Google

Environmental Report

2023

What's inside

About this report

Google's 2023 Environmental Report provides an overview of our environmental sustainability strategy and targets and our annual progress towards them.[1] This report features data, performance highlights, and progress against our targets from our 2022 fiscal year (January 1 to December 31, 2022). It also mentions some notable achievements from the first half of 2023. After two years of condensed reporting, we're sharing a deeper dive into our approach in one place.

ADDITIONAL RESOURCES

- 2023 Environmental Report: Executive Summary
- Sustainability.google
- Sustainability reports
- Sustainability blog
- Our commitments
- Alphabet environmental, social, and governance (ESG)
- About Google

Introduction 3

Executive letters 4
Highlights 6
Our sustainability strategy 7
Targets and progress summary 8
Emerging opportunities 9

Empowering individuals 12

Our ambition 13
Our approach 13
Helping people make more sustainable choices 14
Reducing home energy use 14
Providing sustainable transportation options 17
Sharing other actionable information 19
The journey ahead 19

Working together 20

Our ambition 21
Our approach 21
Supporting partners 22
Investing in breakthrough innovation 28
Creating ecosystems for collaboration 29
The journey ahead 30

Operating sustainably 31

Our ambition 32
Our operations 32
Net-zero carbon 33
Water stewardship 49
Circular economy 55
Nature and biodiversity 67
Spotlight: Building a more sustainable campus in Mountain View 73

Governance and engagement 75

About Google 76
Sustainability governance 76
Risk management 77
Stakeholder engagement 78
Public policy and advocacy 79
Partnerships 83
Awards and recognition 84

Appendix 85

Reporting approach and methodology 86
Environmental data tables 90
Environmental reporting frameworks index 96
Endnotes 101
Glossary 103

Introduction

Executive letters

SVP of Learning and Sustainability

Chief Sustainability Officer

Highlights

Our sustainability strategy

Targets and progress summary

Emerging opportunities

AI for sustainability

Our gigaton aspiration

Executive letters

A letter from our Senior Vice President of Learning and Sustainability

I was introduced to the problem of climate change in the late 1980s through a prescient class I took as an undergraduate. The models were less sophisticated and more uncertain than they are today, but the implications were already worrying. Thirty years later much has changed. The threat is now more immediate, but the world is also taking action—from governmental policy and technology innovation to actions by individuals and organizations—driven by a broader awareness of the danger.

I worked on Search for 20 years, leading the product for many of those, and learned a lot about the unique impact Google can have on the world. I've always been proud of Google's leadership in pushing the boundaries of sustainability in our data centers, including achieving carbon neutrality in 2007 (at the time, such accomplishments were uncommon). Going further, we've matched 100% of our global electricity use with renewable energy purchases for the last six years—a goal that seemed almost crazy when we set it in 2012.

Today our ambitions have evolved—we now have a bold goal to achieve net-zero emissions across all of our operations and value chain, and as part of that goal, to run on 24/7 carbon-free energy on every grid where we operate. The path to get to these goals is difficult, and we're committed to working through the challenges we face with the ultimate aim of driving larger systems change to create a more sustainable future. Further, predicting the future growth of energy use and emissions from AI compute in our data centers is difficult. Despite this, we remain focused on developing new ways to make AI computing more efficient while leveraging the opportunities that AI presents to have a positive environmental impact.

Beyond our own footprint, Google's founding mission—"Organize the world's information and make it universally accessible and useful"—can play a very important role in accelerating progress in climate information and action. A sustainable future will be built upon billions of decisions made by governments, organizations, and individuals, which will need to be grounded in good information. Increasingly, we see through Google Trends that more and more people are looking for ways to live sustainably. I believe that we have many strengths and capabilities in providing quality information that people are seeking to make decisions that'll drive positive action for our planet.

Helpful **information** can be critical in both efforts to reduce emissions as well as adapt to extreme climate events like floods, wildfires, and heat waves. But this information often lives in silos and is hard to access. Making the information accessible and useful can be a tough technical challenge. Our products like Environmental Insights Explorer, Earth Engine, and Data Commons are key solutions to support the decisions that cities and organizations will have to make. Information can also have a significant impact on the decisions of individuals—particularly in the areas of home energy and transportation. Our products like Maps, Search, and Nest reach billions of users around the world, and we're building many features to respond to the demand for that information in our products.

Given the scale of the problem, **innovation** will also be key to getting us to a better future. In order to push the frontiers of innovation, Google has long had a world-class research organization that's been at the forefront of AI and machine learning. These solutions can help in predicting more extreme weather (flood forecasting, for instance), optimizing systems from traffic lights to car routes, and mitigating climate change in new ways, for example.

> **By making information accessible and accelerating innovation, we can help create a more sustainable future.**

In our 2023 Environmental Report, we're highlighting how these themes of information and innovation run through much of our work:

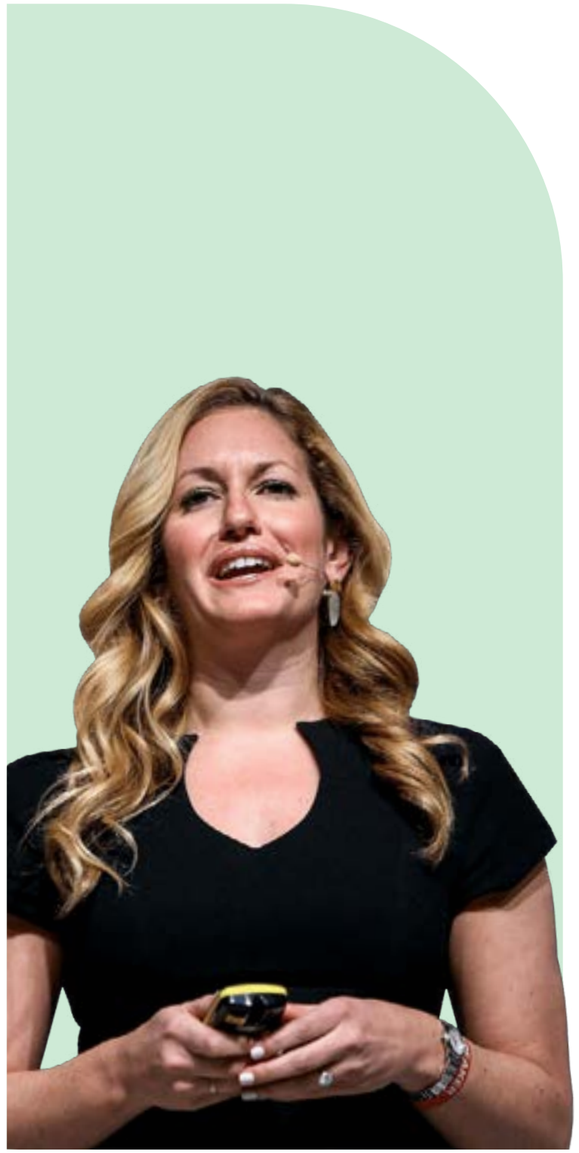
- For information, we'll feature Google Trends insights alongside key initiatives to show how our work is informed by societal trends and expectations.
- And for innovation, we'll call out the many places where AI is helping to break down barriers and advance our work.

Over my tenure at Google, I've seen how we've been working to integrate sustainability into our work. This transition is going to be challenging—both for us and for the world at large—and there's no playbook for making it happen. But we see our efforts as part of a bigger picture, setting our goals to help scale global solutions, and I'm optimistic that we can, through our efforts in both information and innovation, play a helpful role in building a more sustainable and resilient future.

Benedict Gomes

Benedict Gomes
SVP, Learning & Sustainability
Google

A letter from our Chief Sustainability Officer



I grew up in Muir Beach, California, and was fortunate to spend my childhood exploring its beautiful redwood forests and vibrant tidepools with my family. Today, I'm raising my daughter in these same special places, but now these delicate ecosystems are threatened, just like many other parts of the world.

Climate change affects all aspects of society, from food production and human health to infrastructure and the economy. These impacts are interconnected and can have a cascading effect on people and the planet. The response calls for systemic, global action to reduce emissions, improve watershed health, maximize the reuse of finite resources, and protect biodiversity.

Since Google was founded, our efforts to mitigate climate change have started with our own operations, and we've worked hard to lead by example with the ultimate goal of driving larger systemic change. In our third decade of climate action, we'll continue to take a science-based approach to our efforts, while sharing our own lessons and progress with others.

I joined Google eight years ago to lead our sustainability efforts, and have witnessed our sense of urgency and ambition firsthand. We're empowering individuals, governments, businesses, and other organizations to make decisions that can drive positive action for people and our planet.

The opportunity we have through our products and platforms is reflected in our updated environmental sustainability strategy, which focuses on where we can make the most significant positive impact. Our work is organized around three key pillars: empowering individuals to take action, working together with our partners and customers, and operating our business sustainably.

In 2022, we reached our goal to help 1 billion people make more sustainable choices through our products. We achieved this by offering sustainability features like eco-friendly routing in Google Maps, energy efficiency features in Google Nest thermostats, and carbon emissions information in Google Flights. Looking ahead, our aspiration is to help individuals, cities, and other partners collectively reduce 1 gigaton of their carbon equivalent emissions annually by 2030.[2]

After two years of condensed reporting, we're sharing a deeper dive into our approach in one place in our 2023 Environmental Report. In 2022, we continued to make measurable progress in many key ways, such as:

- We enhanced and launched **new sustainability product features**, such as eco-friendly routing in Maps, which is estimated to have helped prevent more than 1.2 million metric tons of carbon emissions from launch through 2022—equivalent to taking approximately 250,000 fuel-based cars off the road for a year.[3]
- We expanded the availability of **Google Earth Engine**—which provides access to reliable, up-to-date insights on how our planet is changing—to include businesses and governments worldwide as an enterprise-grade service through Google Cloud.

> **In 2022, we signed contracts for approximately 2.8 GW of clean energy generation capacity—more than in any prior year.**

- We opened our new **Bay View campus**, which is all-electric, net water-positive, restores over 17 acres of high-value nature, and incorporates the leading principles of circular design.
- We signed 20 more **renewable energy agreements**, bringing our total to more than 80 agreements totaling approximately 10 GW of clean energy generation capacity—we estimate we'll spend approximately $10 billion to purchase clean energy through 2040.[4]

We expect this new era of technological innovation to open up even greater opportunities to accelerate system-level change. It's a big part of the reason we're optimistic about what's possible in the years ahead. If we move forward collectively and decisively, there's no limit to what we can achieve.

Kate E. Brandt

Kate E. Brandt
Chief Sustainability Officer
Google

Highlights

This section provides a snapshot of our highlights as of the end of 2022, and select highlights from the first half of 2023. For a more complete overview of our performance over time, see the Targets and progress summary section and our Environmental data tables.

Empowering individuals

1 billion users

Our core products helped more than 1 billion **users** make more sustainable choices in 2022

1.2 million metric tons

of estimated carbon emissions reductions enabled by **Google Maps** eco-friendly routing as of the end of 2022—equivalent to taking approximately 250,000 fuel-based cars off the road for a year[5]

113 billion kWh

of energy cumulatively saved by customers using **Nest thermostats** from 2011 to 2022[6]—more than double Portugal's annual electricity consumption[7] and equivalent to preventing an estimated 36 million tCO_2e emissions[8]

99% of itineraries

on **Google Flights** included carbon emissions estimates

Working together

40,000+ cities

Environmental Insights Explorer made actionable climate data available to more than 40,000 **cities** and provided Tree Canopy Insights to more than 350 cities

400 startups

supported by our **Startups** for Sustainable Development program in over 60 countries, and global **researchers**, **academics**, and **NGOs** supported with climate- and nature-related data and analytics

80 countries

are included in our Flood Hub platform, covering 460 million **people** globally, and real-time wildfire boundaries in Search and Maps are available in cities around the world

100s of sources

of sustainability data, from most OECD **countries**, aggregated by Data Commons—making data more accessible and useful for addressing sustainability challenges

Operating sustainably

10+ GW

of **clean energy** generation capacity from more than 80 signed agreements from 2010 to 2022—the equivalent capacity of more than 31 million solar panels

271 million gallons

of **water** replenished as of the end of 2022—equivalent to more than 400 Olympic-sized swimming pools

100%

of Pixel, Nest, and Chromecast devices launched in 2022 include recycled **materials**[9]

44 acres

of native **habitat** restored on our Bay Area campuses as of the end of 2022

Our sustainability strategy

We believe Google has a unique opportunity that extends beyond managing the environmental impacts of our own operations and value chain.

By making information accessible and by driving innovation forward through our products and platforms that billions of people engage with every day, we're helping individuals, businesses, and other organizations make decisions that can drive positive action for people and our planet. In shaping our strategy, we consider where we can make the most significant positive impact. Our work is focused on three key pillars: empowering individuals to take action, working together with our partners and customers, and operating our business sustainably.

Information and innovation

We're helping to lead the transition to a more sustainable future by making information accessible and by driving innovation forward.

Empowering individuals to take action

We're empowering people with the information they're seeking to help make more sustainable choices in their everyday lives.

Learn more in the **Empowering individuals** section

Working together with our partners and customers

We're helping partners and customers to reduce their emissions and achieve sustainability goals by advancing transformative technology for sustainability and climate action.

Learn more in the **Working together** section

Operating our business sustainably

We're building on our legacy of sustainability leadership by accelerating the transition to a net-zero carbon future, advancing water stewardship, building a circular economy, and protecting nature and biodiversity.

Learn more in the **Operating sustainably** section

Targets and progress summary

		Topic	Target	Unit	2021	2022	Target year	Status
Product impact		Products	**Help 1 billion people make more sustainable choices through our products by 2022**	Users	N/A	**More than 1 billion**[10]	2022	Achieved (see pg. 14)
Operational targets	**Net-zero carbon**	**Achieve net-zero emissions across all of our operations and value chain by 2030**						
		Carbon reduction	**Reduce 50% of our combined Scope 1, 2 (market-based), and 3 absolute emissions (versus our 2019 baseline) before 2030**	tCO_2e emissions	N/A	**10.2 million**[11]	before 2030	Ongoing (see pg. 36)
		Carbon-free energy	**Run on 24/7 carbon-free energy on every grid where we operate by 2030**	% carbon-free energy	66%	**64%**[12]	2030	Ongoing (see pg. 43)
	Water stewardship	**Replenish more water than we consume and help improve water quality and ecosystem health in the communities where we operate**						
		Water replenishment	**Replenish 120% of the freshwater volume we consume, on average, across our offices and data centers by 2030**	% freshwater replenished	N/A	**6%**	2030	Ongoing (see pg. 52)
	Circular economy	**Maximize the reuse of finite resources across our operations, products, and supply chains**						
		Data centers	**Achieve Zero Waste to Landfill for our global data center operations**	% of data centers at Zero Waste to Landfill	30%	**38%**	N/A	Ongoing (see pg. 57)
		Offices	**Divert all food waste from landfill by 2025**	% food waste diverted	N/A	**85%**	2025	Ongoing (see pg. 60)
		Consumer hardware products	**Use recycled or renewable material in at least 50% of plastic used across our consumer hardware product portfolio by 2025**	% recycled/ renewable material	36%	**41%**	2025	Ongoing (see pg. 62)
			Make product packaging 100% plastic-free by 2025	% plastic-free packaging	97%	**96%**	2025	Ongoing (see pg. 63)
		Supply chain	**Achieve UL 2799 Zero Waste to Landfill certification at all final assembly consumer hardware manufacturing sites by 2022**	% of sites certified	9%	**90%**	2022	Significant progress (see pg. 65)

Emerging opportunities

As the world becomes increasingly aware of the need for sustainability, individuals, businesses, and communities are looking for new ways to reduce their environmental impact. Artificial intelligence (AI) and the power of information to help individuals and organizations reduce emissions are two emerging opportunities that Google is focusing on to help build a more sustainable future.

AI for sustainability

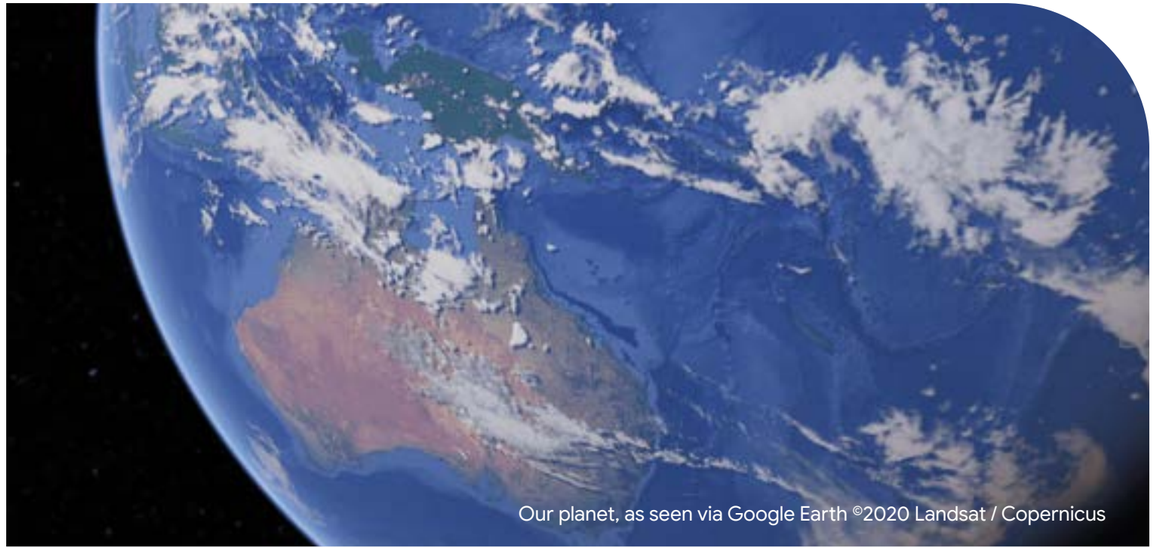
Seven years into our journey as an AI-first company, we've made AI foundational to every part of our business and all Google products. Our approach to AI must be both bold and responsible. To us, that means developing AI in a way that maximizes the positive benefits to society while addressing the challenges, guided by our AI Principles.

