GreenOps–An Emerging Tool to Reduce Operating Costs While Increasing Environmental Sustainability

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Executive summary

IT workloads have been growing exponentially, and the increases in energy and water use strain both operating budgets and the environment. Green Operations (GreenOps) has emerged in response—an integrated set of best practices that includes:

- Renewable energy.
- Hardware and software.
- Advanced metrics.

Heat, water, and energy management.
By implementing GreenOps, technology and business leaders can reduce environmental impact and operating costs and increase shareholder value.
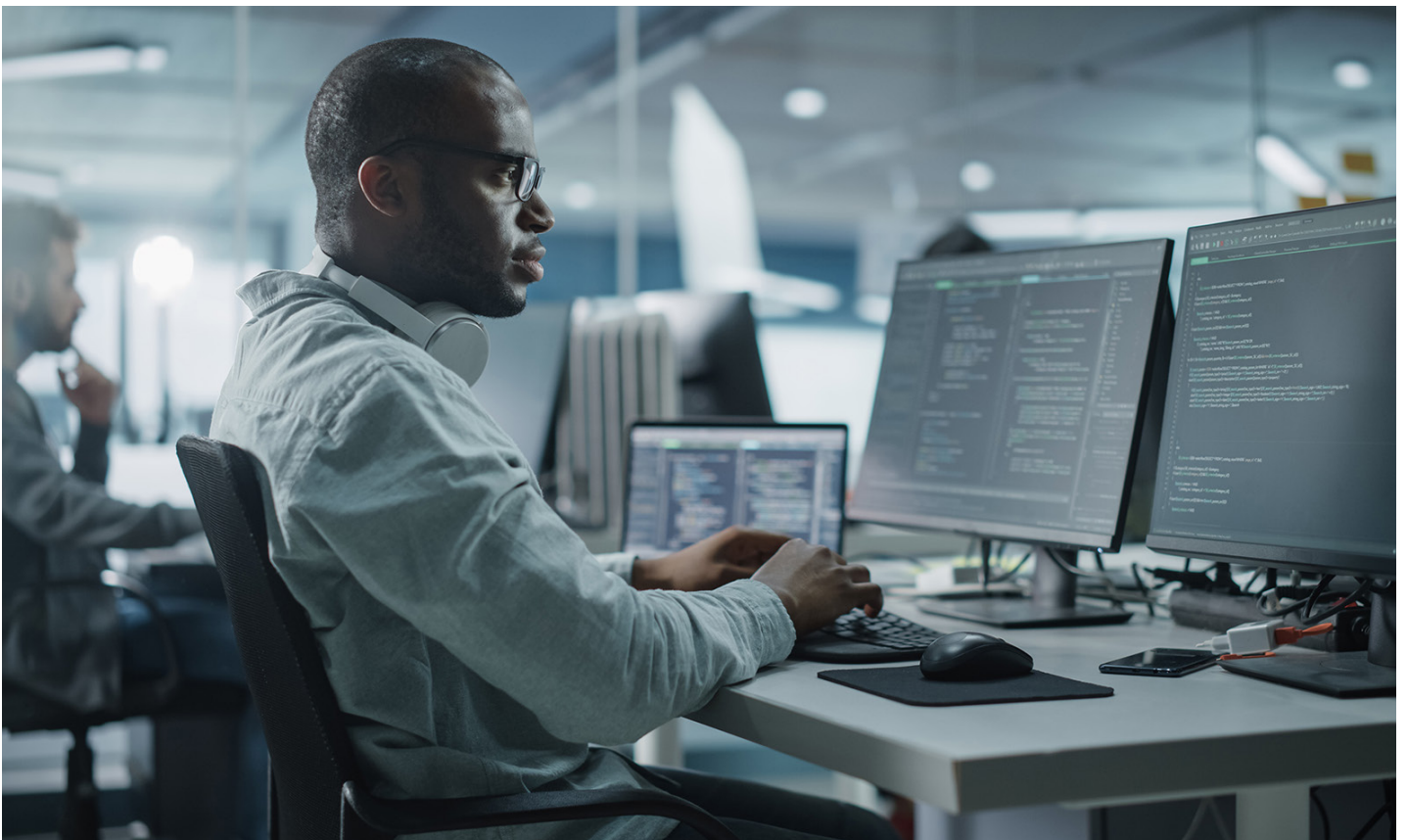
Background

As the cloud becomes central to the ways that we work, live, and play, we can no longer ignore its related costs or incredible resource demands.

