



**Empowering customers to
drive sustainable solutions
for a better future**

Innovation as the driving force for sustainability

Sustainability is a societal initiative that aims for humans to co-exist on the planet over the long term. It touches everyone today: Earth’s billions of people, local and world governments, regulatory bodies, and notably, companies and their customers, employees, and investors, where the challenges of doing business as usual loom larger than ever.

In response to the impacts caused by climate change and other conservation issues, many of today's leading companies are stepping up to play a central role in helping to build a more inclusive, equitable, and sustainable world.

As part of our mission to be Earth’s most customer-centric company, Amazon is committed to building a sustainable business for our employees, customers, and communities.

We’re driving toward a net-zero carbon future by co-founding The Climate Pledge, which is a commitment to reach net-zero carbon emissions by 2040—10 years ahead of the Paris Agreement. As the world’s most comprehensive and broadly adopted cloud offering, AWS is designing data centers that provide the efficient, resilient service our customers expect while minimizing our environmental footprint—and theirs. We focus on efficiency across all aspects of our infrastructure, from the design of our data centers and hardware to modeling the performance of our operations for continually enhanced efficiency.



AWS customers use our services in a wide range of ways to collect, analyze, and manage sustainability data to build transparency and accelerate progress. In this eBook, we’ll explore stories of how several of our leading customers are accomplishing big things along their own paths to sustainability in these areas:



Cloud migration



Sustainable IT



Carbon emissions tracking



Building efficiency





EIGHT YEARS, EIGHT DATA CENTERS

Capital One and its cloud migration for good

Moving from on-premises data centers to the cloud provides a long list of benefits, including greater speed, increased innovation, and lower costs. Importantly, migration can also help IT operations run more sustainably. When organizations decide to migrate to a cloud provider like AWS, they're taking a positive step for our planet, and can do even more by ensuring that the move to the cloud has the smallest environmental impact possible.



A significant move

A financial services enterprise with over 50,000 employees across eight major regional centers, Capital One believes it's essential to take deliberate, thoughtful action to reduce its emissions and address climate change. As part of its commitment to reducing carbon emissions, Capital One recently announced that it completed its migration to AWS, exiting all eight of its data centers during an eight-year journey. This undertaking is a significant move for a major financial institution; banks, credit unions, and credit card companies that manage large amounts of wealth and sensitive data often approach new technology with caution and struggle to move away from mainframes and legacy architectures.

For Capital One, moving to AWS was the logical choice in its sustainability plan. AWS data centers are more energy efficient than enterprise sites and their scale allows customers like Capital One to achieve higher resource utilization and energy efficiency than the typical on-premises data center. In fact, AWS' infrastructure is 3.6 times more energy efficient than the median of surveyed US enterprise data centers and up to five times more energy efficient than the average in the EU.¹



1. The Carbon Reduction Opportunity of Moving to Amazon Web Services, 451 Research, 2019.

Capital One expects to save ten megawatts of power—the equivalent of 650,000 LED light bulbs—per year by exiting its data centers.



Beyond migration

Capital One's migration to AWS took planning that went beyond transforming the company's IT infrastructure. The company also had to think about how to change its culture, technical expertise, and operations to both support the migration and achieve its vision of using the cloud to create new customer experiences.

Energy efficiency through cloud migration was only the first step for lowering the company's carbon emissions. In addition, when Capital One decided to move to the cloud, it established a plan for responsibly disposing of its data center equipment, engaging in a rigorous recycling program. As it migrated, the company recycled 41 tons of copper and 62 tons of steel and removed a total of 13.5 million feet of cable from the last three data centers. Capital One donated the proceeds from recycling its decommissioned assets to the Wounded Warrior Project, a nonprofit organization dedicated to empowering and honoring veterans and service members who incurred a physical or mental injury, illness, or wound.



"From the beginning, Capital One was committed to moving to the cloud in the most responsible and well-managed way possible. It's been incredibly rewarding to contribute to environmental sustainability by recycling decommissioned assets and reducing our carbon footprint by powering down the data centers."

Joe Muratore, VP of Technology, Capital One



CLOUD-POWERED TRANSPARENCY

Scania embraces sustainable IT

A holistic approach to sustainability requires reducing emissions throughout the entire value chain and across all relevant scopes of business. This includes IT, whether in the cloud or outside. For many organizations, however, data-driven services and ever-increasing digitalization call for more and more IT usage, challenging companies to manage the effects of IT on the environment.