We can use AI to help accelerate solutions to tackle climate change by providing better **information** to individuals, operational **optimization** for organizations, and improved **prediction** and forecasting. We must also continue to find ways to reduce the **environmental footprint** of AI models.

Information: Empowering people to live more sustainably through AI. In 2022, searches for "solar energy," "electric bicycles," and "electric cars" reached all-time highs.[13] People are interested in how to live more sustainably, and our goal is to make it easier for them to do so. Features like eco-friendly routing in Google Maps leverage AI to help people get to their destinations as quickly as possible while minimizing fuel or battery consumption. Eco-friendly routing has helped prevent 1.2 million metric tons of estimated carbon emissions since launch—equivalent to taking approximately 250,000 fuel-based cars off the road for a year.[14]

Additionally, for over a decade, our Nest Learning Thermostats have used machine learning (ML) to help people save energy and money at home. From 2011 to 2022, Nest thermostats have helped customers cumulatively save more than 113 billion kWh of energy[15]—more than double Portugal's annual electricity consumption[16] and equivalent to avoiding an estimated 36 million tCO_2e emissions.[17]

Optimization: Bringing carbon-efficient computing to customers and partners. We've made significant investments in cleaner cloud computing by making our data centers some of the most efficient in the world and sourcing more carbon-free energy. We're helping our customers make real-time decisions to reduce emissions, and mitigate climate risks with data and AI. For example, Google Cloud customers can reduce their cloud footprint with a feature called Active Assist, which uses machine learning to identify unused (and potentially wasteful) workloads that could reduce carbon emissions if removed.



Our planet, as seen via Google Earth ©2020 Landsat / Copernicus

We believe that AI is a foundational and transformational technology that will provide compelling and helpful benefits to people and society through its capacity to assist, complement, empower, and inspire people in almost every field of human endeavor. It has the potential to contribute to tackling some of society's most pressing challenges and opportunities—among these, climate and sustainability, where we're researching and innovating to help unlock scientific discoveries and to assist people in making informed choices and communities impacted by climate change.

We believe that getting AI right—which to us involves innovating and delivering widely accessible benefits to people and society, while mitigating its risks—must be a collective effort involving us and others, including researchers, developers, users (individuals, businesses, and other organizations), governments, regulators, and citizens. It's critical that we collectively earn public trust if AI is to deliver on its potential for people and society. As a company, we embrace the opportunity to work with others to get AI right.

James Manyika
SVP, Research, Technology, & Society
Google

> We're making advancements in many transformative areas of AI, but I'm particularly excited about AI for Social Good, including climate adaptation. AI has great potential to both reduce overall emissions as well as help us address the effects of climate change, including helping people adapt to new challenges.

Jeff Dean
Chief Scientist
Google DeepMind and
Google Research

Optimization: Helping communities with AI-powered climate action planning. Green Light is an AI-based tool that helps city traffic engineers optimize the timing of light changes to reduce stop-and-go traffic. Our recent tests in Hamburg, Germany, showed that at traffic lights with our AI-driven recommendations, cars made over 25% fewer stops, resulting in approximately 10% fewer emissions.[18] The Environmental Insights Explorer (EIE) is a freely available online tool built with and for cities and regions to support effective climate action planning. Many features in EIE are made possible through machine learning, such as estimating the solar potential of rooftops, calculating transportation emissions, and mapping tree canopy coverage.

Prediction: Using AI to help communities address extreme weather events. AI-powered tools can help address some of the worst impacts of climate-related disasters, from early warnings of natural disasters to reducing the impact of wildfires. In 2022, we launched Flood Hub, which allows local governments and aid organizations to identify when a riverine flood will occur, up to seven days in advance. In early 2023, we expanded this tool from 20 to 80 countries across the globe. By using AI to analyze satellite imagery, we're also helping to enable rapid detection when a wildfire starts and to predict how it will spread, enabling authorities to better manage fires and provide emergency alerts to individuals who are at risk.

Prediction: Using AI to predict locust outbreaks, helping farmers protect their crops. Locust infestations can have a devastating effect on food crops. Through collaborations with AI product-focused company InstaDeep and the Food and Agriculture Organization (FAO) of the United Nations, the Google AI Center in Ghana is building a model that forecasts locust breeding grounds using historical data from the FAO and environmental variables like rainfall and temperature. This model will help to better detect locust outbreaks and enable farmers to implement control measures.

Prediction: Using generative modeling for nowcasting rain. We're using generative modeling to make detailed and plausible predictions, up to two hours ahead, that capture the amount, timing, and location of rainfall. With such methods, we can both accurately capture large-scale events, while also generating alternative rain scenarios. We're interested in the ability of these models to make predictions on medium- to heavy-rain events, which most impact people and the economy.

Environmental footprint: Leveraging AI to optimize our own operations, and working to reduce energy use and emissions from AI computing in our data centers. AI and machine learning workloads are quickly becoming larger and more capable, raising concerns about their energy use and their impact on the environment.

With AI at an inflection point, predicting the future growth of energy use and emissions from AI compute in our data centers is challenging. Historically, research has shown that as AI/ML compute demand has gone up, the energy needed to power this technology has increased at a much slower rate than many forecasts predicted. We have used tested practices to reduce the carbon footprint of workloads by large margins; together these principles have reduced the energy of training a model by up to 100x and emissions by up to 1,000x. We plan to continue applying these tested practices and to keep developing new ways to make AI computing more efficient.

Google data centers are designed, built, and operated to maximize efficiency—even as computing demand grows. On average, a Google-owned and -operated data center is more than 1.5 times as energy efficient as a typical enterprise data center[19] and, compared with five years ago, we now deliver approximately three times as much computing power with the same amount of electrical power.[20] To support the next generation of fundamental advances in AI, our latest TPU v4 is proven to be one of the fastest, most efficient, and most sustainable ML infrastructure hubs in the world.

We're excited about the progress we've already made in developing more sustainable tools and products that harness the power of AI, and we're optimistic about the progress we'll unlock in the years ahead.

> AI is one of the most transformational technologies of our time. I believe it has the potential to unlock major benefits for us all, including tackling climate change. At Google DeepMind, we're committed to driving responsible research that can make a positive and lasting impact on society. I'm hopeful AI will accelerate scientific progress and help us address a number of global challenges to leave the world a better place for the generations that follow.

Lila Ibrahim
Chief Operating Officer
Google DeepMind

A row of servers in our St. Ghislain, Belgium, data center

Our gigaton aspiration

We believe that Google has a unique opportunity that extends beyond reducing the environmental impacts of our own operations and value chain.[21]

In 2020, Google shared our aspiration to help others reduce 1 gigaton (GT) of their carbon equivalent emissions annually by 2030. This is an ambitious vision that we've set to push us to contribute meaningfully to helping with climate solutions beyond our own operations and value chain.

We initially focused on helping cities and local governments reduce 1 GT of emissions. A key tool in this effort is the Environmental Insights Explorer (EIE), which provides actionable climate and sustainability data to government officials in cities and regions worldwide. It's been used in multiple ways across the globe, including by city leaders in Dublin to analyze bicycle usage and inform smart transportation policies, and by the city of Austin to prioritize planting trees in areas with the highest need.

To better reflect the broader group of partners we aim to help, we're updating our shared ambition:

ASPIRATION

We aim to help individuals, cities, and other partners collectively reduce 1 gigaton of their carbon equivalent emissions annually by 2030.

For context, 1 GT is comparable to the entire annual emissions of Japan.[22] Helping others to reduce 1 GT of carbon equivalent emissions per year, starting in 2030, is a bold aspiration focused on where we can have the most impact—enabling others to reduce emissions in key areas like energy and transportation. Our ultimate measure of success will be how much we've helped individuals, cities, and other partners to achieve their own greenhouse gas (GHG) emissions reduction goals.

Many of the solutions to achieve a gigaton of carbon emission reductions don't yet exist. However this ambition pushes us to innovate and be audacious in our approach and to collaborate with others to drive systemic solutions. We'll share progress and learnings along the way.

Estimating impact

Estimating the carbon impact of actions taken by many millions of people, communities, and organizations will be inherently difficult, imprecise, and fundamentally different from measuring a corporate carbon footprint. However, it's also useful to enable us to prioritize the most helpful solutions for others.

After reviewing emerging best practices and applying our internal product measurement expertise to advance our measurement work, we've identified a set of approaches and known challenges that will inform how we estimate enabled emissions reductions.

Approaches

Consider carbon accounting principles
Established carbon accounting principles (such as well-defined baselines and true and fair representation of data) provide helpful insights as we develop estimation methodologies for enabled emissions reductions.

Quantify and evaluate real world action
The data available to us from our technology, products, or services may be several steps removed from actual, real-world action and impact that resulted in reduced or avoided emissions. We'll have to use inference and judgment to evaluate the effect of those actions.

Challenges

Unintended impacts
Emissions reduction efforts don't happen in isolation. Actions in one industry or sector might result in net new emissions in another. Similarly, emissions reductions in one area can sometimes lead to increases in another. These are difficult effects to control for, but they must be considered when estimating enabled emissions reductions.

Inherent uncertainty
Uncertainty is inherent to most GHG accounting methodologies and results, and it increases when considering enabled emissions reductions due to a lack of primary data and precise information about real-world actions and their effects. However, understanding the sources, types, and magnitude of uncertainty is crucial to deploy conservative estimates, inform improved data inputs, and properly interpret results.

While carbon accounting principles and these concepts are a good start towards estimating enabled emissions reductions, we expect that methodologies will rapidly evolve, and we welcome the opportunity to collaborate with others to advance best practices.

The Empowering individuals and Working together sections include many examples of how we're already supporting and enabling individuals and partners to reduce their emissions.

The Environmental Insights Explorer makes actionable climate data available to more than 40,000 cities and regions worldwide.

Empowering individuals

We’re empowering people with information to make more sustainable choices

Our ambition

Our approach

Helping people make more sustainable choices

Reducing home energy use

Providing sustainable transportation options

Sharing other actionable information

The journey ahead

Our ambition

At Google, we have an opportunity to lead the transition to a more sustainable future by making information accessible and by driving innovation forward. Grounded in our mission, we're empowering people with the high-quality information they're looking for. Through our products and platforms that billions of users engage with every day, we're helping people make decisions that can drive positive action for our planet.

Last year's Intergovernmental Panel on Climate Change (IPCC) AR6 Working Group 3 Report, for the first time, set out measurable ways that individuals can take meaningful climate action in line with the Paris Agreement. The IPCC report offers a detailed and practical plan for societal emissions reduction, complementing the critical action required by governments, policymakers, and organizations to decarbonize energy, transport, and material systems. The report also calculates the significant well-being and economic benefits that will result from these actions, including for individuals.

These important findings have reinforced our conviction that Google can make a meaningful difference beyond our own operations and value chain, and they highlight the benefits of helping individuals through our products and platforms.

Our approach

Every day, billions of people turn to Google to ask questions, discover something new, or learn about what's important to them. More people are interested in how to live more sustainably than ever, and our aim is to make it easier for them to do so. In 2022, searches for "solar energy," "electric bicycles," and "electric cars" reached all-time highs.[23]

These kinds of changes to lifestyles and behavior matter: the International Energy Agency (IEA) estimates that around 55% of the cumulative emissions reductions needed to achieve a net-zero global energy system by 2050 are linked to consumer choices. Yet, there's a wide "say-do gap" among consumers—between those who are concerned about sustainability, and those who ultimately make sustainable decisions.[24]

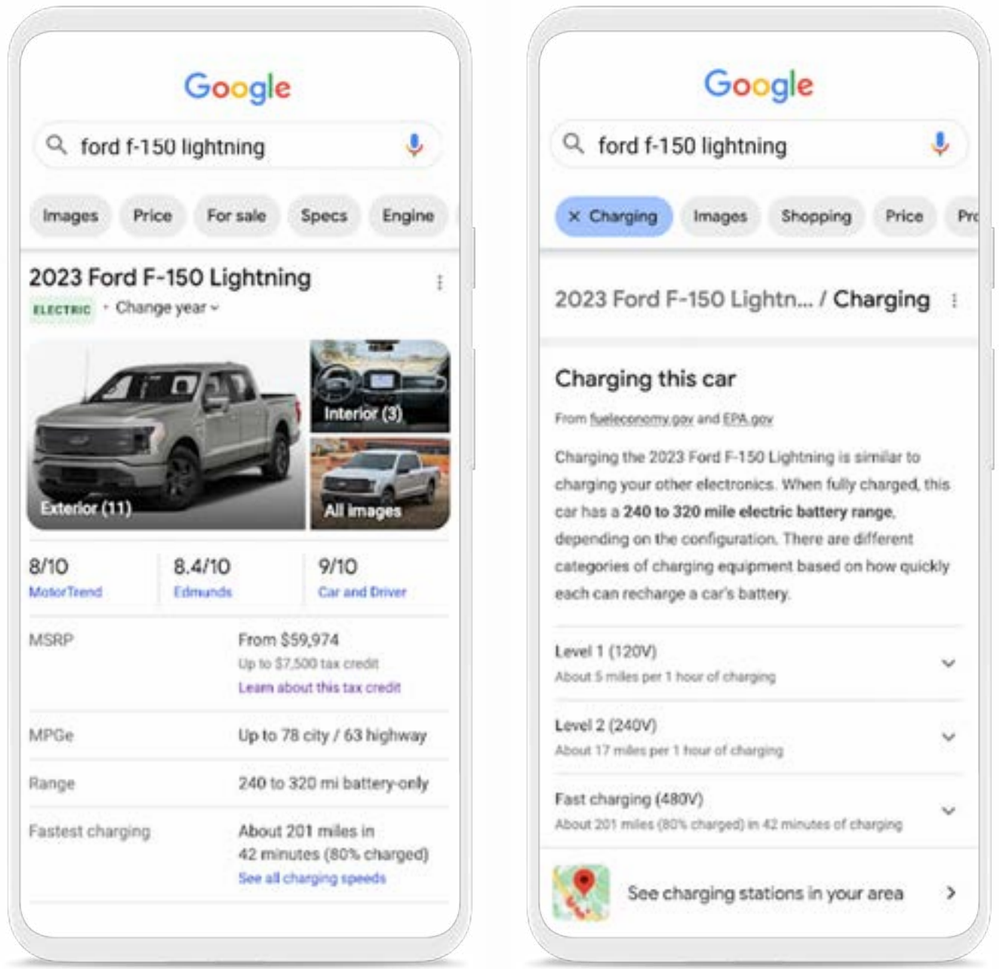
To tackle a problem at the scale of climate change, it can be hard to know where to start. That's why we've taken a first-principles approach, looking at what's contributing the most to global emissions. **Home energy** and **transportation** are two such areas—collectively they account for more than 20% of emissions.[25] They're also sectors where people are actively searching for sustainable alternatives that often provide benefits like saving them money or time, or improving their health.

The accuracy and quality of the information that informs these decisions is critical. When people come to us looking for answers, we aim to provide high-quality and authoritative information.

FIGURE 1

See hybrid and electric vehicle options on Google Search

When people search for car models and brands, we tag hybrid and electric options to make them easier to find. And when people look into a specific EV, we show compatible charging stations nearby and typical charge times.



Helping people make more sustainable choices

In 2020, we announced a goal to help 1 billion people make more sustainable choices through our products by 2022. We're pleased to share that we reached that goal in 2022, through innovative solutions offered to users, including:

- **Google Nest:** Programmable energy efficiency schedules for homes that can help users save energy, money, and carbon emissions throughout the day.
- **Google Maps:** Eco-friendly routing feature that shows users the most fuel-efficient route, based on factors such as traffic and road incline.
- **Google Travel:** Users can see associated carbon emissions for nearly every flight, sustainability certifications and attributes for hotels, and quickly find more sustainable options.

TARGET

Help 1 billion people make more sustainable choices through our products by 2022

2022 PROGRESS

Achieved: Helped **more than 1 billion** users make more sustainable choices

DETAILS

Year set: 2020 | Base year: N/A | Target year: 2022

Scope: Unique, signed-in Google users that were provided information so they could make a more sustainable choice by at least one sustainability product feature.

Nest thermostats help people save energy at home.

Reducing home energy use

We've launched a number of products and features to help people make more informed choices about the products they buy and the energy they use.

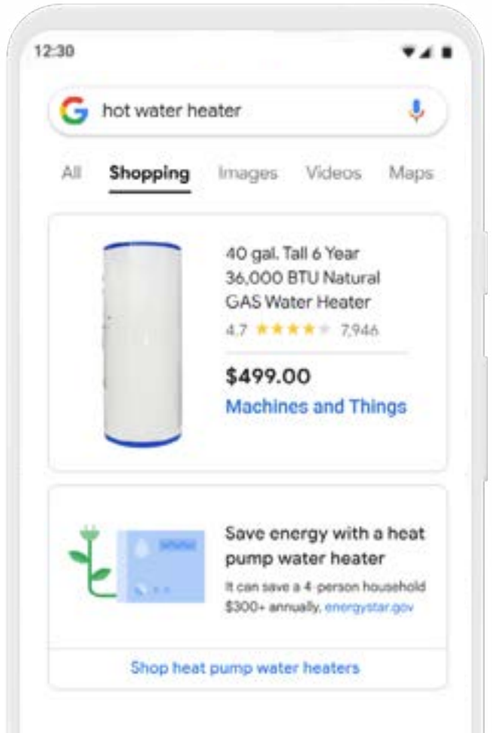
Energy-efficient products

Searches for "how to save energy" reached a 10-year high, worldwide, in 2022.[26] And global searches for "heat pumps" reached an all-time high in 2022.[27]

When someone uses Google Search in the U.S. to look for furnaces or water heaters, suggestions in the Shopping tab can help narrow their search to cost-effective and efficient options (see Figure 2).