Analysts estimate that by 2025, every person in the developed world will have at least one interaction with the cloud every 18 seconds of their lifetime.[1] The growth in cloud workloads has profound implications for operating costs and resource utilization, particularly for electricity and water. This immense infrastructure requires electricity for power, and since electricity generates heat, it also requires tremendous amounts of water to cool the hardware.

The emerging crisis of rising costs and increased resource utilization in the cloud has created an urgent need to refine, deploy, and advance the suite of techniques, technologies, and business practices known as Green Operations (GreenOps).

Nature of the Opportunity

The increasing reliance on the cloud is creating new opportunities. Companies can simultaneously address concrete business challenges while working to alleviate the sustainability problems confronting the societies in which they're long-term stakeholders.
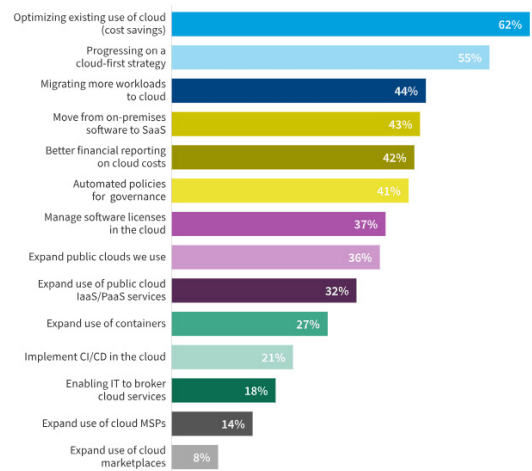
According to the Flexera 2023 State of the Cloud Report, 28% of cloud spending in 2023 was wasted or inefficient. At the enterprise level, awareness is growing that eliminating such waste is critical to improving the financial viability of many organizations.

Reducing operational costs is one benefit of GreenOps. Marketing strengths are another. Both consumers and other businesses are increasingly interested in purchasing from green brands with strong environmental, social, and corporate governance (ESG) credentials.

A survey of the 175 top finance executives by CFO Research revealed that more than half believe their companies will increase revenues through strong sustainability initiatives.[2] By implementing a GreenOps program, organizations can address environmental challenges and reap the financial and marketing benefits from their status as a green brand with bona fide ESG commitments.

GreenOps can also boost employee morale and retention by providing them with the sense of purpose that's so essential to a cohesive company culture. According to the international HR company Adecco, 52% of employed adults feel their companies should be more environmentally aware.[3]

Which of the following initiatives are you planning to make progress on in the next year?

Initiative	Percentage
Optimizing existing use of cloud (cost savings)	62%
Progressing on a cloud-first strategy	55%
Migrating more workloads to cloud	44%
Move from on-premises software to SaaS	43%
Better financial reporting on cloud costs	42%
Automated policies for governance	41%
Manage software licenses in the cloud	37%
Expand public clouds we use	36%
Expand use of public cloud IaaS/PaaS services	32%
Expand use of containers	27%
Implement CI/CD in the cloud	21%
Enabling IT to broker cloud services	18%
Expand use of cloud MSPs	14%
Expand use of cloud marketplaces	8%

N=750
Source: Flexera 2023 State of the Cloud Report
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Green Ops

GreenOps integrates the technologies, techniques, and business practices designed to maximize energy efficiency in the cloud while lessening the environmental impact.