Responding to IT impact

Scania, a Volkswagen Group brand since 2008, is a world-leading provider of transport solutions—including trucks and buses for heavy transport applications combined with an extensive product-related service offering. With a connected fleet of 500,000 vehicles—and growing—Scania's purpose is to drive the shift towards a sustainable transport system with its partners and customers. It's creating a world of mobility that's better for business, society, and the environment.

Minimizing the environmental footprint of its IT services is an important part of this vision. During an internal hackathon, Scania's developers determined that increased transparency of sustainability key performance indicators (KPIs), down to the application level, would enable each of its application teams to gain insight into their individual sustainability impact.

"An environmentally friendly and efficient IT solution is not only good for the planet, but also saves cost and is good for business. We want to ensure that we, as a company, only use what we need."

Jan Andries Oldenkamp, CIO, Scania



Visibility and accountability

Scania has been on its cloud journey for over seven years and has adopted an AWS-first cloud strategy, with more than 700 AWS accounts. Leveraging the transparency of the cloud, the company's developer team built KPIs using Scania's own data combined with hourly granularity from AWS usage reports and service metrics.

Together with AWS Solutions Architects, developers from Scania are working to create a monitoring mechanism with dashboards that provide hundreds of application teams a transparent overview of KPIs for their applications such as "vCPU hours per active user." Gaining visibility into these KPIs will allow each application team to work independently on potential enhancements.

AWS allows Scania to experiment with different compute configurations and automate scale as necessary, helping to minimize resources and maximize utilization.

With the new transparency, Scania can determine which applications have the biggest impact on sustainability by optimizations, application size, and utilization. To increase power efficiency, teams can also switch to more energy-efficient processors, including those custom-built by AWS. By implementing more rigid lifecycle policies for the retention of data, teams can automatically delete unnecessary data to reduce digital waste.

The longer-term vision is to create an efficiency rating for Scania IT solutions. To enable the most sustainable IT system possible, Scania teams will start by visualizing the organization's present environmental impact, and create guidelines and a concrete, scalable solution—while also sharing best practices with other AWS customers.

To work towards a greener IT environment for developers, Scania is establishing new ways of working cross-functionally. With this initiative and in collaboration with AWS, Scania aims to become the leader in sustainable IT and challenge the IT industry to think and act more responsibly.





FROM FARM TO TABLE

Bayer provides visibility across the agricultural supply chain

The world relies on farmers to produce food for people and animals, as well as feedstocks for biofuel production. In the process, the agricultural industry in the US alone contributes about 10 percent of all greenhouse gas (GHG) emissions. Because the amount of land around the world dedicated for agriculture is limited, farmers need to find more ways to operate sustainably, efficiently, and profitably while also reducing GHG emissions.²



Connecting the dots

Bayer, a global enterprise with core competencies in the life science fields of healthcare and nutrition, is committed to contributing to sustainable development as a core element of its corporate strategy. Guided by its vision of “Health for all, hunger for none,” Bayer promotes inclusive growth and a responsible use of resources to help people and the planet thrive. As part of its sustainability strategy, Bayer launched Project Carbonview, a supply chain carbon-tracking application, built and powered by AWS.

Bayer came to AWS to discuss how to track carbon emissions through the value chain from farmer to end purchaser of agricultural goods. Companies purchasing crops for downstream processing have limited visibility into the carbon footprint of their supply chain and are often forced to make estimates based on rough averages and outdated reports. Even in instances where emissions are accurately captured in one part of the supply chain, critical information is often lost at the next transition point due to limited interoperability between systems used by growers, transportation companies, and downstream purchasers.



Project Carbonview will enable US ethanol producers to report, analyze, and better assess their end-to-end supply chain carbon footprint, and US farmers to participate, deriving value from emerging low-carbon fuel markets.



Making it real

Bayer participated in Amazon's process of discovery and invention known as "working backwards," which entails working backwards from the moment that a product, service, or experience is in a customer's hands, and helps participants stay customer obsessed. Bayer identified four main objectives for the solution and collaborated with AWS to define the customer experience, translate the working backwards vision into a technical requirement, and determine appropriate data sources and formats that resulted in an architecture for the project. This led to a ten-week build phase with the AWS Professional Services Global Sustainability Practice team, creating wireframes to design and visualize the user experience, and building out the front-end web interface and backend solution on AWS.