FIGURE 2

Google Shopping feature for water heaters



Smart thermostats

Nest thermostats help control residential heating and cooling systems, saving energy in a variety of ways. The collective impact of these savings is significant. From 2011 to 2022, Nest thermostats have helped customers cumulatively save more than 113 billion kWh of energy[28]—more than double Portugal's annual electricity consumption[29]—and equivalent to preventing an estimated 36 million tCO_2e emissions.[30] In 2022 alone, Nest thermostats helped customers save more than 26 billion kWh of energy[31]—more energy than Google used in the same year.

Nest thermostats use AI and machine learning to reduce energy consumption and achieve collective savings as they learn how and when to keep customers comfortable, while optimizing for energy efficiency.

Clean energy

Because electricity grids tend to be cleaner at certain times of day, *when* we use electricity can be as important as *how much* electricity we use. That's why we launched Nest Renew in the United States to help individuals automatically shift their energy consumption to times of day when local grid electricity is cleaner or less expensive

Features such as Energy Shift gather local power grid emissions forecasts and identify opportunities where heating or cooling a home slightly earlier or later would mean taking advantage of cleaner energy. These small actions add up; as of December 2022, we estimate that Energy Shift[32] has already helped Nest Renew users[33] collectively prioritize cleaner energy usage for more than 110 million hours.

For people who want to do more to support the growth of clean energy from their homes, Google offers Nest Renew Premium as a paid subscription option. It matches the fossil fuel electricity used in their home with enough clean energy to cover the average U.S. household. We're working with renewable energy plants that support projects in Google's own portfolio—like the Bethel Wind plant in Castro County, Texas—to purchase high-quality renewable energy credits for Nest Renew customers, beyond Google's existing clean energy purchases.

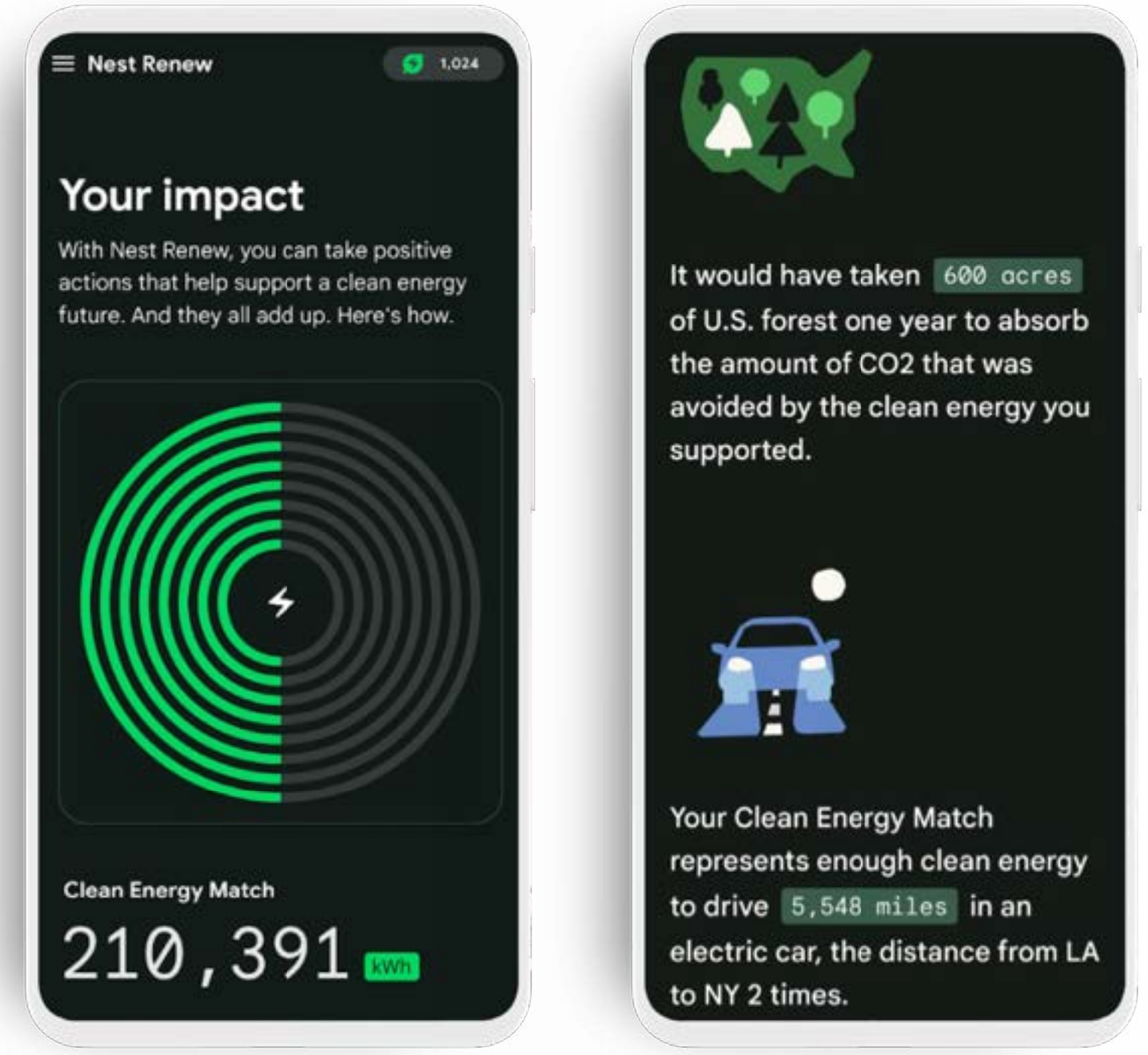
People can also access features like impact reports and the Energy Impact Program, which lets them direct Nest Renew funds to nonprofit partners working toward an equitable sustainable future (see Figure 3).

2022 HIGHLIGHT

In 2022 alone, Nest thermostats helped customers save more than 26 billion kWh of energy[34]—more energy than Google used in the same year.

FIGURE 3

Nest Renew features



Information about energy

Global search interest in "eco-anxiety" reached a 15-year high in 2022, as did search interest in how to "save energy at home,"[35] showing us that people want—and need answers.

Due to the energy crisis in Europe, people, businesses, and governments across the continent are concerned about rising prices and increased pressure on the energy grid, which is evident from the information they're searching for.

In 2022, we worked with the IEA to rapidly develop a set of recommendations to help individuals reduce energy use at home. When people searched for topics such as "Europe energy crisis" and "energy price", they saw news articles, local information including financial assistance that may be available, and recommended actions to help conserve energy (see Figure 4).

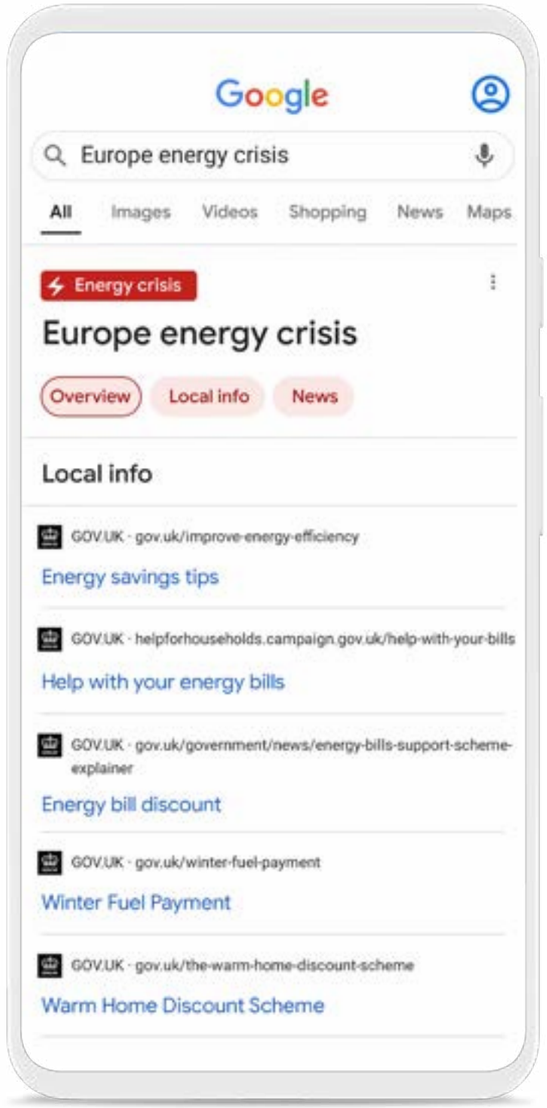
Going solar

Global search interest in "solar energy" and "solar installation" reached all-time highs in 2022.[36]

Project Sunroof, launched in 2015 in the United States and Puerto Rico, helps people decide whether to go solar. It uses AI to analyze high-resolution aerial mapping and 3D modeling of residential roofs, making estimations of solar potential faster and easier.

FIGURE 4

Europe energy information panels



Exploring potential solar capacity for homes in San Francisco, California in the Project Sunroof tool.

Providing sustainable transportation options

Global search interest in "sustainable transport" reached a 15-year high in 2022.[37] Transportation relies more heavily on fossil fuels than any other sector.[38] This is why, for people in most high-income countries, changing travel patterns is a high-impact way to reduce their footprint. We've added several features across our products to allow people to more easily make sustainable travel and transportation decisions.

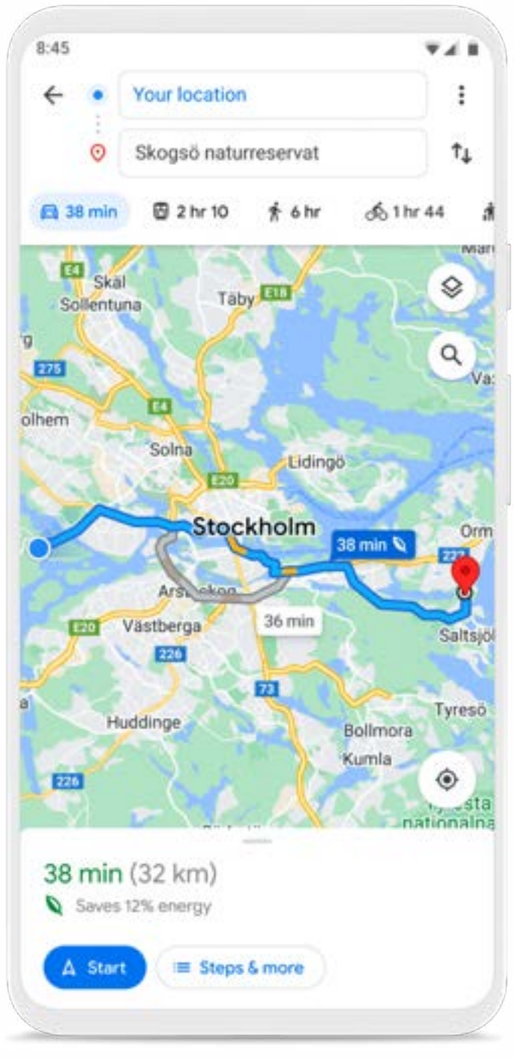
Eco-friendly routing

A simple thing everyone can do to reduce emissions is use existing vehicles more efficiently. Global searches for "how to save fuel when driving" have increased by 60% between 2022 and 2023.[39] In 2021, we launched **eco-friendly routing** in Google Maps to help people get to their destinations as quickly as possible while minimizing fuel or battery consumption (see Figure 5). By building AI models on the emissions profile of diverse vehicle types, this feature leverages insights from the U.S. Department of Energy's National Renewable Energy Laboratory and data from the European Environment Agency to optimize fuel-efficient route choices.

In 2022, we expanded eco-friendly routing to Canada and nearly 40 European countries, as well as in Egypt ahead of COP-27. As of the end of 2022, it's estimated to have helped prevent more than 1.2 million metric tons of carbon emissions since launch—equivalent to taking approximately 250,000 fuel-based cars off the road for a year.[40]

FIGURE 5

Eco-friendly routing



Since the most fuel-efficient route will vary by engine type, drivers using eco-friendly routing in Europe, Egypt, the U.S., and Canada can now select their engine type—petrol or gas, diesel, hybrid, or electric vehicle (EV)—in order to get the best route and most accurate fuel or energy efficiency estimates.

Electric vehicles

EVs accounted for nearly 14% of new global car sales in 2022,[41] and global search interest for "electric vehicles" reached an all-time high in 2022.[42]

For people considering purchasing a new vehicle, we want to make it easy to understand when switching to a hybrid or electric vehicle makes sense for them. Search can help people figure out how much they can save by going electric by providing **fuel savings estimates** and information about how similar cars compare in **range and emissions**. We also show which models qualify in the U.S. under the latest **government rebate programs** designed to help make EVs a more affordable option. For people considering a new bike or scooter, in select Asian countries, Search provides information such as range, speed, and price for electric bikes and scooters.

When EV owners search for "EV charging" on Google Maps, they'll see charging stations nearby with charger availability displayed in some cases. People with a car that has Google Maps built in are routed to the most convenient charging location based on factors like traffic, charge levels, and charger speed. By the end of 2022, Google Maps included nearly 300,000 EV charging locations globally.

In the Waze app, individuals can also find compatible charging stations along their route. Thanks to local map editors from our Waze Community, EV data is reviewed and updated in real time to provide the most accurate, comprehensive information.

An EV plugged in at a charging station. Finding a place to charge your EV is easy with Google Maps.

Sustainable commuting

One sustainable way to travel is to avoid driving altogether, which is why we're making it easier to use Google Maps for sustainable commuting in urban areas, by providing **mass transit options**, **bike routes**, **bike shares**, and **walking directions**.

By tapping on the Google Maps transit icon, individuals can get directions to their destination by bus, train, subway, and even ferry. Google Maps provides, on average, more than 2 billion kilometers (1.2 billion miles) of public transit results per day.

Global searches for "e-bikes" have doubled over the past three years.[43] In 2022, we added over 90,000 kilometers (56,000 miles) of **bike lanes** and **bikeable roads** to Google Maps. Individuals can also find nearby bike and scooter shares in over 400 cities around the world.

We're also helping people get from point A to point B on foot. Google Maps offers turn-by-turn directions for pedestrians, with Immersive View and Street View offering route previews, and Live View, which uses augmented reality to display arrows and directions clearly overlaid on the map.

2022 HIGHLIGHT

Google Maps provides, on average, more than 2 billion kilometers (1.2 billion miles) of public transit results per day.

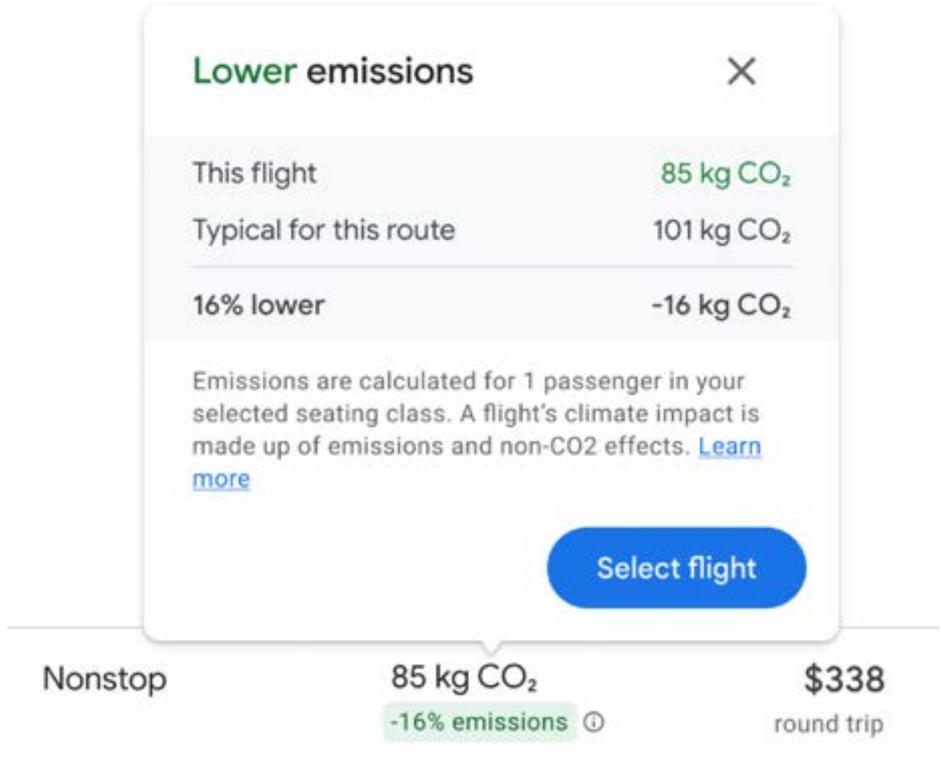
Long-distance travel

When individuals search in Google Flights, they now see **carbon emissions estimates** for nearly every flight, right next to price and duration (see Figure 6). Lower emissions flights are labeled with a green badge, and results can be sorted or filtered by carbon impact. If people want to view only flights that have lower emissions compared to the average for similar trips, they can simply tap the "Less emissions only" filter. In 2022, we expanded coverage of carbon emissions estimates to 99% of itineraries on Google Flights.

We also created the **Travel Impact Model (TIM)**, a public and freely accessible methodology for predicting the per-passenger CO_2 emissions produced by an upcoming flight. Today, the TIM powers the emissions estimates you see on Google Flights, as well as select travel sites, through our work in the Travalyst coalition.

FIGURE 6

Google Flights emissions estimates



Over time, we've refined and improved the TIM with help from academic and nonprofit experts, as well as various partners in the travel industry. We then formalized these collaborative efforts by establishing an independent advisory committee to oversee future changes to the TIM.

Google Search can also help people find **more sustainable alternatives to flying** when available. Trips taken by train or bus often produce lower emissions and can frequently save individuals time or money over shorter distances.