GreenOps optimizes resource usage with better cooling, smarter control systems, greener building materials, and improved waste management.[4] GreenOps organizations minimize energy use from fossil fuels and reuse excess heat thereby, reducing CO_2 emissions. GreenOps also focuses on water conservation, which holds increasing importance globally and nationally, particularly in drought- and heatwave-stricken areas like the American West and Western Europe. The collective impact of GreenOps can be powerful. Between 2013 and 2019, companies with consistently high ESG performance enjoyed 4.7 times higher operating margins and less volatility than low ESG performers over the same period.

Green Ops Model

The field of GreenOps is still nascent, but Dr. Magesh Kasthuri has developed a strong model. His Cloud Sustainability Framework integrates some of the best components from AWS, Azure, and GCP, as well as others.[6] The five elements include:[7]

- "A well-architected framework in AWS, Azure, and GCP. This focuses on increasing performance efficiency, scalability, security, compliance, reliability, and operational excellence in the cloud."
- "An operating model to deploy automation for managing and monitoring cloud resources and controlling usage patterns. This saves the energy consumed by running unnecessary resources."
- "Leveraging best practices in Active FinOps. This improves cloud resource usage and reduces overhead from usage patterns such as server consolidation. It also rightsizes compute instances to save energy indirectly."
- "Harnessing passive sustainability practices to redesign and re-architect applications. This makes them lightweight, self-healing, and endowed with self-controlled resource usage patterns."
- "Integrating services with GreenOps and FinOps tools to automate operational tasks, reduce manual operational activity, and measure operational benefits using business and technical KPIs and metrics."

This holistic model gives cloud users and providers a solid outline of the essentials for cloud sustainability.

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Green Operations Case Study: Amazon Web Services

In recent years, AWS has emerged as the leader in the cloud GreenOps space. AWS has embraced sustainability in its cloud operations to become the world's largest purchaser of renewable energy.[8] The company has 310 sustainable energy projects (134 wind and solar farms and 176 rooftop solar projects) worldwide across 19 countries that generate 15.7 GW of power annually.[9] AWS aims to reach net-zero carbon emissions by 2040.[10]

This overarching commitment to cloud sustainability and GreenOps is embodied in the AWS Sustainability Pillar, which is designed to:[11]