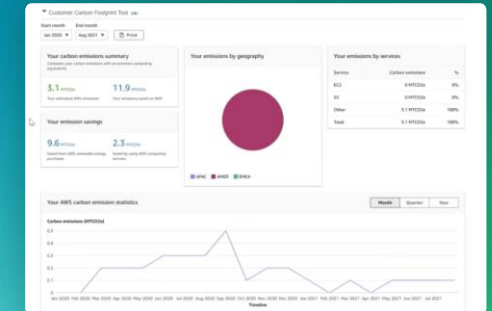
Starting with US corn producers, the first release of the solution will compute the carbon footprint of corn through the supply chain. The solution captures the estimated carbon footprint associated with corn grown on the farm and combines it with the computed carbon footprint of transporting the corn from farm to ethanol facility.

The end goal of Project Carbonview is to provide grain buyers visibility into their Scope 3 emissions with reports and raw data. Buyers can request reports from grain deliveries over a desired time range and, optionally, aggregate by the farmer. This affords them insights into the carbon footprint of their value chain and will drive future purchasing decisions.

"Project Carbonview will make it possible for farmers to drive sustainability improvements across the entire value chain. The integration of our leading digital and data science under Project Carbonview will give farmers greater choice and resources to be compensated for more productive and sustainable decisions on-farm."

Leo Bastos, Global Commercial Ecosystems Lead, Bayer Crop Science

AWS customers like Salesforce, Workday, and Pinterest are also implementing carbon reduction and tracking strategies with the goal of more accurately measuring emissions associated with their use of AWS. In an effort to better support customers like these on their sustainability journey, AWS recently launched the [customer carbon footprint tool](#), which makes it easy for customers to monitor, analyze, and reduce their carbon footprint.





BUILDING FOR THE FUTURE

Amazon is reimagining facility construction and management

In a world where buildings generate nearly 40 percent of annual global CO₂ emissions,³ one of the priority areas for corporate sustainability across all industries is in sustainable building management—having the ability to measure, monitor, and manage energy, materials, and emissions. Sustainable building practices can help minimize waste, conserve energy, water, and other resources, and save money.

amazon.com

Laying the foundation

Amazon operates a wide range of buildings—corporate offices, data centers, a customer fulfillment network, physical retail locations, and more—across the globe in every region. The company is on course to gain deeper understanding about how to measure and disclose emissions and engage in decarbonization of its buildings.

In partnership with AWS, Amazon is using a wide range of building data to execute on its ambitious sustainability goals and to serve a variety of stakeholders, occupants, and customers, as well as the communities in which it's building.

For Amazon and AWS, sustainable building means more than just reducing the carbon footprint. The company's goals include achieving:

- **Zero carbon**
Fully electric, use of natural or ultra-low GWP refrigerants, use of industry-leading energy efficient technologies, powered by renewable energy, and that have a demonstrated reduction in embodied carbon in the building's construction materials.
- **Resource positive**
Positive contributors to the local environment through advanced water and waste strategies.
- **Health and wellness**
Create spaces that prioritize the health and wellbeing of building occupants and communities—employees, visitors, vendors, and customers.



Zero carbon focus through facility energy efficiency

When the Amazon buildings team started this project in collaboration with AWS, it determined that existing building management systems couldn't provide data in a structured way that was easy to analyze. Gaining access to data across buildings was a challenge due to lack of standardization in the data.

As the AWS team looked to support Amazon's sustainability goals, they were able to uncover ways to control the power state of devices through the cloud to achieve real results. The first step was to add control logic and libraries to the building management systems and design a backend analytics platform that could carefully filter data, allowing Amazon to focus on the right information. AWS also complemented the building management system feed with new sensors and utility data sources and, ultimately, delivered a streamlined building systems reporting platform that's highly flexible, modular, and scalable.

Initial results of the project have been positive, showing an up to 25 percent reduction in equipment energy consumption.

As part of Amazon's goal to utilize energy-efficient technologies to achieve its net-zero goal, the AWS team is building models to provide optimal conditions for running energy-consuming assets such as HVAC, lighting, and electrical systems. AWS is also building forecasting models to accurately predict future energy demand based on historical trends and various environmental factors. AWS artificial intelligence and machine learning tools are being deployed for energy management, helping to reduce costs and energy consumption of equipment by optimizing efficiency. This means that any given piece of equipment consumes less energy, water, and resources.

Data brings new possibilities

By leveraging AWS capabilities, Amazon can generate building metrics not previously obtainable. For example, Amazon can now track its use of onsite natural gas combustion, including in domestic hot water, diesel generators, and refrigerants in heating and cooling systems. Amazon can also track electricity use across its entire building network, as well as all the renewable energy it purchases to offset that electricity.