People can now compare train ticket prices directly on Google Search for travel in and around select countries. As an example, when looking for "Berlin to Vienna trains," individuals will see a new module in the search results that lets them choose their departure date and compare the available options. To further expand individual choices for intercity travel, we've also started testing a similar feature for bus tickets.

Hotel accommodations

When people search for travel accommodations, they can see which hotels have been certified for meeting high standards of sustainability by select independent organizations. For example, hotels certified by Green Key or EarthCheck will have an **eco-certified badge** next to their name.

Sharing other actionable information

Outside of home energy and transportation, individuals can make other sustainable choices that add up to create a positive impact. This includes understanding local air quality, accessing climate change information, identifying nearby recycling locations, or purchasing pre-owned items.

Air quality

Air quality around the world is being negatively impacted by air pollution and increasingly severe wildfires. We've added a new Air Quality feature in Google Search and Maps that shows the air quality conditions for the day, whether it's unusually smoggy or dangerously smoky. Available in cities in the U.S., Singapore, Brazil, and Chile, among other locations, this data can help people consider their activities for the day, including whether to stay indoors.

Google Maps and Waze both support user alerts for **clean air zones**. A clean air zone is a designated urban area with high air pollution where measures are implemented to improve air quality, such as charging an entry fee to drivers of high-emissions vehicles. If a route crosses a clean air zone, the driver will be alerted to add a permit if they own one, then eligible routes will be suggested for them based on that pass.

Climate change information

We're making it easier for people to find climate change information. When people search for "climate change" in certain languages, they'll see information panels and visuals on the causes and effects of climate change, and individual actions they can take to live more sustainably, provided by **authoritative sources** like the United Nations.

We're also engaging with individuals on climate and other environmental topics via **YouTube**. On Earth Day 2022, we launched a Non-Fungible Planet campaign, where we teamed up with environmental non-profits, creators, and other organizations to show what makes Earth so special and worth protecting. They journeyed to one-of-a-kind locales and created videos to highlight the stress our environment is under and what we can do to help. In 2022, YouTube also held our first ever Creators for Climate Action summits, one in New York and one with TED Countdown in London.

To stay safe during extreme weather events, people often turn to the internet with questions. For example, global search interest in "heat waves" reached an all-time high in July 2022.[44] To surface authoritative and helpful information in these moments, we're providing information through Search alerts on flooding, wildfire boundaries, and extreme heat. More details on how AI enables these alerts can be found in the Working together section.

Recycling points

People recognize that recycling plays a crucial role in preserving the future of our planet; global searches for "recycling" are the highest of any sustainability action.[45]

In 2021, we launched a new feature that makes it easier for people to find nearby recycling points on Search and Maps. In addition to providing information on **recycling depots** and waste transfer stations, we're also helping small businesses share when they offer **in-store recycling**. By adding the new recycling attribute to Business Profiles on Search and Maps, local storefronts and shops can show the recycling services they offer in just a few clicks—whether it's for plastic bottles, packaging, or electronics.

Pre-owned items

Global search interest in "slow fashion" reached a 15-year high in 2022.[46] And global searches for "thrifting" have nearly tripled over the most recent three-year period compared to the previous three-year period,[47] reaching a 15-year high in 2022.[48] The apparel industry is responsible for nearly 7% of global carbon emissions, so clothing choices have a big impact on reducing both waste and emissions.[49]

Buying pre-owned items is a small action people can take to live more sustainably. In 2022, we launched enhancements to the Google Shopping experience in the United States for pre-owned products, such as used and refurbished products.

The journey ahead

While a single individual's actions may seem small, when billions of people have the tools to make more sustainable decisions, they add up to have a meaningful impact on their communities and the entire planet.

We're excited by the opportunity to enable climate and environmental action far beyond Google's direct impact, through information and innovation.

LEARN MORE

- Empowering with technology
- Google Maps eco-friendly routing
- Searching for sustainability with Google
- Supporting a clean energy future with Nest Renew
- The search for sustainability

Working together

We're working together with our partners and customers to advance technology for sustainability

Our ambition

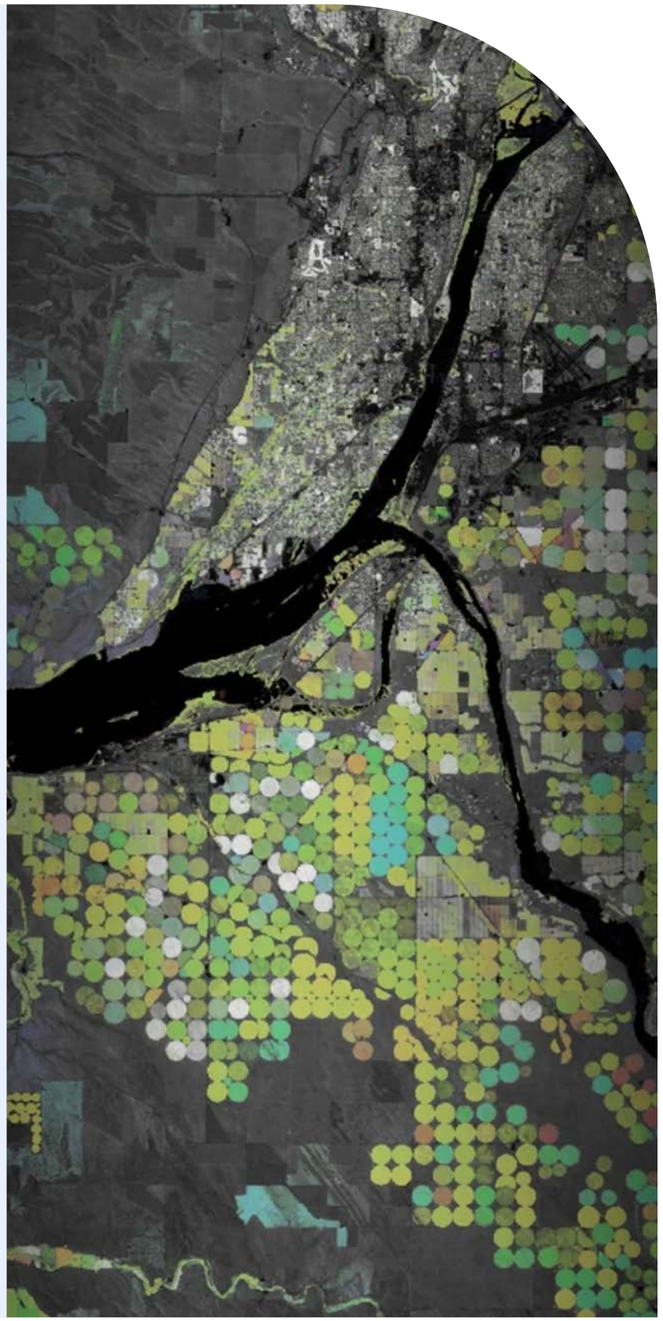
Our approach

Supporting partners

Investing in breakthrough innovation

Creating ecosystems for collaboration

The journey ahead



Our ambition

We believe that Google has a unique opportunity that extends beyond reducing the environmental impacts of our own operations and value chain. By organizing information about our planet and making it actionable through technology and platforms, we can help partners and customers create even more positive impact.

Digital technologies play a critical role in industry transitions, allowing us to measure and track sustainability progress, optimize the use of resources, reduce greenhouse gas emissions, and enable a more circular economy.[50] Cloud computing and digital technologies underpin the transformation in many sectors, such as energy, transportation, and agriculture. Research that we commissioned in 2022 found that 20%–25% of what's required for the EU's 2050 net-zero goal requires some sort of digital enablement.[51]

Our approach

By combining Google's suite of unique capabilities in data, geospatial analytics, cloud computing, and AI, we're enabling our partners and customers to advance sustainability goals.

Data

To effectively mitigate and adapt to climate change and protect ecosystems, organizations need a data-driven understanding of their impacts. Currently, much of this data is fragmented across thousands of silos and a multitude of databases. To help solve this problem, we've curated a large catalog of Earth observation datasets in the Earth Engine Data Catalog. We created Environmental Insights Explorer, which empowers thousands of cities and regions with actionable data and insights to reduce global emissions. More recently, we also built Data Commons, an open-source tool to organize hundreds of public sustainability datasets into a single, accessible resource.

Geospatial technology

Google has made deep investments over nearly two decades in geospatial technology and platforms such as Google Maps and Google Earth. Google Earth Engine is a leading technology platform for planetary-scale environmental monitoring that was launched in 2010 for scientists and NGOs. In 2022, it was expanded for commercial use by businesses and governments as an enterprise-grade service through Google Cloud. Researchers from academic institutions, NGOs, and intergovernmental organizations have leveraged and built upon our tools for a wide variety of use cases from measuring habitat ranges to protecting forest and ocean ecosystems.

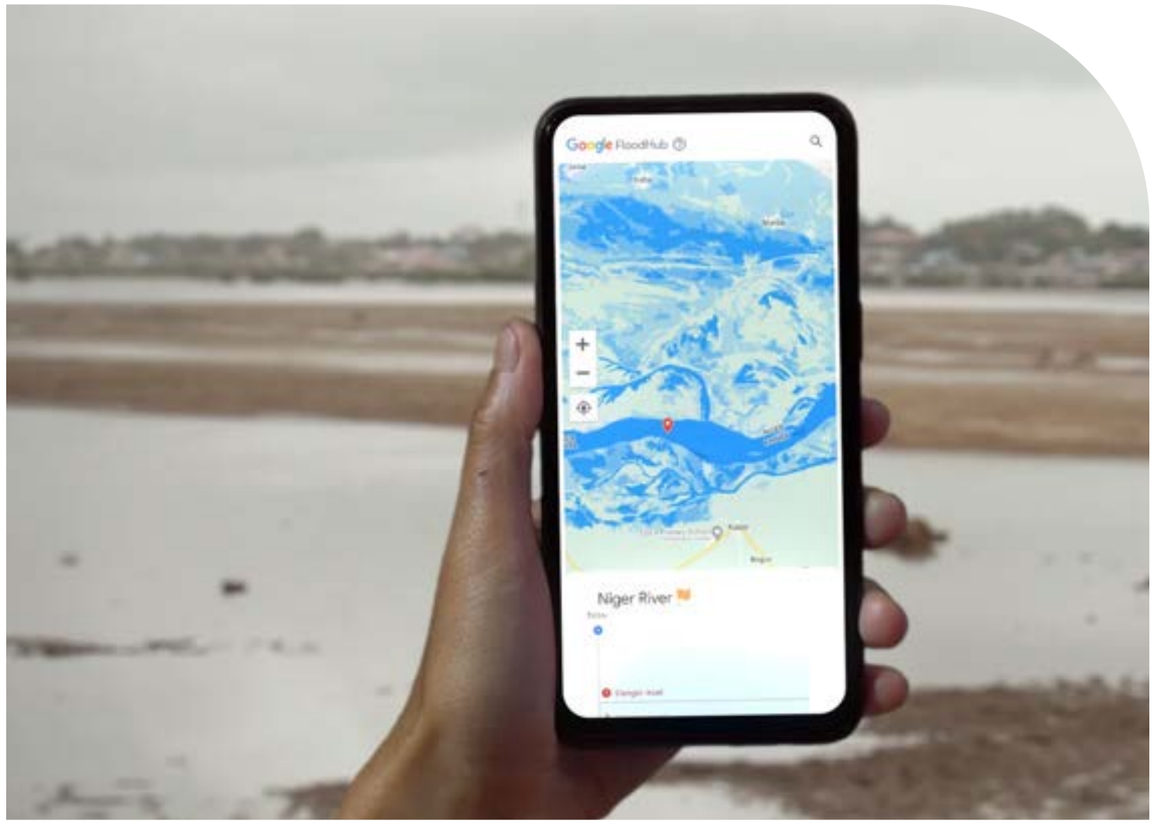
Cloud

Google Cloud is helping to transform a number of carbon-emitting sectors, such as energy, transportation, and agriculture. We've made significant investments in cleaner cloud computing by making our data centers among the most efficient in the world and sourcing more carbon-free energy. This enables others to expand their use of digital technologies in a more sustainable way, by monitoring and optimizing cloud-related emissions, and choosing cleaner regions in which to run their workloads.

AI

As an AI-first company, we've established a track record of applying AI to some of the most significant challenges facing humanity, such as environmental degradation and climate change, and we see exciting opportunities for further impact. AI is embedded into many of our sustainability initiatives—including detecting and forecasting floods and wildfires, helping people and cities adapt to extreme heat, and protecting critical species habitat.

We're leveraging this unique suite of capabilities in three key ways: **supporting partners, investing in breakthrough innovation**, and **creating ecosystems for collaboration**.



Governments, aid organizations, and individuals can use Flood Hub to take timely action and prepare for riverine floods, seeing locally relevant flood data and forecasts up to 7 days in advance.

Supporting partners

We're building partnerships to advance sustainability goals through technology across three key groups: governments and intergovernmental organizations; customers and commercial partners; and researchers, academics, and NGOs.

Governments and intergovernmental organizations

We're creating tools to help governments and intergovernmental organizations make decisions on key topics—such as **urban infrastructure, transportation systems, regulations, and investments**—that have a significant, long-term impact on people and our planet. Cities and urban areas are a particular focus for our work, since they're home to a large proportion of the global population and produce a significant amount of GHG emissions. More than half the world's population now lives in urban areas, with this number expected to grow to 68% by 2050,[52] and cities account for 70% of energy-related carbon dioxide emissions globally.[53]

Environmental Insights Explorer

Google created Environmental Insights Explorer (EIE) with and for cities and regions. This freely available online tool brings many of our technological advancements together to help measure emission sources, analyze data, identify strategies to reduce emissions, and adapt to climate change impacts. EIE is supported and offered to cities for validation by leading city networks including the Global Covenant of Mayors for Climate & Energy (GCoM), C40 Cities Climate Leadership Group, ICLEI, and others.

EIE makes actionable climate data available to more than 40,000 cities and regions worldwide. Over a thousand cities globally have signed up to view their data and use the insights for their GHG inventories and climate action planning. For example, Iniciativa Climática de México is working with city officials to evaluate Mexico City's building emissions and the potential to generate renewable energy from rooftop solar, using data from EIE, and support from Google.org and ICLEI.

Building emissions

In 2022, EIE released building emissions data for 4,000 new cities, bringing our total buildings data coverage to over 13,000 cities worldwide. We've substantially increased our geographic coverage of the world, improving it by over 250%—from just over 9.5 million square kilometers to over 35 million square kilometers—resulting in over 50% more buildings counted and 40% more building floor area used to estimate emissions.

Transportation emissions

Using anonymized traffic patterns and other geospatial information, EIE is also able to estimate transportation emissions for trips within a city's boundary. For example, in Izmir, Turkey's third most populous city, transportation emissions accounted for almost 23% of total city emissions in 2018.[54] Izmir is using EIE to assess the effectiveness of GHG emissions mitigation actions and apply them to policy and decision-making to align with the goals defined in the city's Sustainable Energy and Climate Action Plan.

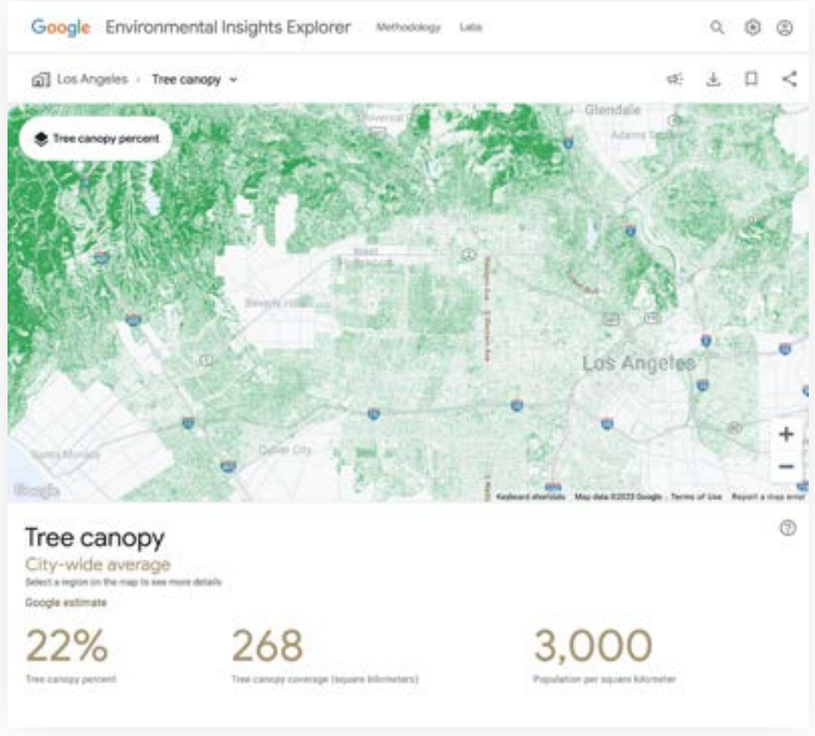
Tree canopy coverage

EIE also provides Tree Canopy Insights, which uses AI and aerial imagery to detect and map tree canopy coverage in cities (see Figure 7) to help them create cooler environments. As of March 2023, we expanded our coverage to more than 350 cities on four continents. For example, the city of Austin has used the EIE Tree Canopy tool to prioritize planting trees in vulnerable areas and help place bus shelters to increase shade.

Tree Canopy Insights uses AI and aerial imagery to detect and map tree canopy coverage in cities.

FIGURE 7

EIE Tree Canopy Insights



Air quality

Google has worked with several cities to capture hyperlocal air quality insights used to help improve the lives and health of residents. We partnered with Dublin City Council to map air quality street-by-street using an electric Street View car, to increase awareness of air quality levels and help implement smart transportation policies. We also partnered with New York state to launch a statewide air quality and greenhouse gas mobile monitoring initiative in areas overburdened by environmental pollution.