"[H]elp organizations learn, measure, and improve their workloads using environmental best practices for cloud computing…[T]he Sustainability Pillar contains questions aimed at evaluating the design, architecture, and implementation of your workloads to reduce their energy consumption and improve their efficiency. The pillar is designed as a tool to track your progress toward policies and best practices that support a more sustainable future, not just a simple checklist."
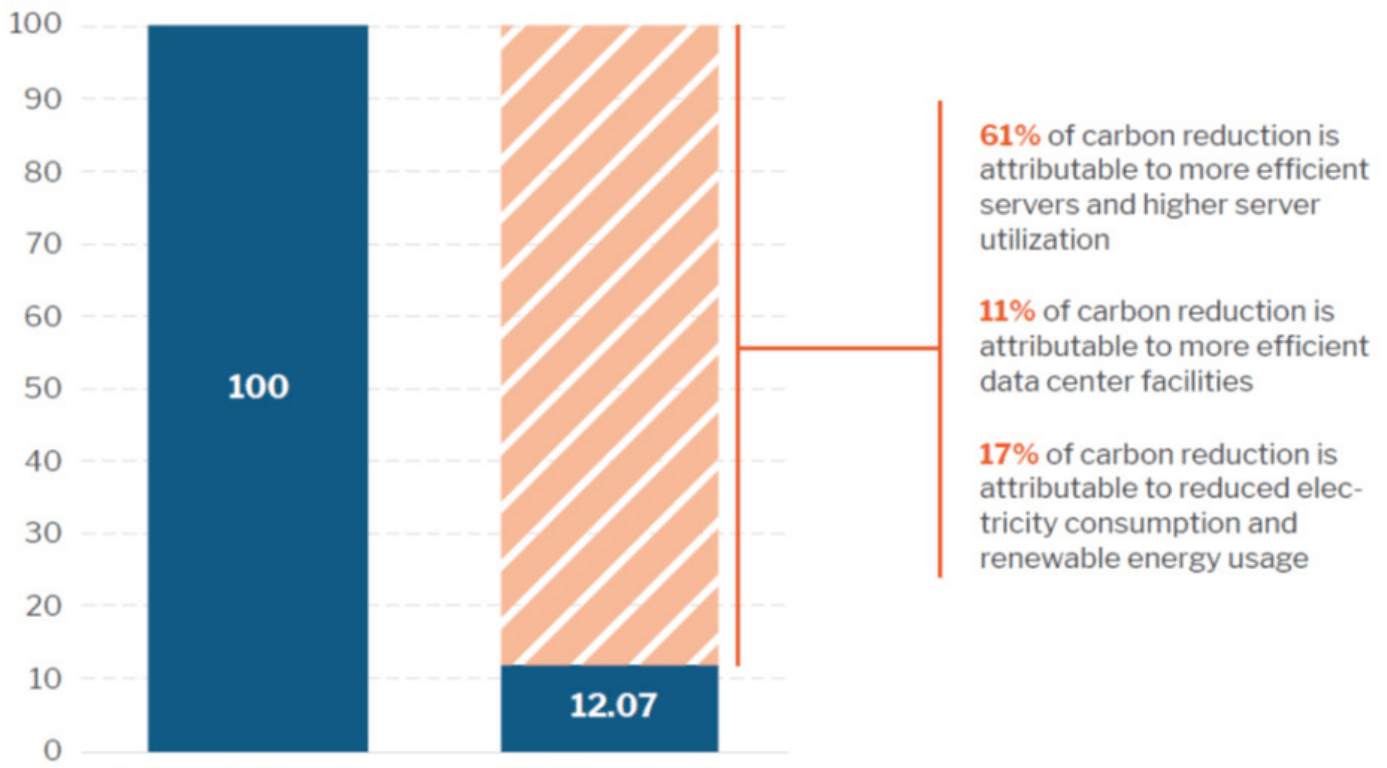
Still, committing to renewable energy is only part of the solution. Good metrics and tools to quantify usage amounts and patterns are also essential. To that end, AWS has developed a Customer Carbon Footprint Tool designed to help corporate customers track, measure, review, and forecast the carbon emissions generated from using AWS cloud services.[12]
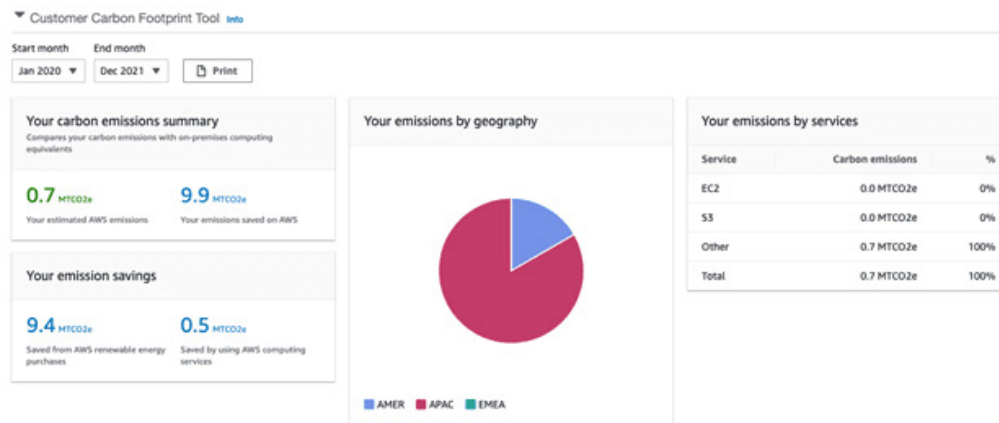
Using the tool, customers can access data from as far back as January 2020. Monthly reports let them view emissions by geographical location and from specific AWS services.[13] Customers can also measure changes in their carbon footprint over time.[14] This degree of openness is a sea change for AWS, which has traditionally been reluctant to share such information, and reflects how mainstream a commitment to sustainability is becoming for both corporate customers and the general public.