Amazon is able to measure and disclose carbon emissions released into the atmosphere through the manufacturing of building materials, transporting those materials to a project site, and constructing a building. With the ability to measure building data, Amazon can better manage it and, through continued insight and partnering with the AWS data systems team, understand where the organization is today and where the opportunities are for improvement over time on its path to change.

ON THE RIGHT PATH

AWS sustainability initiatives

In addition to empowering its customers to drive their sustainability goals, AWS is well on its way to powering its own operations around the globe with 100 percent renewable energy by 2025—five years ahead of the original target of 2030—and is driving toward net-zero carbon by 2040. As of September 2022, Amazon is the world's largest corporate buyer of renewable energy with 379 renewable energy projects. Once every project becomes operational, they will generate 50,000 gigawatt hours (GWh) of clean energy, which is the equivalent amount of electricity needed to power 4.6 million U.S. homes each year.



By operating with more energy efficiency, the cloud can help lower many companies' carbon footprints. After analyzing several geographies, 451 Research found that AWS can lower customers' carbon footprint related to specific workloads by nearly eighty percent compared to surveyed enterprise data centers and up to ninety-six percent once AWS is powered with 100 percent renewable energy, a target it's on path to meet by 2025.

Additional 451 Research findings include:

Energy efficiency

US

AWS Cloud infrastructure is 3.6 times more energy efficient than the median of surveyed enterprise data centers.

EU

AWS Cloud infrastructure is up to five times more energy efficient than typical EU enterprise infrastructure.

ASIA

A survey of organizations in Japan, South Korea, Singapore, Australia, and India, found moving to the cloud is up to five times more energy efficient, on average, than on-premise data centers for these companies.

Lowering carbon footprint

US

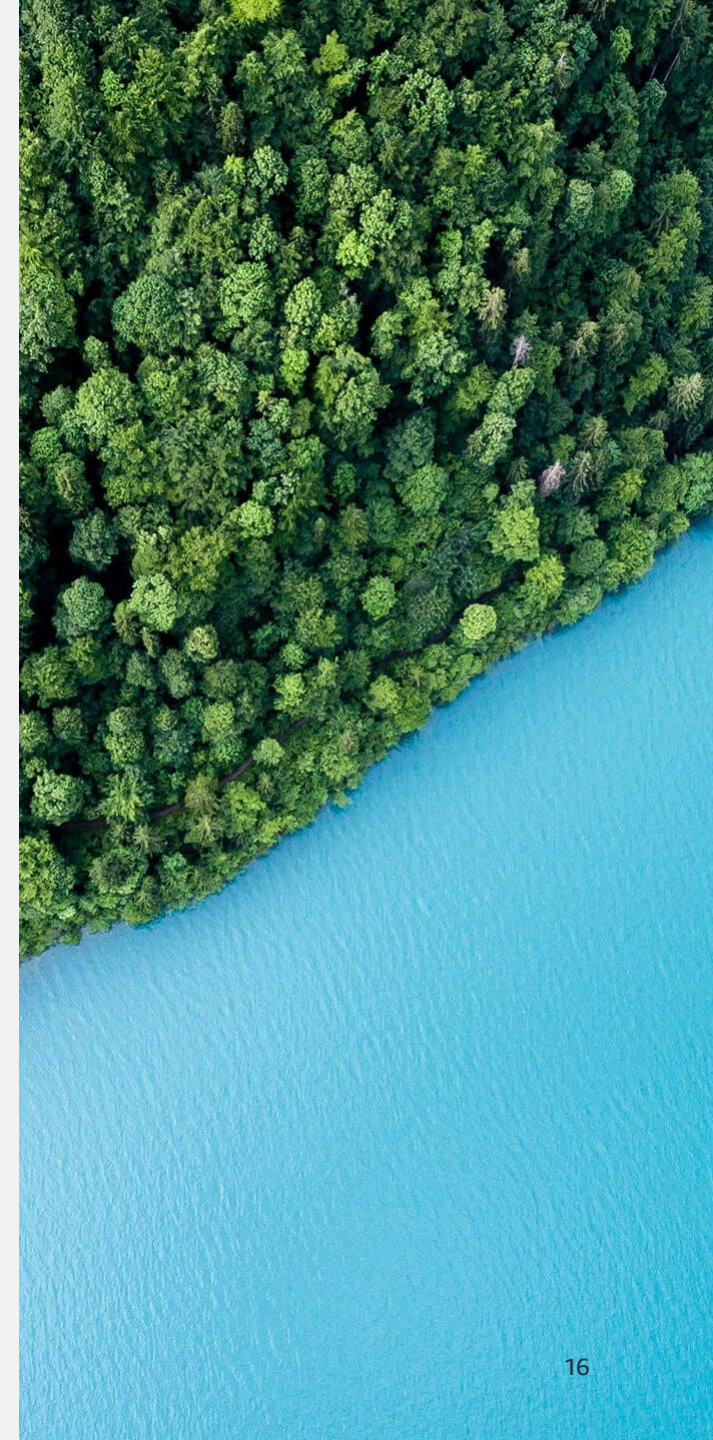
Moving on-premises workloads to AWS can lower the workload carbon footprint by 88 percent for the median surveyed US enterprise data centers.