Road traffic

We also know that many cities suffer from urban road traffic, which wastes fuel and creates harmful air pollution. That's why we created **Green Light**, an AI tool that measures driving trends at intersections and develops recommendations that city traffic engineers can use to optimize the timing of light changes to reduce stop-and-go traffic. Our recent tests in Hamburg, Germany showed that at traffic lights with our AI-driven recommendations, cars made over 25% fewer stops, resulting in approximately 10% fewer emissions at intersections.[55]

Cool roofs

Cool roofs are designed to reflect sunlight and absorb less heat, and they're especially impactful in communities that may not have access to reliable air conditioning. We're exploring how our technology—such as AI algorithms and aerial imagery—can help more places implement cool roofs. We're able to map out the solar reflectivity of cities so urban planners and governments can identify what areas would benefit most from cool roofs. We'll soon begin piloting this tool with select cities.

We're exploring how AI and aerial imagery can be used to help cities and governments address "heat islands" by implementing cool roofs in relevant locations.

Adaptation support for communities

As climate change increases extreme weather events around the world, we're also helping communities adapt to environmental changes and stay one step ahead of natural disasters.

Wildfire detection and prediction

Climate change is increasing the frequency and severity of wildfires, which are having a devastating impact on communities and ecosystems around the world.[56] To minimize the impact of wildfires on communities, Google has developed a new AI-based technology to **map wildfires** in near real time. It uses data from geostationary satellites such as NOAA's GOES constellation to show the size of a wildfire, with data being refreshed roughly every 15–20 minutes. Additionally, we're collaborating with the USFS on wildfire research by using advanced simulation and AI techniques to accelerate their fire spread model.[57]

We've also been working closely with U.S. agencies, such as the U.S. Forest Service (USFS). USFS used Google Earth Engine and Google Cloud technology to build a Landscape Change Monitoring System to map and monitor land cover change across the United States and support forest planning and post-fire recovery.

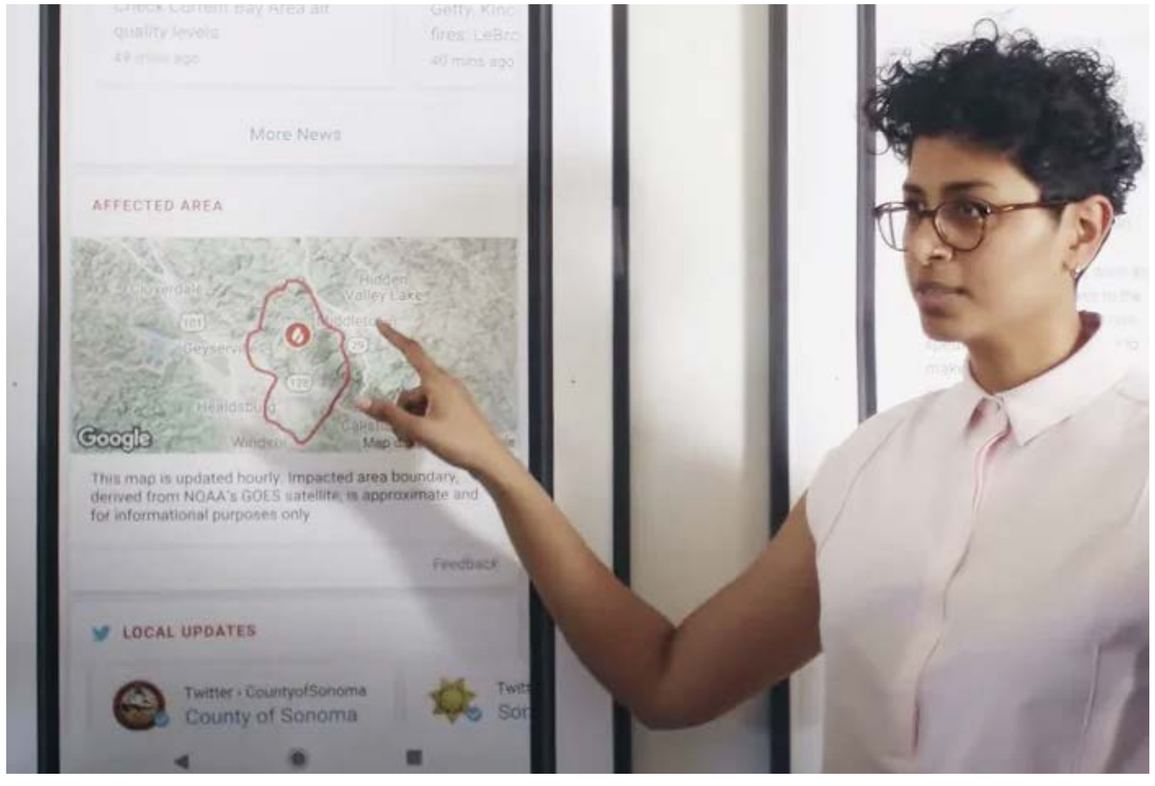
Flood forecasting

Annually, floods cause thousands of fatalities worldwide,[58] disrupt the lives of millions, and cause significant financial damages.

Our Flood Forecasting Initiative, launched in 2018, uses AI to predict when and where riverine flooding will occur, helping to keep people safe and informed. Our **Flood Hub** platform now displays flood forecasts to help governments, aid organizations, and at-risk communities take timely action. These breakthroughs are a result of innovative modeling approaches that use machine learning to create scalable models in real-world settings.

In May 2023, we expanded coverage to territories in 60 new countries across Africa, the Asia-Pacific region,

We're applying AI and working with fire authorities to detect, track, and predict wildfires, and to help authorities respond better to new wildfire threats.



From wildfire mapping, to earthquake detection and alerts to flood forecasting, we continue to find new ways for technology to be helpful at the most critical times.

Europe, and South and Central America. Flood Hub now displays forecasts for 80 countries. This includes some of the territories with the highest percentages of population exposed to flood risk and experiencing more extreme weather, covering 460 million people globally. All forecasts are displayed for free.

We're applying advanced machine learning methods to forecast when and where riverine floods may occur, up to seven days in advance, helping to save lives and livelihoods.

Risk to infrastructure and natural resources

In 2022, we announced our Google Cloud climate insights offerings to help government agencies better understand the risks to infrastructure and natural resources due to climate change.

For example, we partnered with the State of Hawaii Department of Transportation (HDOT), which manages 2,500 miles of highway—much of which is facing risks due to erosion and sea level rise. HDOT is leveraging Google Earth Engine and other Google Cloud services for its Climate Resilience Platform, using big data and insights to assess risk and prioritize investment decisions based on multiple climate risks, asset conditions, and community impact.

Water security

We're putting Google's products and technology in service of helping others to study and respond to water security challenges. Improving water security requires an accurate accounting of freshwater resources and how they change over time.

As an example, we partnered with the United Nations Environment Programme (UNEP) and the European Commission's Joint Research Centre to develop the Freshwater Ecosystems Explorer. Following the launch of the Sustainable Development Goals, UNEP requested that all 193 member states provide indicator 6.6.1 data on the extent of their water-related ecosystems.[59] At that time, the majority of member states couldn't report on this metric. To fill this gap, the Freshwater Ecosystems Explorer (sdg661.app) helps to **quantify and visualize surface water changes** over the course of decades. This free, easy-to-use geospatial platform and data product helps decision-makers access national, sub-national, and basin-level data on freshwater ecosystems (see Figure 8).

In addition to other water outflows, freshwater is transferred to the atmosphere via evapotranspiration. Together with government and academic research groups and the nonprofit OpenET, Google has helped improve water management by supporting the automation and scaling of **evapotranspiration (ET) models**. These models provide estimates of how much water is transferred from the land to the atmosphere, a crucial but difficult to measure process within the overall hydrological cycle. Now OpenET is making satellite-based ET data widely accessible to farmers, landowners, and water managers.

FIGURE 8

Freshwater Ecosystems Explorer

The Freshwater Ecosystems Explorer helps to quantify and visualize surface water changes.

Cloud customers and commercial partners

We're collaborating with customers and commercial partners across a number of sectors—including energy, transportation, agriculture, manufacturing, consumer goods, and financial services—to work towards sustainability goals.

We're providing powerful insights to help our Google Cloud customers around the world predict climate risk, increase visibility across their supply chain, and reduce and report on their emissions.

Carbon footprinting

In 2022, we introduced the Carbon Sense Suite, which includes products such as Carbon Footprint and Active Assist, and tools such as Cloud region picker. The suite is enabling Google Cloud customers to accurately measure, report, and reduce their cloud-related carbon emissions. We help developers and organizations make low-carbon architecture decisions and provide best practices to improve sustainability.

Developers at companies such as L'Oréal and SAP are using Google Cloud tools to reduce the emissions associated with their technology footprint. Working closely with these customers, we developed our **Carbon Footprint** product—a freely available tool that provides monthly emissions data on a per service, project, and region basis. The data can be accessed in BigQuery for analysis and can be easily integrated with popular carbon accounting tools. Carbon Footprint data is also integrated with recommendations to reduce emissions.

Climate risk and resilience

Many of our commercial customers are eager to assess and improve their resilience to climate change. From transportation companies to financial service organizations, Google is helping organizations integrate climate data and geospatial analysis into business strategy and risk management. For example, we partnered with RSMetrics and Infosys to publish a design pattern for portfolio climate risk analysis and we're helping insurers boost responses to disaster-related claims.

We've launched SpatiaFi, together with our partner Climate Engine, to help the banking sector harness the power of geospatial analytics to support climate finance. For example, geospatial data can help a bank's agriculture customers build a personalized picture of flood and drought risks and biodiversity at a field-specific level.

Responsible sourcing

As global demand for raw materials continues to grow, deforestation is increasing, contributing to GHG emissions. Companies want to know more about the origins of their raw materials, including which are sourced responsibly—and how they can improve their sourcing practices.

Google Cloud, in partnership with NGIS (a geospatial solutions company) is helping brands gain a deeper understanding of sustainable sourcing practices across supplier networks. By combining the power of our cloud computing, AI, and geospatial analytics, we're helping companies get real-time, reliable information into operations at a local supplier level, globally. For example, we're helping Unilever build a more holistic view of the forests, water cycles, and biodiversity that intersect its supply chain. We also helped launch TraceMark, a Google Cloud Ready – Sustainability Solution designed for enterprises, which aims to accelerate the delivery of traceability and transparency in global supply chains for raw materials.

Transportation-related emissions

We're working with a number of commercial organizations to tackle transportation-related emissions. Ecommerce shipments are on track to double by 2026,[60] and 90% of U.S. consumers expect free two-to-three-day shipping,[61] so we're helping businesses optimize every stage of the last mile delivery journey: capturing valid addresses, optimizing delivery routes, efficiently navigating drivers, tracking shipment progress, and analyzing fleet performance. We're also helping organizations harness the power of data and AI to drive more intelligent logistics operations and supply chains. For example, our customer EV Suitability Assessment helps organizations monitor their fleet of vehicles and make choices that minimize environmental impact.

Data analytics tools from Google Cloud are also helping airlines. Lufthansa Group partnered with Google Cloud and Google Research to develop a platform that facilitates better planning and management of daily flight operations.

We're helping organizations harness the power of data and AI to drive more intelligent supply chains.

Renewable energy

Wind farms are an important source of carbon-free electricity, but wind can fluctuate depending on the weather. Through Google Cloud, customers like Engie (a global energy and renewables supplier) can optimize their wind portfolio in short-term power markets by predicting wind power output 36 hours ahead of actual generation and making optimal hourly delivery commitments to the grid, a full day in advance.

Sustainability partner solutions

Partner solutions are important to scale the impact for our customers and help them get the support they need, from processing ESG data to reducing carbon emissions. This is why we launched Google Cloud Ready – Sustainability, a designation to validate and promote sustainability partner solutions built on Google Cloud.

Great Western wind farm in Oklahoma (225 MW for Google)

Researchers, academics, and NGOs

We're providing cutting-edge climate- and nature-related data and analytics to scientific researchers from academic institutions and NGOs. This support is enabling advances in the most complex areas of their fields, applying AI, machine learning, and geospatial analytics at a global scale to accelerate the shift to a sustainable future.

Planetary-scale platforms

Launched in 2010, **Google Earth Engine** is Google's planetary-scale platform for Earth science data and analysis. It offers over 1,000 Earth observation datasets with powerful cloud computing to show timely, accurate, high-resolution insights about the state of the world's habitats and ecosystems—and how they're changing over time.

Scientists, researchers, and developers have been using Earth Engine for more than a decade to detect changes, map trends, and quantify differences on the Earth's surface. In 2022, over 90,000 users regularly used Earth Engine's data analytics and computing for research and educational purposes. Multiple global conservation and restoration tools have also been built on the platform. For example, founded by Crowther Lab in Zurich and powered by Google Earth Engine and Google Cloud, **Restor** allows anyone to analyze the restoration potential of any place on Earth. When you outline a given area on the Restor map, it will show you data on local biodiversity, the current and potential amount of solid carbon stored in the soil, land cover, soil pH, and annual rainfall. With this information, the platform connects practitioners, facilitates the exchange of information, and makes projects visible to potential funders and the public.

In 2022, researchers addressed urban climate change inequities using publicly available data from Earth Engine. This study used Earth Engine to combine medium-to-high-resolution satellite observations with census data to calculate the feasible area available for planting new trees in urban areas for over 200 areas in California.[62] By quantifying this, they were able to provide estimates of several co-benefit of tree cover.

To accelerate the innovation that we've seen from the scientific and NGO communities, we're now bringing Google Earth Engine to public and private sector users. In 2022, we expanded Google Earth Engine's availability for commercial use by businesses and governments worldwide as an enterprise-grade service through Google Cloud. With access to reliable, up-to-date insights on how our planet is changing, organizations will be better equipped to move their sustainability efforts forward.

Google Earth

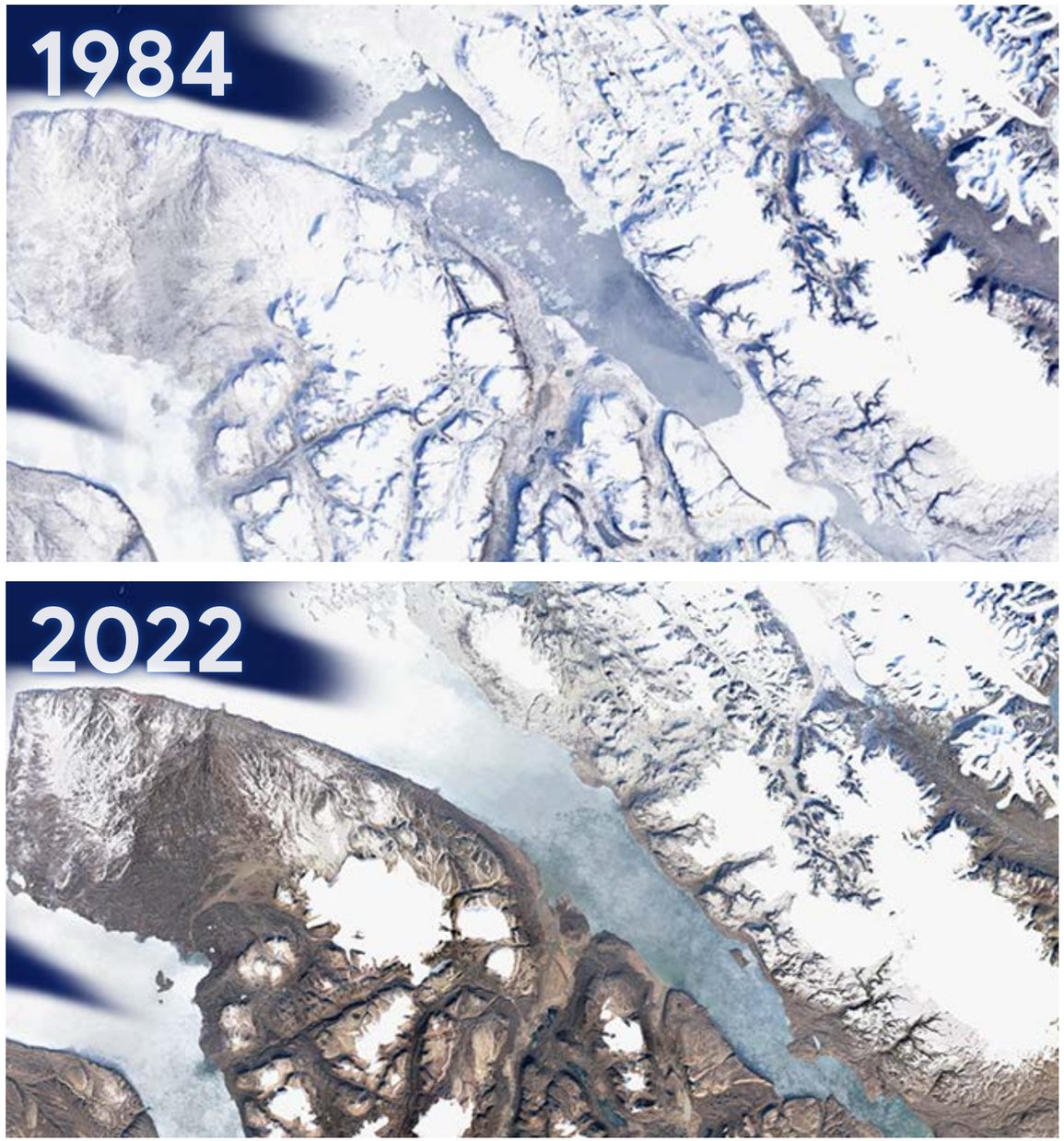
Our planet has seen rapid environmental change in the past half-century—more than at any other point in human history.

Timelapse in Google Earth is a global, zoomable time-lapse video of the planet, providing a clearer picture of Earth's dynamic change since 1984—not just problems, but also solutions, as well as beautiful natural phenomena that unfold over decades—from irrigation systems emerging in the deserts of Egypt to volcanic eruptions, logging, and wildfires changing the landscape of California's Lassen National Forest and glaciers retreating in Sermersooq, Greenland (see Figure 9).