According to Accenture, these myriad initiatives make the AWS cloud infrastructure 3.6 times more energy efficient than the median US enterprise data center.[15] AWS servers are renowned for their efficiency and high-capacity utilization rates. This is crucial, since a study by the Uptime Institute showed that approximately "20% of racked enterprise servers are completely unused and abandoned by application administrators" due to "insufficient monitoring of the infrastructure and the lack of a rigorous decommissioning process."[16]

Indeed, two-thirds of AWS's energy efficiency advantage are due to a combination of energy-efficient servers and much higher server utilization.[17] Overall, AWS performs similar tasks with an 88% lower carbon footprint:[18]

Carbon efficiency of AWS infrastructure compared to surveyed US enterprises

61% of carbon reduction is attributable to more efficient servers and higher server utilization

11% of carbon reduction is attributable to more efficient data center facilities

17% of carbon reduction is attributable to reduced electricity consumption and renewable energy usage

Just as significantly, AWS has developed technology that enables its water-cooled facilities to actively measure water efficiency and select conservation options to suit regional climate patterns and local resources.[19] Fresh water is even scarcer than renewable energy. By adapting water usage to the environment instead of simply draining water from the surrounding locale, these innovations around conservation are worthy of emulation and further refinement.

On-premises vs public cloud:

Organizational imperatives will also drive your choice of cloud strategy, particularly with regard to the cost-versus-speed tradeoff. If your main priority is to cut costs, you're better off with your own data center. But if you value speed and agility more, you're better off with a public cloud solution.

Also important are your preferences for operating expenditures (OpEx) or capital expenditures (CapEx). OpEx includes the day-to-day expenses a company incurs to keep its business operational, while CapEx involves the major purchases a company makes for the long term. Generally, organizations that prefer OpEx will use the public cloud, while those that prefer CapEx will prefer an on-premises solution.

For workloads running on-premises, you'll have full control over the facilities, hardware, power, and cooling. You'll want to invest more time and effort into optimizing data center efficiency.

For workloads in the public cloud, you'll only be able to control which cloud services you use in certain regions and availability zones. If your organization is concerned about its carbon footprint, you'll want to consider the trade-offs between workload cost and carbon impact. For example, one region might have a cheaper compute by relying on coal for energy. Another region might be slightly more expensive but run on solar power.

You should make your organization's executive leadership aware of these trade-offs so they can make decisions and implement governance around both cost and environmental impact.

Recommendations

GreenOps Best Practices

Select the right sites: When designing on-premises data centers, it's essential to optimize energy consumption through intelligent site selection. Put a premium on placing cloud operations in a location with maximum access to renewable energy rather than depending on energy from fossil fuels.

Excellent examples are GCP's 490 megawatt (MW) solar farm in Texas, and the AWS 115 MW wind farm in Ireland. In contrast, new data centers in Northern Virginia are being built that require Dominion Energy, the area's largest electricity supplier, to build more fossil fuel power plants to meet the new energy demand.[21]

Site selection will become even more challenging in the future as the growing demand for low latency pushes businesses to seek cloud sites that are closer to major population centers but not necessarily best suited for access to renewable energy.can make decisions and implement governance around both cost and environmental impact.

Ironically, the COVID-19 pandemic may prove to be beneficial as it encourages more decentralized remote work, which reduces the imperative to be near large urban centers.

Drive GreenOps governance throughout the enterprise: To successfully facilitate a GreenOps regime, you'll have to implement several enterprise-wide best practices. The Uptime Institute has observed that the energy efficiency practices most implemented to reduce energy in cloud data centers require minimal investment and affect only a single process or discipline. Such changes are relatively minor and incremental.