EU

AWS infrastructure can reduce energy use by nearly eighty percent when organizations run their applications on AWS instead of operating their own data centers.

ASIA

In Japan, South Korea, Singapore, Australia, and India, when factoring in the carbon intensity of consumed electricity and renewable energy purchases, AWS performs the same task with a nearly eighty percent lower carbon footprint than on-premises data centers.





Along the path to achieving its own sustainability commitment, AWS is focused on key initiatives in several areas.

➤ To learn more about all of Amazon's sustainability efforts, visit the [Amazon Sustainability website](#).



Energy efficiency

We focus on efficiency across all aspects of our infrastructure, from the design of our data centers and hardware to modeling the performance of our operations for continually enhanced efficiency. We're using innovation to improve power efficiency in multiple ways, including our investment in AWS-designed chips and the AWS Nitro System. With the world's increasing need for computing and as machine learning has become mainstream, continually innovating at the chip level will be critical to sustainably powering the workloads of the future. We also continually innovate on cooling efficiency, such as working with vendors to optimize the longevity and airflow performance of the cooling medium used in our data center cooling systems. The new medium provides twice the service life and allows air to pass through more easily than previous iterations, saving fan energy. This has significant impacts on building energy performance, reducing the energy use of cooling equipment by 20 percent.

Renewable energy

To achieve our goal of powering our operations with 100 percent renewable energy by 2025—five years ahead of our original 2030 target—Amazon contracts for renewable power from utility scale wind and solar projects that add clean energy to the grid. These new renewable projects support hundreds of jobs while providing hundreds of millions of dollars of investment in local communities. We also may choose to support these grids through the purchase of environmental attributes, like Renewable Energy Certificates and Guarantees of Origin, in line with our Renewable Energy Methodology.



Net-zero carbon emissions

To meet The Climate Pledge commitment of reaching net-zero carbon emission by 2040, AWS must reduce a broad category of emissions from sources not directly controlled by us, but that result from our business operations. Some of our largest sources of indirect emissions come from constructing our data centers and the manufacturing of our hardware. Our Sustainability, Engineering, Construction, and Procurement teams are focused on reducing these emissions. Steel is one of the largest contributors of embodied carbon in the structure of AWS data centers and we're lowering these emissions by working with mills using electric arc furnace production processes. Unlike conventional steel produced from primary materials, coal, and gas, our suppliers are using up to 100 percent recycled content and are powered by electricity only, reducing embodied carbon up to 70 percent. Additionally, our design standards now require concrete with a 20 percent reduction in embodied carbon versus standard concrete for new U.S. data centers, and we're expanding this requirement globally.



Water stewardship

We know water is a precious resource. We're committed to conserving and reusing water, both in our on-site operations and by working with private and public entities to support water availability in communities where we operate data centers. Our preferred cooling strategy for data centers uses evaporative technologies. AWS is constantly innovating the design of our cooling systems to further reduce water usage, including identifying opportunities to reduce water usage based on real-time sensor data. We also evaluate the opportunity to reduce our consumption of potable water and are actively expanding our use of nonpotable and recycled water for cooling purposes. Along with reducing our water usage, AWS looks for opportunities to return water to the communities within which we operate.

Renewables + energy storage

In April 2022, Amazon announced it continues to invest in renewable energy projects paired with energy storage. The energy storage systems allow Amazon to store clean energy produced by its solar projects and deploy it when solar energy is not available, such as in the evening hours, or during periods of high demand.

It's happening now

As we've seen in these wide-ranging examples, leveraging the cloud can help companies on their sustainability journey. We believe that these challenges can be met with ongoing commitment, leading-edge tools, and determined collaboration—and it's all happening today.

AWS customers are implementing sustainability practices across their operations and around the globe, using cloud-based technology and scalable solutions to meet their sustainability goals to make a positive difference in the world.

[Learn more](#) about how organizations are collaborating with AWS to build sustainable solutions, while advancing diversity, equity, and inclusion, and powering mental health and wellness solutions.