The imagery also captures how cities have adapted to combat climate change—like offshore wind farms in Middelgrunden, Denmark and a large-scale solar installation in Granada, Spain.

FIGURE 9

Glacier retreat in Sermersooq, Greenland, seen from Timelapse in Google Earth.



Data Commons

Sustainability data is fragmented across thousands of silos, in many formats and schemas, and across a multitude of databases. In 2017, we started the **Data Commons** project, which aggregates data from a wide range of sources into a unified database to make it more accessible and useful. Data Commons was developed by Google to organize sustainability data from hundreds of sources, such as the World Bank, National Aeronautics and Space Administration, and the U.S. Centers for Disease Control and Prevention (CDC). It makes this data available to researchers, journalists, policymakers, individuals, and other stakeholders around the globe.

Today, Data Commons is one of the world's largest knowledge graphs on sustainability, including data about climate, health, food, crops, shelter, emissions, and more. Anyone can access, explore, and understand this data using Google Search or our free dashboards and visualization tools, and they can use our open and free APIs to build new tools based on this data. For enterprise customers, this data is available via Data Commons on the BigQuery Analytics Hub.

Data Commons is being used to monitor and address a variety of sustainability challenges, including climate change, natural disasters, water quality, and food security.

Climate change

Data Commons can ingest health data from the CDC and climate data from the IPCC, and combine them by aligning data on location, health conditions, or dates. A policymaker can then use Data Commons to compare these two datasets to identify outliers and understand how temperature changes may affect populations with pre-existing conditions.

Natural disasters

Partnering with the John Doerr School of Climate at Stanford, Data Commons has helped Stanford create a climate disaster dashboard to identify areas affected by wildfires, wet bulb temperatures, and other natural disasters exacerbated by climate change. The Data Commons team was able to take numerous climate models and model probabilities for future temperature ranges in specific areas.

Water quality

Data Commons is helping communities get a better understanding of water use, quality, and availability. For example, a researcher at the Indian Institute of Technology Madras is working with Data Commons to add India-based data on water quality.

Food security

Feeding America is a nationwide network of 200 member food banks serving tens of millions of people in need in the United States. Data from their annual Map the Meal Gap study is accessible in Feeding America Data Commons, so anyone can explore food security and how it intersects with variables like health, climate, and education. For example, it shows that counties that will be most affected by climate change are also already most affected by food scarcity. This data allows Feeding America to quickly identify U.S. locations where food insecurity is most exacerbated by other root causes of disparities and hardship.

Nonprofit TechSoup used Data Commons to identify how climate change will impact food security needs in California. This allowed them to see that agricultural counties that will be most impacted by temperature changes are already at the highest levels of food insecurity. They can then map out specific food support sites to see which counties will need more civil society organizations helping with food insecurity.

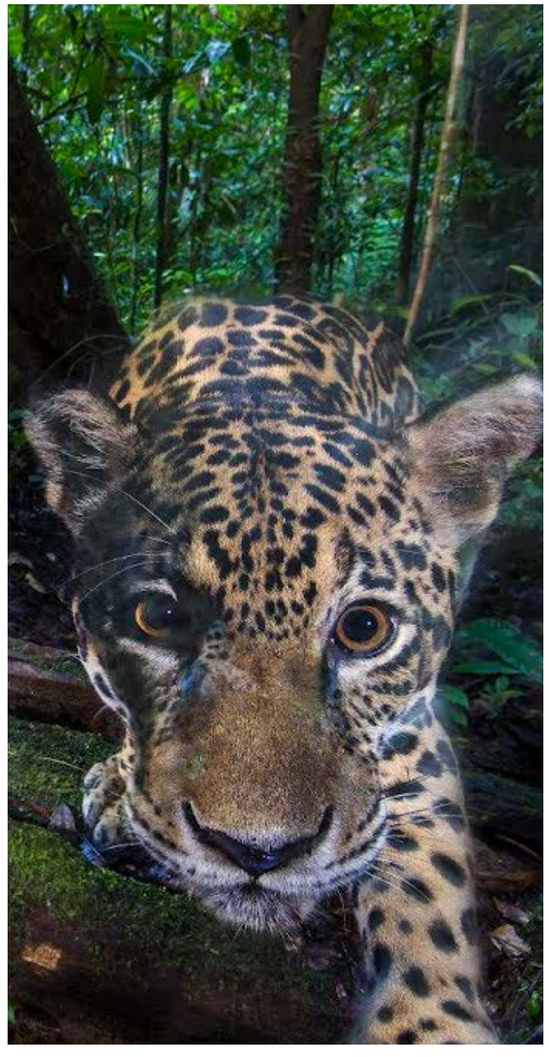
Wildlife monitoring

In 2022, global search interest in "wildlife" nearly tripled,[63] reaching a 15-year high.[64] We're using our technology to support wildlife conservation efforts around the world. **TerrAdapt** uses satellite monitoring technology powered by Google Earth Engine to project habitat conditions given future climate and land-use scenarios. TerrAdapt can help prioritize areas for conservation actions—like habitat restoration, increasing protection status, and building wildlife crossings.

Google teamed up with the Commonwealth Scientific and Industrial Research Organisation (CSIRO—Australia's national science agency) and the Kaggle data science community to protect coral reefs including Australia's Great Barrier Reef, the world's biggest coral reef system. We developed a machine learning solution to analyze underwater images of a species of starfish that feed on living coral. By detecting them more accurately and efficiently, scientists can now more easily monitor the reef and manage the impact of the starfish more effectively. In collaboration with CSIRO and other partners, we're also applying AI to measure carbon sequestration capacity of seagrass ecosystems.

Since 2017, Google has been a founding technology partner in **Wildlife Insights**—a collaboration between seven leading conservation organizations to streamline biodiversity monitoring with the help of AI and to fill critical data gaps to inform data-driven decisions. This platform makes it easier for conservationists and scientists to collect and analyze data from remote cameras.

We're working with partners to leverage machine learning to monitor and protect wildlife habitats, such as coral reefs.



Wildlife Insights helps conservationists protect species from extinction with AI.

Investing in breakthrough innovation

We're helping advance the next generation of audacious technologies to address sustainability challenges. Incubating breakthrough technologies is essential for the transformative change needed to deliver deep emissions reductions at scale and to bend the curve of climate change.

And at X, Alphabet's "moonshot factory," our teams are developing cutting-edge technology that aims to solve problems for millions of people and change systems worldwide. Climate-related projects comprise more than half of X's current moonshots, which include experiments in ocean health, carbon sequestration, clean energy, wildfire awareness, waste reduction, and sustainable agriculture. X is using what they've learned from a decade of climate projects to shape the work they're doing now.

Clean electricity

Tapestry aims to unlock access to clean, reliable, and affordable electricity worldwide by providing greater insight into our increasingly dynamic and complex electricity system. As X's moonshot for the electric grid, it's creating a single virtualized view of the electricity system that can predict and simulate what might happen on the grid from nanoseconds to decades into the future. Insights from such computational models can lead to reduced energy consumption, lower emissions, and improved resilience to outages, as well as reduce interconnection queues, enabling more renewable energy capacity to be added to the grid.

Ocean ecosystems

Tidal is X's moonshot to protect the ocean with technology systems while feeding humanity sustainably. Its underwater sensor system and machine perception tools are bringing visibility to our ocean ecosystems so we can better understand and protect them while sustainably harnessing the ocean to solve some of humanity's biggest challenges—from food production to climate change.

Tidal's first product monitors fish and environmental conditions underwater to detect and interpret things like fish behaviors, which are helpful for feeding and health tracking, and predict outcomes such as growth trends over time—all of which can help fish farmers make better, more environmentally-friendly and cost-effective decisions about fish feeding, welfare, and health.

Autonomous driving

Waymo's mission is to make it safe and easy for people and things to get where they're going. Waymo's fleet of shared electric vehicles provides a fully autonomous ride-hailing service in Phoenix and San Francisco, connecting communities with the benefits of EVs. Waymo's EV fleet is also matched with 100% renewable electricity.

Sustainable food systems

Mineral is using robotics, AI, and computer vision to create a more sustainable food production system.

Increasing agricultural productivity and sustainability is imperative to feed the planet's growing population. Modern agriculture has a significant environmental impact, such as soil degradation and biodiversity loss due to weeds, pests, diseases, herbicide resistance, and excess chemical input waste. **Mineral** uses robotics, AI, and computer vision to create a more sustainable food production system. It's developing perception-powered solutions with partners across the agriculture value chain—from grocery retailers and enterprise farms to equipment manufacturers and crop protection companies—to develop a better understanding of the complex interactions of plants, their growing environment, and farm management practices.

Tidal testing its technology at a fish farm north of the Arctic Circle.

Creating ecosystems for collaboration

Beyond our own tools and programs, we continue to invest in promising initiatives that aim to create scalable, high-impact collaboration ecosystems for climate change and sustainability.

Google.org

Google.org aims to bring the best of Google to help solve some of humanity's biggest challenges. This includes combining funding, innovation, and technical expertise to support underserved communities, provide opportunity for everyone, and help address a number of sustainability challenges.

Launched in 2022, the Google.org **Impact Challenge on Climate Innovation** allocates up to $30 million to support breakthrough projects that use data and technology to accelerate climate action. Selected organizations will receive funding to scale their activities, along with access to Google's technical expertise and products to help them maximize their impact. Our first recipient, the World Resources Institute (WRI), will receive $5 million to support its project, which will use sensors, satellite imagery, and AI to help decision-makers understand where to implement cool surface infrastructure to reduce the impact of extreme heat.

We've launched the Google.org **Impact Challenge: Tech for Social Good**—the first open call for European organizations to apply for pro bono technical support and funding for charitable projects focused on tackling complex issues, including sustainability.

Examples of other sustainability-focused investments include:

- **AI for the Global Goals**, $25 million in funding to support the development of new AI-driven approaches that accelerate progress on the UN Sustainable Development Goals.
- A $10 million grant to **ICLEI-Local Governments for Sustainability** to support 10 nonprofit-led projects that help cities accelerate their sustainable transition through data-driven environmental and climate action at the local level.
- The **Environmental Justice Data Fund**, a collection of grants totaling nearly $9 million that aim to help frontline communities that have been historically underserved and disproportionately impacted by climate change and environmental injustice.
- AVPN's **APAC Sustainability Seed Fund** provides $3 million in grant funding to 13 local organizations focused on sustainability solutions for vulnerable and underserved communities in Asia Pacific.

Googlers collaborate in the Event Center at our Bay View campus.

Google for Startups

By investing early in technologies aimed at tackling sustainability challenges like climate change, we have the potential to move the needle on sustainability and positively impact our planet. We have a portfolio of sustainability-focused accelerators, which support early stage innovations to grow and scale.

Google for Startups Accelerator

Google for Startups is working to identify, support, and scale startups that are building technologies to combat climate change and build a more circular economy. These accelerators are 10-week programs for Seed to Series A technology startups, designed to bring the best of Google's programs, products, people, and technology to some of the most innovative and impactful climate change and circular economy technologists. In addition to mentorship and technical project support, the accelerator focuses on product design, customer acquisition, and leadership development for founders.

- **Google for Startups Accelerator: Climate Change**: Since launching the program in 2021, we've hosted four climate accelerators, each with a distinct geographic focus. The first three cohorts included 33 startups in North America that report they've raised over $650 million in funding. We also announced the expansion of this program to Europe, in partnership with Google Cloud, where we worked closely to accelerate 13 climate tech companies from the sub sectors of Agtech, SaaS, fintech, real estate, supply chain, and circular economy.
- **Google for Startups Accelerator: Circular Economy**: Launched in 2022, this new program focuses on supporting startups and nonprofits in North America and Asia Pacific working on challenges related to advancing a more circular economy—from food waste to fashion, recycling, and reuse—with technical solutions.

Startups for Sustainable Development

Through our Startups for Sustainable Development program, we're working with impact-driven startups using technology to build a more sustainable future. All are on a mission to address one or more of the U.N.'s 17 Sustainable Development Goals, from eradicating poverty and hunger to improving healthcare and advancing climate action. We provide them with long-term support to scale their impact: mentoring from expert advisors, connections to funding partners, and access to cutting-edge research and technology. The program now supports nearly 400 startups in over 60 countries, working with a network of over 140 partner organizations.

2022 HIGHLIGHT

Our Startups for Sustainable Development program now supports nearly 400 startups in over 60 countries working with a network of over 140 partner organizations.

The Google.org Impact Challenge on Climate Innovation supports breakthrough projects that use data and technology to accelerate climate action.

The journey ahead

From measuring and monitoring changes on the Earth's surface, improving forecast and prediction models for flooding and wildfires, optimizing operations, combining disparate data sources, and designing more efficient products, we continue to leverage our expertise in technology and apply the latest advancements to help solve global challenges.

We believe that by working together with our partners and customers, we can make a real difference in addressing the challenges of climate change and ecosystem degradation.

LEARN MORE

- Data Commons
- Environmental Insights Explorer
- Google Cloud sustainability
- Google Earth Engine
- Sustainability-focused accelerators

Operating sustainably

We're showing the way forward through our own operations

Our ambition

Our operations

Net-zero carbon

Water stewardship

Circular economy

Nature and biodiversity

Spotlight: Building a more sustainable campus in Mountain View

Google's data center in St. Ghislain, Belgium.

Our ambition

Our work on sustainability started with our own operations, and we've worked hard to lead by example, with the ultimate goal of driving larger systems change. We set ambitious sustainability goals. We share the innovations we create and the lessons we learn with others, so we can help accelerate the global transition to a low-carbon and sustainable future.

We're working to drive sustainability across our operations in four key ways: accelerating the transition to a net-zero carbon future, advancing water stewardship, building a circular economy, and protecting nature and biodiversity.

Our operations

Google uses energy, natural resources, and products and services to build our workplaces, data centers, and consumer hardware products. At the end of 2022, we had offices and data centers in roughly **200 cities** and nearly **60 countries** around the world. We also had two retail stores, both in New York City.

The products and services that our customers and users rely on—like Gmail, Google Cloud, Search, and YouTube—are powered by our data centers and networking infrastructure. At the end of 2022, we had 28 Google-owned and -operated data center campuses across 24 data center locations[65] on four continents, as well as more than 30 Google Cloud regions. In addition to our Google-owned and -operated data centers, we use additional third-party-operated data centers as well.

We work worldwide with suppliers that support our business and operations, including hardware manufacturing and indirect services. Through our Supplier Responsibility program, we collaborate with stakeholders across our supply chain to uphold our high standards for protecting workers and the environment.

Net-zero carbon

We aim to achieve net-zero emissions across all of our operations and value chain by 2030

Our ambition

Our approach

- Measuring our carbon footprint
- Reducing carbon emissions
- Advancing carbon-free energy
- Managing residual emissions

The journey ahead

Our ambition

The United Nations Intergovernmental Panel on Climate Change is unequivocal: climate change is an urgent threat to human well-being and the health of the planet.[66] While the last several years have seen significant progress in mobilizing the global community to take more ambitious climate action, the world isn't on track to meet the targets established by the Paris Agreement to limit temperature rise to 1.5°C.[67]

At Google, we're working to accelerate the transition to a carbon-free future. We know that our responsibility begins with our own carbon footprint, which is why we've taken significant steps over the past two decades to minimize our own emissions. In 2021, we set our most ambitious goal yet: to achieve **net-zero emissions** across all of our operations and value chain by 2030. To accomplish this, we aim to reduce 50% of our combined Scope 1, Scope 2 (market-based), and Scope 3 absolute emissions (versus our 2019 baseline) before 2030, and plan to invest in nature-based and technology-based carbon removal solutions to neutralize our remaining emissions. We've formally committed to the Science Based Targets initiative (SBTi) to seek their validation of our absolute emissions reduction target.

One of the key levers for reducing emissions from our operations is transitioning to clean energy. Energy use contributes to a significant share of our carbon footprint due to the electricity needs of our operations—in particular, our data centers. That's why, in 2020, we set a goal to operate our data centers and office campuses on **24/7 carbon-free energy** on every grid where we operate by 2030 (24/7 CFE). We've been working hard to transition our operations and the electricity grids that serve us to cleaner sources of power, through a combination of clean energy procurement, technology innovation, and policy advocacy. And we expect our work to decarbonize electricity grids where we operate to contribute to decarbonization across our value chain as well.

Charting our path

Achieving net-zero emissions and 24/7 CFE by 2030 are extremely ambitious goals—what we call "moonshots." We also know that our path to net-zero emissions won't be easy or linear; it may require us to navigate significant uncertainty and deploy new systems and technologies across our business. Some of our plans will take years to deliver their full results, particularly where they involve building new large-scale infrastructure with long lead times. So as our business continues to evolve, we expect our emissions to rise before dropping towards our absolute emissions reduction target.

In our **third decade of climate action**, we recognize that we can't achieve our goals alone. Transitioning to a carbon-free future will require stronger government policies and partnerships with many other organizations, as well as new technologies and structural changes to the broader systems that serve our operations and value chain, such as electricity grids and hardware supply chains.

It will be especially critical for governments around the world to enact policies that drive rapid technological and economic transformations, including the full decarbonization of the global energy system. That's why Google advocates for stronger clean energy and climate policies, and partners with many other organizations to accelerate clean energy and climate progress. We've played instrumental roles in setting up advocacy organizations, including the Clean Energy Buyers Association (CEBA) in the United States, the RE-Source Platform in Europe, and the Asia Clean Energy Coalition (ACEC).

To learn more about our public policy and advocacy, including policy engagement, trade associations, memberships, and partnerships, see the Governance and Engagement section.