> *Carbon-neutral, carbon-offset, and carbon credits are not what they are cracked up to be and can ultimately mean absolutely nothing in terms of actual climate impact... Focus on the grid and the renewable technologies in the data center, not on the carbon-offset.*

In contrast, the practices implemented least require cross-cutting and multidisciplinary cultural and strategic changes, and have the potential for the highest impact.[22] Consequently, 90% of data centers aren't optimized for energy efficiency.

Only executive leadership can achieve holistic cultural and strategic change. As the hybrid cloud becomes central to business strategy and business innovation, CEOs must prioritize GreenOps, using their clout to drive successful enterprise-wide transformation. A great way of starting is by establishing a cross-functional Center of Excellence team that incorporates personnel from across public cloud and data center teams.

Report on efficiency measures, not just on cost:
Many enterprises lack detailed visibility and reporting around carbon emissions. To implement effective GreenOps programs, enterprises should establish effective monitoring and management of all infrastructure resources.

For example, data center teams can leverage dynamic resource monitoring tools such as Datacenter Infrastructure Management (DCIM) solutions to aggregate metrics on resource utilization. User-friendly dashboards can help both business professionals and engineers understand the current state of resource use and measure progress toward objectives. Consider additional metrics as well. While many use Power Usage Effectiveness (PUE), some have criticized it for not incorporating any environmental impacts beyond energy, such as water and the life cycle of IT equipment.

In response, the Green Grid has developed Carbon Usage Effectiveness (CUE) as another metric data center teams can use in tandem with PUE. CUE was developed specifically for the data center industry. It's calculated by dividing the carbon dioxide emissions from the facility's total energy use by the energy used by its IT equipment.[23] The ideal value for CUE is 0.0, which demonstrates no carbon use associated with the data center's operations.[24] Data center operators can use PUE and CUE in combination to:

Effectively assess the sustainability of their operations. Compare the trends over time. Identify opportunities for energy efficiency or sustainability improvements.[25]

Optimize hardware power draw: Processors of physical machines can adapt their levels of voltage and frequency based on the levels of power consumed.[26] This is known as dynamic voltage and frequency scaling (DVFS). DVFS reduces electricity costs for powering servers, as well as their thermal output, lowering the energy demand for cooling.

Automate server consolidation: Data center operators can enhance power efficiency through consolidation—minimizing the number of active servers. For virtualized environments, operators can run a workload orchestrator that monitors the utilization of the physical hosts, then puts to sleep underutilized hosts while redirecting inbound requests to the VMs running on the active hosts.[27]

Optimize rack space: Rack space is generally cheap compared to hardware, so data center operators might not pay much attention to it. But it can have an impact for GreenOps. According to Jeff Riggen, Stratascale's Senior Technical Advisor—Hybrid Cloud: "The leasing of rack space is becoming more common. The more intensively you use rack space, the less energy inefficient things are."[28]

Implement applied scheduling: The applied scheduling method assigns users' requests for services to VMs within the boundaries of their service level agreement (SLA).29 To achieve the targeted reductions in power consumption, the applied scheduling method then selects VMs on the servers that are capable of consuming less power.[30]

Optimize your applications

Data center professionals often think of energy use as within the domain of infrastructure. But the application itself can have a massive impact on energy consumption. For example, increasing the accuracy of an image recognition model workload from 96% to 98% resulted in nearly seven times the energy consumption.[31] Code optimization and choice of programming language can also have large impacts on workload efficiency.

Learn and apply tax policies

Organizations should take advantage of tax incentives not only for using energy from renewable sources but also for reduced energy use as well as for increased energy reuse. Likewise, since aging equipment produces bottlenecks, it's also important to have a cloud-specific policy of accelerated depreciation that increases the financial feasibility of upgrading to the latest technology.

