace of scaling up innovative and entrepreneurial solutions for sustainable development. In this regard, the role of digital technologies cannot be underestimated. By their very nature, as virtual and scalable assets, they are ideally suited for achieving greater and faster sustainable impact. ◦

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