Challenges to address

While we're excited about our net-zero emissions journey, we recognize that we face many challenges. For example:

Growing energy needs

- As we work towards our absolute 50% emissions reduction target, our business is continuing to evolve to meet the needs of a rapidly digitalizing world, and to harness the opportunities presented by AI technology.
- Our operations and value chain are global and involve a diverse range of industries, which means we must make progress within hard-to-abate sectors and carbon-intensive geographies, such as the Asia Pacific region.
- We have a large number of different suppliers, both direct and indirect, each with climate programs that differ widely in maturity. In some cases, this limits our ability to successfully influence them, and to collect the data needed to accurately estimate our Scope 3 emissions.

Availability of carbon-free energy

- There are often long lead times between our investments and resulting GHG reductions. For example, with new wind and solar projects, it can take years before projects that we contract are constructed and begin to generate clean electricity.
- System-level decarbonization is proceeding more slowly than needed in many regions and sectors, and while we aim to accelerate these changes through our efforts and engagement, they aren't within our control.

Use of carbon removals

- Because the carbon removals sector is in the earliest stage of development, costs are currently high, and there are limited volumes of removals available for purchase.[68]

As we move towards our net-zero goal, the scale of these challenges will only increase, along with the difficulty of additional progress. We believe that the urgency of climate change demands immediate action, and setting ambitious, near-term targets is a valuable way to focus our efforts and drive important progress across the energy systems and value chains in which we operate.

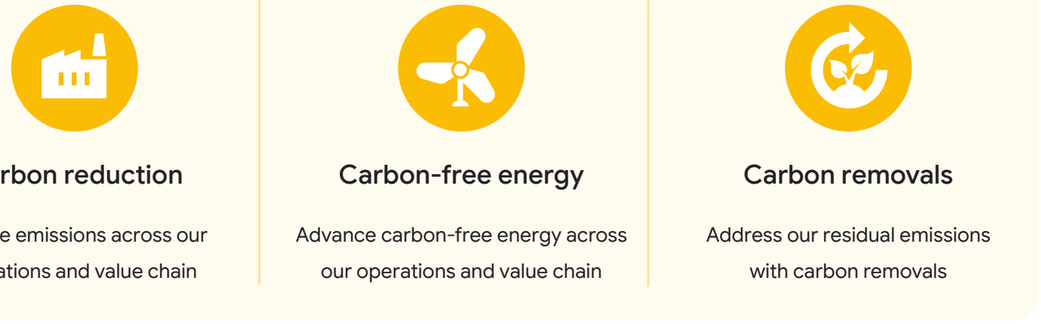
Norther Offshore wind farm in Belgium (92 MW for Google)

Our approach

Our core business involves using data to solve hard problems, and our unique strength is combining engineering skills with an innovative mindset and a global reach.

There are three main focus areas that make up our approach to our net-zero goal: reducing emissions across our operations and value chain, advancing carbon-free energy, and addressing our residual emissions with carbon removals (see Figure 10).

FIGURE 10 **Our net-zero approach**



Measuring our carbon footprint

We began calculating our annual carbon footprint in 2006. Every year since 2009, we've publicly reported the results to CDP, a global organization that asks companies to disclose information on their GHG emissions performance and management.

In 2022, our total GHG emissions were approximately 10.2 million metric tons of carbon dioxide equivalent (tCO_2e), which represents our Scope 1, Scope 2 (market-based), and Scope 3 emissions. In 2022, our total operational emissions were approximately 2.9 million tCO_2e, where operational emissions represent Scope 1 and Scope 2 (market-based) emissions, as well as Scope 3 emissions from business travel and employee commuting, including teleworking (see Figure 11).

Scope 1 emissions

Scope 1 emissions represent 1% of our carbon footprint. Our main sources of Scope 1 emissions include transportation (company vehicles and aircraft), fuel use from back-up generators, natural gas use, and refrigerant leakage in our data centers and offices.

Scope 2 emissions

Scope 2 (market-based) emissions represent 24% of our carbon footprint, mainly due to the electricity demands of our data centers. Scope 2 emissions are thus a key focus of our decarbonization efforts, given that we have more direct control over our data centers than many other parts of our value chain. For over a decade, we've procured clean energy to reduce the carbon emissions from our electricity use: our Scope 2 (location-based) emissions, which don't take into account our renewable energy procurement through power purchase agreements (PPAs), represent 51% of our carbon footprint, demonstrating the dramatic emissions reductions that we've achieved through PPAs.

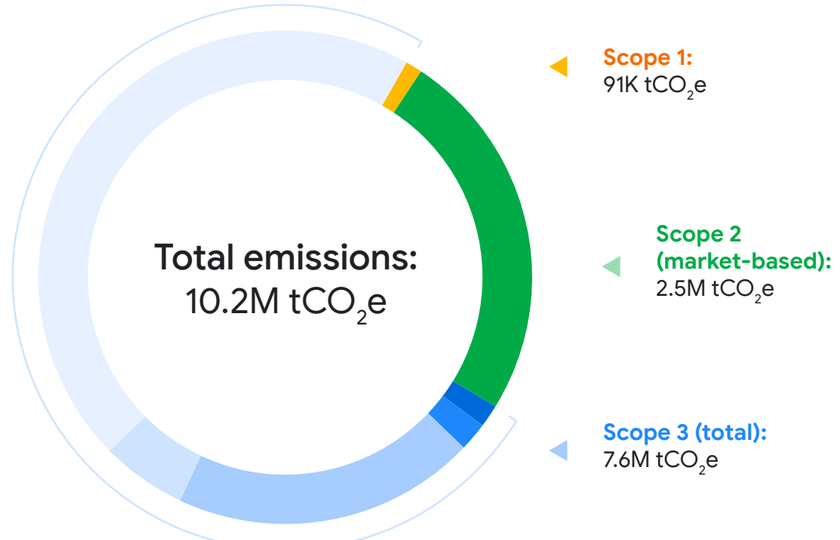
Scope 3 emissions

Our Scope 3 emissions are indirect emissions from other sources in our value chain, such as our suppliers, use of our consumer hardware products, and business travel. The majority of these emissions come from upstream manufacturing of consumer hardware products, the production of capital goods we have purchased for use in our data centers, and data center construction. After accounting for the impact of renewable energy procurement through PPAs, **Scope 3 emissions represent 75% of our carbon footprint.**

For more information on our GHG emissions, see the Reporting approach and methodology section and our Environmental data tables.

FIGURE 11

Our carbon footprint



Scope		tCO_2e	%
Scope 1		91,200	1%
Scope 2	(market-based)	2,492,200	24%
Scope 3	Business travel	211,000	2%
Scope 3	Employee commuting (including teleworking)	151,000	2%
Scope 3	Capital goods	2,096,000	21%
Scope 3	Upstream transportation and distribution	556,000	5%
Scope 3	Other categories	4,586,000	45%
Scope 3	(total)	7,600,000	75%
Total emissions		**10,183,400**	**100%**

Operational emissions: 2.95M tCO_2e

Reducing carbon emissions

We're working to reduce our emissions across our operations and value chain. Key efforts include energy-efficient and low-carbon facilities, electrification, sustainable travel and commuting, and supplier engagement.

Clean energy is also critical to reducing emissions across our value chain. Procuring carbon-free energy has a significant impact on reducing our Scope 2 emissions by eliminating emissions associated with our electricity use. In addition, a significant share of our Scope 3 emissions can be traced back to the electricity grids that power our suppliers and users, so accelerating the decarbonization of electricity grids is also key to our net-zero goal. For more information, see the Carbon-free energy section.

Our emissions reduction goal

In 2022, our total GHG emissions were approximately 10.2 million tCO_2e. We revised our Scope 3 methodology to calculate upstream emissions related to consumer hardware manufacturing by moving away from using a spend-based methodology to a Life Cycle Assessment (LCA)-based methodology.

We also made improvements to the quality of data used to estimate our emissions associated with manufacturing our data center hardware, as well as the LCAs and LCA emission factors used to calculate emissions related to data center construction.

These changes are reflected in our reported Scope 3 emissions for fiscal year 2022, but not for the prior years. Had we not made these changes, we estimate that our reported Scope 3 emissions would have been approximately 18% higher, remaining relatively flat when compared to the prior year (see Figure 12).

Our Scope 2 (market-based) emissions increased by 37%, primarily due to increased data center electricity consumption and a lack of full regional coverage of renewable energy procurement in the United States and Asia Pacific regions.

In 2022, we reported Scope 2 (location-based) emissions of 8.0 million tCO_2e, which doesn't take into account our renewable energy procurement, and Scope 2 (market-based) emissions of 2.5 million tCO_2e. This means that through our PPAs, in 2022, we achieved a 69% reduction in our emissions from our electricity use (see Figure 17).

Since 2011, our carbon intensity per unit of revenue has decreased by 76% while our business grew significantly over the same period.[69] We continue working to lower the correlation between our business growth and our GHG emissions.

TARGET

Reduce 50% of our combined Scope 1, 2 (market-based), and 3 absolute GHG emissions before 2030

2022 PROGRESS

Total GHG emissions:
10.2 million tCO_2e*

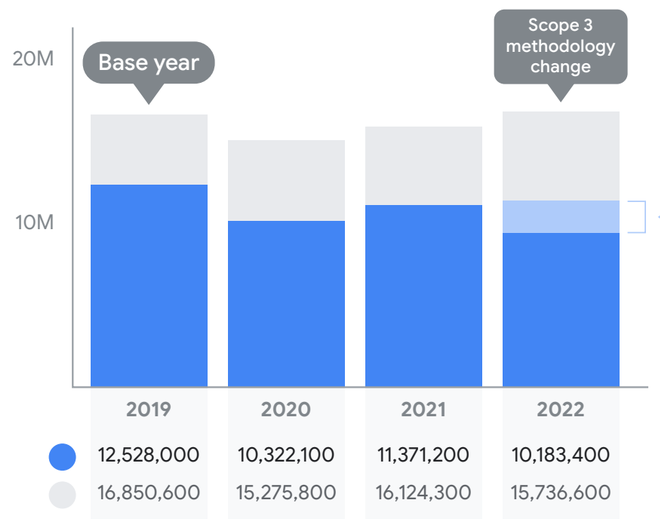
*Due to a methodology change, we're not reporting a percent progress towards this target for 2022

DETAILS

Year set: 2021 | Base year: 2019 | Target year: before 2030
Scope: Percent reduction in combined Scope 1, 2 (market-based), and 3 absolute emissions across our operations and value chain, when compared to a 2019 base year. This represents our operations and value chain, including consumer hardware products.

FIGURE 12

Annual emissions



(in metric tonnes of carbon dioxide equivalent [tCO_2e])

Legend

- Total emissions
- Business as usual (footprint in absence of PPAs)
- Estimated difference in 2022 total emissions due to Scope 3 methodology update

In 2022, our reported total GHG emissions decreased **due to improvements we made to our Scope 3 accounting methodology**, which we haven't yet applied to prior years.

Had we not made these methodology changes, we estimate that our reported 2022 Scope 3 emissions would have been approximately 18% higher, **remaining relatively flat when compared to 2021**.

Energy-efficient and low-carbon facilities

We pursue a set of integrated strategies to reduce the carbon footprint of our facilities, including energy efficiency, building and fleet electrification, on-site generation of clean energy, and carbon-free energy procurement. Reducing waste is another strategy, which is covered in the Circular economy section.

When designing our data centers and offices, we consider options to reduce their carbon impacts, such as the incorporation of low-GHG materials and adaptive reuse of existing buildings. For example, in Sunnyvale, California, we're building our first ground-up mass timber building, which is projected to have 96% fewer embodied carbon emissions than an equivalent steel and concrete structure, factoring in sequestration.[70]

Preventing refrigerants from leaking and finding low-global warming potential (GWP) alternatives is critical for reducing global emissions.[71] We're taking steps to more accurately measure refrigerant leak rates and working to develop new technology solutions that can prevent emissions from these leaks. For example, at our data centers, we're developing and deploying cooling solutions that include natural, **low-GWP refrigerants**.

Google is a founding member of the iMasons Climate Accord, an industry coalition working to reduce GHG emissions across the technical infrastructure systems that support the digital economy. As a part of this effort, we're collaborating with industry peers to highlight the importance of low-GHG construction materials, such as greener concrete, and to accelerate progress in the development and deployment of these materials.

A visualization of the roof of our landmark Platform G office development in King's Cross, London.

Data centers

Google's data centers are the engine of our company, powering products like Gmail, Google Cloud, Search, and YouTube for billions of people around the world. We've worked to make Google's data centers some of the most efficient in the world, improving their environmental performance even as demand for our products has risen. We've done this by designing, building, and operating each one to maximize efficient use of energy, water, and materials.

In 2022, we filed a patent for using machine learning technology to improve our ability to prevent emissions from refrigerant leaks.

Our long-standing data center efficiency efforts are important because our data centers represent the vast majority of our direct electricity use. To reduce their energy use, we strive to build the world's most energy-efficient computing network, outfitting each data center with high-performance servers that we've custom-designed to use as little energy as possible. For example, our tensor processing unit v4 has enabled us to train machine learning algorithms with industry-leading efficiency, resulting in significant emissions reductions compared to business as usual.[72] We also install **smart temperature and lighting controls**, redesign how power is distributed to reduce energy loss, and employ **advanced cooling techniques,** including energy-efficient evaporative cooling.

At some sites, we also **recapture heat** generated by our servers and use it to heat our data center office spaces and other on-site facilities. We continue to assess opportunities

2022 HIGHLIGHT

Compared with five years ago, we now deliver approximately three times as much computing power with the same amount of electrical power.[73]

for off-site heat recovery, where environmentally sound and technically feasible, considering the remote location of many of our data centers and the infrastructure required. Heat recovery is also a key part of our office development strategy, as well as one of the main levers to help us electrify—because reusing heat often requires less energy than creating new heat.

Our efforts have paid off. On average, a Google-owned and -operated data center is **more than 1.5 times as energy efficient** as a typical enterprise data center[74] and, compared with five years ago, we now deliver approximately three times as much computing power with the same amount of electrical power.[75] In 2022, the average annual power usage effectiveness (PUE)[76] for our global fleet of data centers was 1.10, compared with the industry average of 1.55[77]—meaning that Google data centers use about 5.5 times less overhead energy for every unit of IT equipment energy. Since 2012, our average annual fleet-wide PUE has stayed at or below 1.12 (see Figure 13).

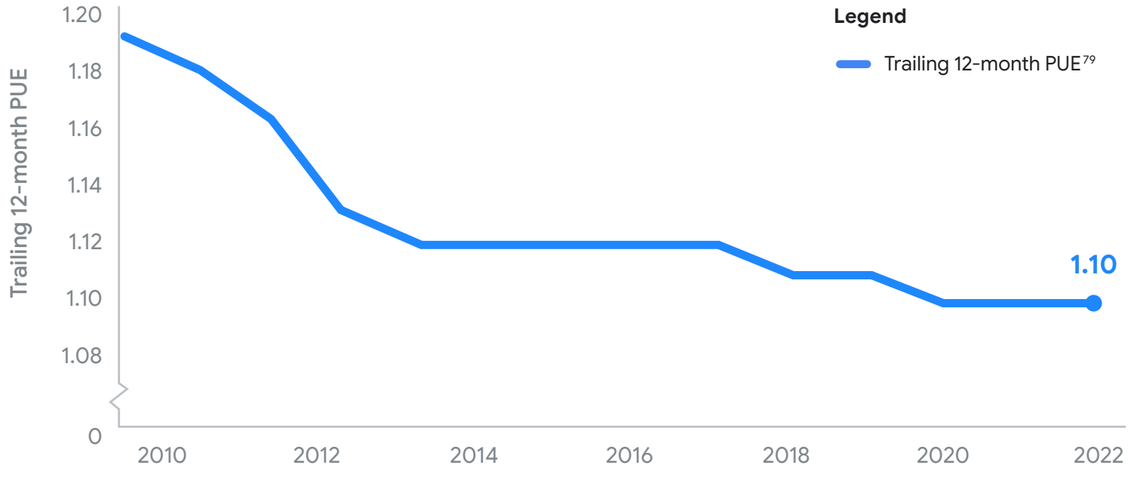
In 2022, we maintained our ISO 50001 certification for all Google-owned and -operated data centers in Europe that met our operational threshold for power usage. We were the first major internet company to achieve a multi-site energy management system certification to ISO 50001, which we first obtained in 2013.

2022 HIGHLIGHT

On average, a Google-owned and -operated data center is more than 1.5 times as energy efficient as a typical enterprise data center.[78]

FIGURE 13

Energy efficiency at Google-owned and -operated data centers



Historically, research has shown that as AI/ML compute demand has gone up, the energy needed to power this technology has increased at a much slower rate than many forecasts predicted. We have used tested practices to reduce the carbon footprint of workloads by large margins; together these principles have reduced the energy of training a model by up to 100x and emissions by up to 1,000x. For more information, see the AI for sustainability section.

Offices

For new office buildings and spaces, we optimize overall performance, including both efficiency and user experience (see Figure 14 on the next page for some examples). We design to internationally recognized and industry-leading **green building standards**, such as Leadership in Energy and Environmental Design (LEED) certification, Building Research Establishment Environmental Assessment Method (BREEAM), and International Living Future Institute's (ILFI) Living Building Challenge (LBC) and Zero Carbon Certification.

As of 2022, over 1.8 million square meters (nearly 20 million square feet) of Google office facilities have achieved LEED certification. Of our LEED-certified square footage, 27% has achieved a Platinum rating, and 60% a Gold rating.

As we work to improve performance across our existing portfolio, we use energy management strategies, building optimization, and data analytics to help drive efficiency measures like equipment upgrades, setpoint adjustments, and lighting retrofits.