Foster a culture of experimentation:

New developments rely on risk-taking, so they will involve mistakes and failures. To encourage experimentation, enterprises and regulators must develop safe spaces for research and development. Danfoss, a multinational Danish engineering company, has recommended the establishment of regulatory-free test zones. By removing the technical, regulatory, and financial barriers for reusing energy between sectors, stakeholders can innovate and develop new energy- efficient technology.[32]
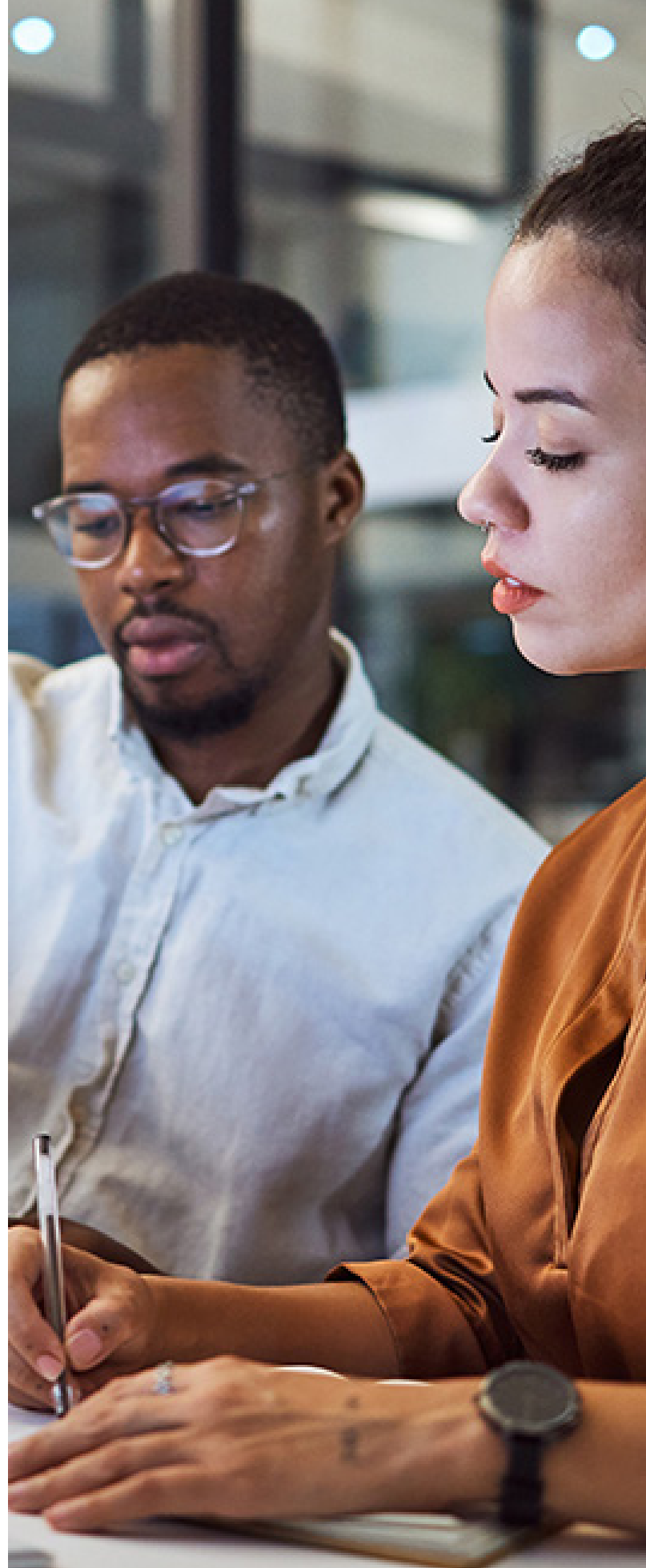
Summary and Conclusion

The growth in IT workloads isn't slowing down. As a holistic practice, GreenOps has implications and benefits across business, data center, infrastructure, and applications teams. IT and technology leaders should drive cross-functional GreenOps programs to reduce environmental impact and operating costs and increase shareholder value.

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