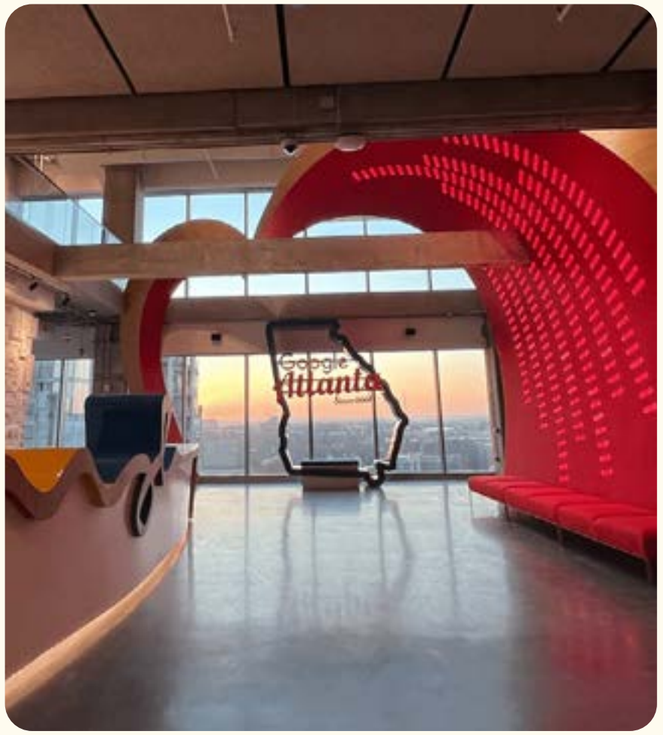
2022 HIGHLIGHT

As of 2022, over 1.8 million square meters (nearly 20 million square feet) of Google office facilities have achieved LEED certification.

We received the highest LEED certification for our Google store in New York City's Chelsea neighborhood.

FIGURE 14

Examples of energy- and carbon-efficient Google offices



1105 Peachtree

in Atlanta, Georgia, U.S.A.

In 2022, we opened our 1105 Peachtree office, which is designed to meet LEED v4 Gold Certification. To promote low-carbon commutes, it's located near mass transit and offers on-site bike parking. It also includes smart building technology throughout to decrease energy use.

6 Pancras Square

in London, U.K.

Our 6 Pancras Square office was the first building project in the world to receive ILFI Zero Carbon Certification. It's also certified LEED v2009 Platinum and received a BREEAM Excellent rating.

Energy audits

in Asia-Pacific

In 2022, we conducted more than 20 energy audits across our largest Asia Pacific sites. As a result, we identified more than 200 energy conservation measures that we're now actively implementing—which are projected to save a total of 5,600 MWh of energy.

Electrification at our offices

Electrification—which helps enable transitioning away from fossil fuels—is an essential first step toward decarbonizing our operations, followed by 24/7 CFE procurement. We're exploring opportunities to **electrify our facilities**, from retrofitting existing building systems, to including electrification standards for new development, to working with landlords on electrification-friendly leases for buildings we don't own.

We've been piloting technologies to enable building electrification since 2010. For example, our first all-electric office—1842 North Shoreline in Mountain View, California—has been in operation for over a decade. Many of these pilots led us to confidently implement new technology in our large development projects. In 2022, we advanced a comprehensive plan to electrify systems across our building portfolio.

More recently, in 2022, we opened Bay View—an all-electric campus with an innovative geothermal installation and the largest electric kitchen in our global portfolio. Learn more in our Bay View spotlight.

We're also working to **eliminate use of natural gas** by designing all-electric kitchens at our offices, including in the Bay Area, Europe, and Latin America.

2022 HIGHLIGHT

In 2022, we opened Bay View—an all-electric campus.

Sustainable travel and commuting

Our transportation team plans, implements, and operates sustainable commuting options that help Googlers get to work by riding shuttles, carpooling, taking public transit, biking, or walking.

We have a growing number of **electric vehicles** in our corporate fleet, and the majority of our global fuel consumption from non-electric vehicles is renewable diesel. We strive to provide electric vehicle charging stations for 10% of the total parking spaces at our Bay Area headquarters, and we continue to work toward this design standard for new development projects.

To date, we've installed more than 5,000 electric vehicle charging ports at our offices. We estimate that employee EV commuting in the United States and Canada prevented roughly 12,000 tCO_2e emissions in 2022.[80]

Many campuses offer **commuter shuttles** to reduce individual vehicle trips. In 2022, we launched an expansion of our all-electric buses for the Bay Area and are introducing these throughout 2023 to replace our existing fleet. For 2022, our shuttle buses in the Bay Area produced savings of more than 10,000 tCO_2e emissions—the equivalent of avoiding more than 41 million vehicle km (25 million vehicle miles) or taking on average more than 2,000 cars off the road for a year.[81]

2022 HIGHLIGHT

Google shuttle buses in the Bay Area produced savings of more than 10,000 tCO_2e emissions—the equivalent of taking on average more than 2,000 cars off the road for a year.[82]

Supplier engagement

We work with many suppliers that are committed to sustainability, and we're partnering with them to develop decarbonization roadmaps and build essential data infrastructure to accurately quantify emissions and reductions across the value chain.

We engage with our suppliers—including hardware manufacturing and indirect services suppliers—to help reduce their energy consumption and GHG emissions, as stated in our Supplier Code of Conduct, which all suppliers are required to sign. We assess suppliers' practices to report, manage, and reduce their emissions and incorporate this into our supplier scorecard.

Reporting environmental data

We expect all our suppliers to report environmental data, and we encourage them to respond to CDP's Climate Change survey. In 2022, we invited 222 suppliers to participate, and at least 90% of our hardware suppliers, by spend, provided data. Our supplier data is used to help set goals and priorities for our sustainability program and we continue to refine our data quality and methodology for calculating the carbon footprint associated with the manufacturing of our hardware products throughout their life cycle.

In 2022, in addition to our CDP supply chain disclosure requests, we engaged with suppliers directly to drive improved data and accounting, including increased completeness and accuracy for their Scope 1, 2, and 3 emissions.

Developing roadmaps to reduce emissions

Since setting our net-zero emissions goal, we've engaged our key suppliers to develop roadmaps to reduce emissions across our supply chain. During Google's 2022 Supplier Sustainability Summit, we communicated the expectation for suppliers to publicly set targets to reduce GHG emissions. We provide in-depth training for key suppliers on setting ambitious GHG reduction and renewable electricity targets. For suppliers that completed our CDP supply chain survey, 75% reported having GHG emissions reduction targets, and of those suppliers, 36% reported that their target is science-based. We aim to accelerate our suppliers' GHG emissions reductions through further integration of climate performance into key procurement tools and the development of new mechanisms to drive deep supplier decarbonization.

Advancing carbon-free energy

Our primary approach for reducing our Scope 2 emissions is through the procurement of carbon-free energy.[83] Since 2017, we've matched 100% of the electricity consumption of our global operations with purchases of renewable energy on an annual basis.[84]

However, because of differences in the availability of renewable energy sources like solar and wind across the regions where we operate—and because of the variable supply of these resources—we still need to rely on carbon-emitting energy sources that power local grids (see Figure 15). That's why, in 2020, we set a goal to run on 24/7 carbon-free energy on every grid where we operate by 2030, aiming to procure clean energy to meet our electricity needs, every hour of every day, within every grid where we operate. Achieving this will also increase the impact of our clean energy procurement on the decarbonization of the grids that serve us.[85]

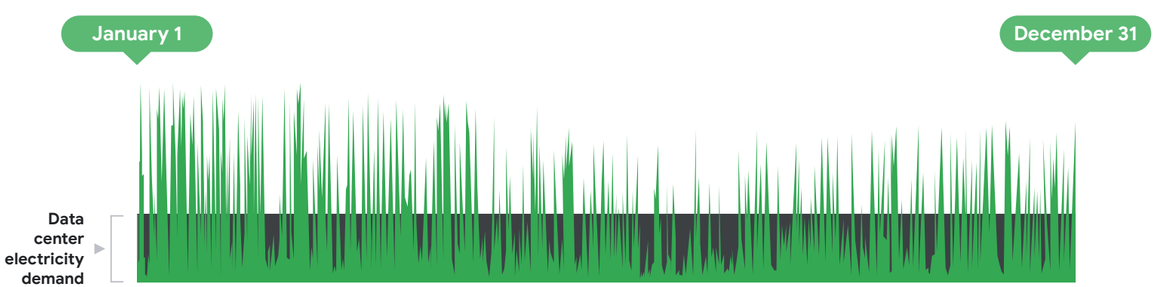
We're working to achieve 24/7 CFE through three main initiatives: **purchasing carbon-free energy**, **accelerating new and improved technologies**, and **transforming the energy system** through partnerships and advocacy.

Purchasing carbon-free energy

Achieving 24/7 CFE is far more complex and technically challenging than annually matching our energy use with renewable energy purchases. No company of our size has achieved 24/7 CFE before, and there's no playbook for making it happen. But we see our efforts as part of a bigger picture, and we've set this ambitious goal to help scale new, global solutions. We're excited to see others—like the U.S. federal government—set similar goals as well.

FIGURE 15

Hourly carbon-free energy performance at an example data center
While Google buys large amounts of wind and solar power (symbolized by green spikes below), these resources are variable, meaning that our data centers still sometimes rely on carbon-based resources.



Renewable energy procurement

We buy electricity directly from new wind and solar farms via long-term PPAs on the grids where we operate, and we also buy renewable power through utilities via renewable energy purchasing models that we helped create.

From 2010 to 2022, we signed more than **80 agreements totaling approximately 10 GW** of clean energy generation capacity—the equivalent of more than 31 million solar panels. Through these agreements, we estimate we'll spend approximately $10 billion to purchase clean energy through 2040.[86]

In 2022, we signed contracts for approximately 2.8 GW of clean energy capacity—more than in any prior year. This included two new projects in the U.K. and Spain, our first in each country, that will help our Cloud regions and offices move closer to 24/7 CFE.

2022 HIGHLIGHT

From 2010 to 2022, we signed more than 80 agreements totaling approximately 10 GW of clean energy generation capacity. Through these agreements, we estimate we'll spend approximately $10 billion to purchase clean energy globally through 2040.[87]

Maevaara wind farm in Sweden (105 MW for Google)

In 2022, we also saw projects we'd contracted over the past few years becoming operational in Belgium, Chile, Denmark, and Finland—providing important clean energy resources to the grids where we operate, and bringing us closer to 24/7 CFE:

- **Belgium:** At our facility in St. Ghislain, Belgium, we installed the first-ever battery-based backup power system for a data center.
- **Chile:** In 2019, Google signed a contract with AES Chile to build 23 new wind turbines in Chile's Biobío region. The project is part of a hybrid wind and solar portfolio that adds 125 MW of clean energy generation capacity. With this wind farm now operational, our data center in Chile operated at 90% CFE in 2022.
- **Denmark:** The Rødby Fjord solar project began adding carbon-free energy to the grid that powers our data center in Fredericia, Denmark. In total, this project adds 54.5 MW of generation capacity to the more than 100 MW of existing operational solar resources in Denmark.
- **Finland:** Google signed a contract with Ilmatar for approximately 60% of the 211 MW generation capacity Piiparinmäki, Finland's largest wind farm, which was completed in November 2021. Google's early agreement to buy the output of this project was critical to the wind farm getting built, and in 2022 it became fully operational and began feeding into the grid that powers our Hamina data center.

In 2017, we became the first major company to match 100% of the annual electricity consumption of our global operations with renewable energy purchases. As of the end of 2022, we've now achieved **six consecutive years** of 100% renewable energy matching on an annual basis (see Figure 16).

From 2011 to 2022, our renewable energy purchasing has resulted in emissions savings of more than 30 million tCO_2e—equivalent to taking more than 6 million cars off the road for a year, or the carbon sequestered by more than 36 million acres of U.S. forests in a year[88] (see Figure 17).

Rødby solar farm in Denmark (55 MW for Google)

FIGURE 16

Renewable energy purchasing compared with total electricity use

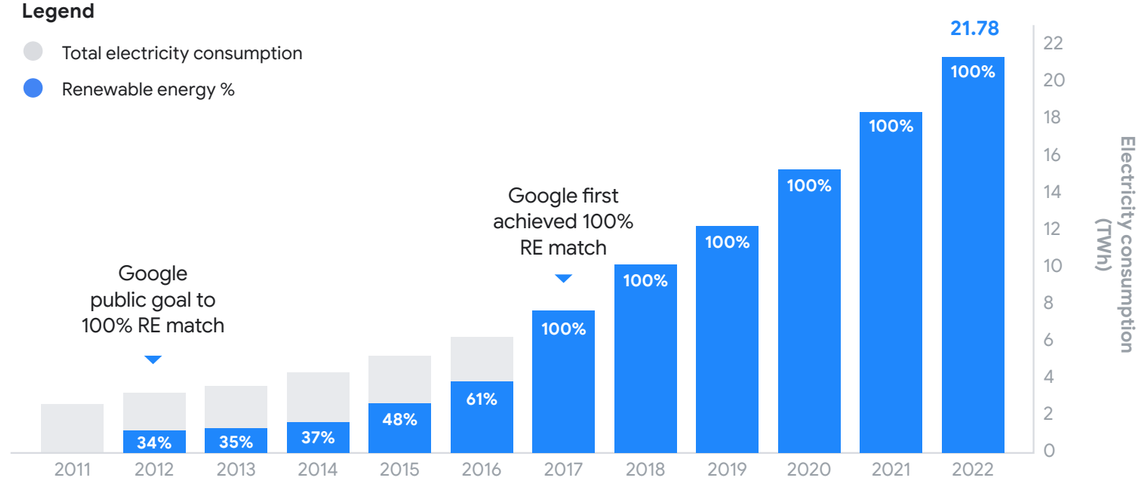
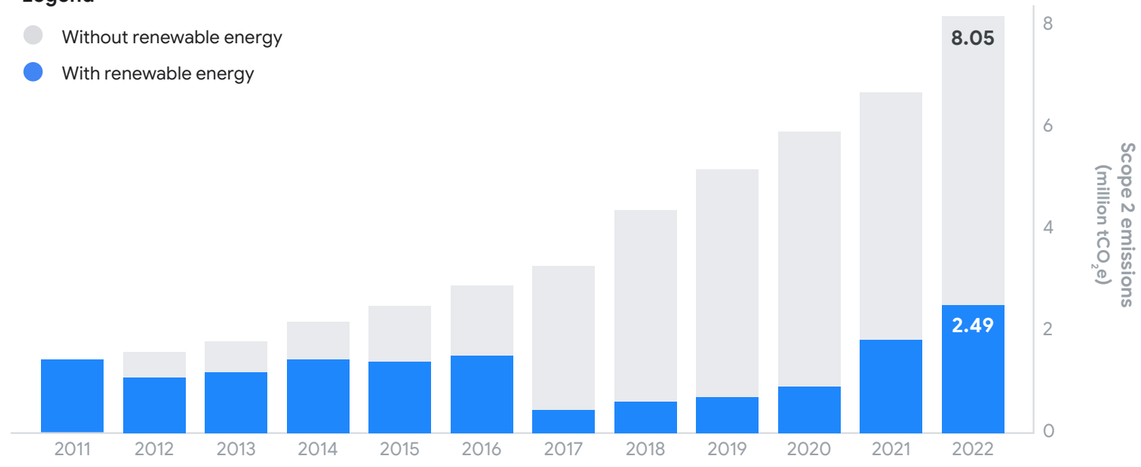


FIGURE 17

Annual impact of renewable energy purchases on Scope 2 emissions



TARGET

Run on 24/7 carbon-free energy on every grid where we operate by 2030

2022 PROGRESS

64% global average carbon-free energy across our data centers and offices

DETAILS

Year set: 2020 | Base year: N/A | Target year: 2030

Scope: Regional % carbon-free energy scores[89], averaged across Google's global portfolio of data centers and offices for 2022. This represents the clean energy procured to meet our electricity needs, every hour of every day, within every grid where we operate. In 2022, we expanded our reporting from only Google-owned and -operated data centers to also incorporate offices and third-party data centers.

24/7 CFE progress

We believe in transparency as a guiding principle, so this year, we're expanding our carbon-free energy reporting. For the first time, we're including CFE scores for both Google-owned and -operated data centers and **third-party facilities** where Google leases space and data processing capacity to support our services. As a result, there are new grid regions[90] included in this year's reporting. We're also including a separate CFE score of the global average for our **offices**.

Data centers

In 2022, we achieved approximately **64%** round-the-clock carbon-free energy across all of our data center sites, inclusive of those operated by third parties. Our 2022 CFE represents a 2% change from 2021 (66% CFE), as a result of updating our metric this year to include third-party operated facilities. Without this change in methodology, CFE for Google-owned and -operated data centers would have remained relatively flat year-over-year.

Our total electricity load across all data center facilities increased by roughly 3 TWh (18%) from 2021 to 2022, while our contracted CFE[91] increased by roughly 2 TWh (17%). Despite this significant expansion of carbon-free energy supply, the percentage of our energy use that came from carbon-free sources remained relatively flat because of the significant growth in our total electricity load.

Beyond the **challenge of growing our CFE procurement** to keep up with our growing power demand, last year we also faced headwinds that made it more challenging to purchase CFE—including continued disruptions to renewable energy supply chains, delays for interconnecting new utility-scale projects, and increased demand for clean energy projects. Adding to these difficulties, load growth continued in regions where CFE contracting is especially difficult given local market dynamics and resource availability constraints (such as the PJM [Pennsylvania-New Jersey-Maryland] grid region in the eastern United States and certain Asia Pacific grid regions).

Despite these significant headwinds, we're proud of the progress we were able to make across many of our data center facilities. **Seven of our 41 grid regions achieved at least 90% CFE**, and 13 achieved at least 85% CFE (see Figure 18). These 13 grid regions span North America, Latin America, and Europe.

While load grew significantly within the central United States, our CFE procurement in this region kept pace—keeping the Midcontinent Independent System Operator and Southwest Power Pool among our highest-scoring grid regions. We increased our contracted CFE in the U.K., Finland, and Germany.

To see more data regarding CFE by region, see the Environmental data table.

Offices

For our offices, which represent a small portion of our global CFE score, we achieved approximately **56%** round-the-clock carbon-free energy.

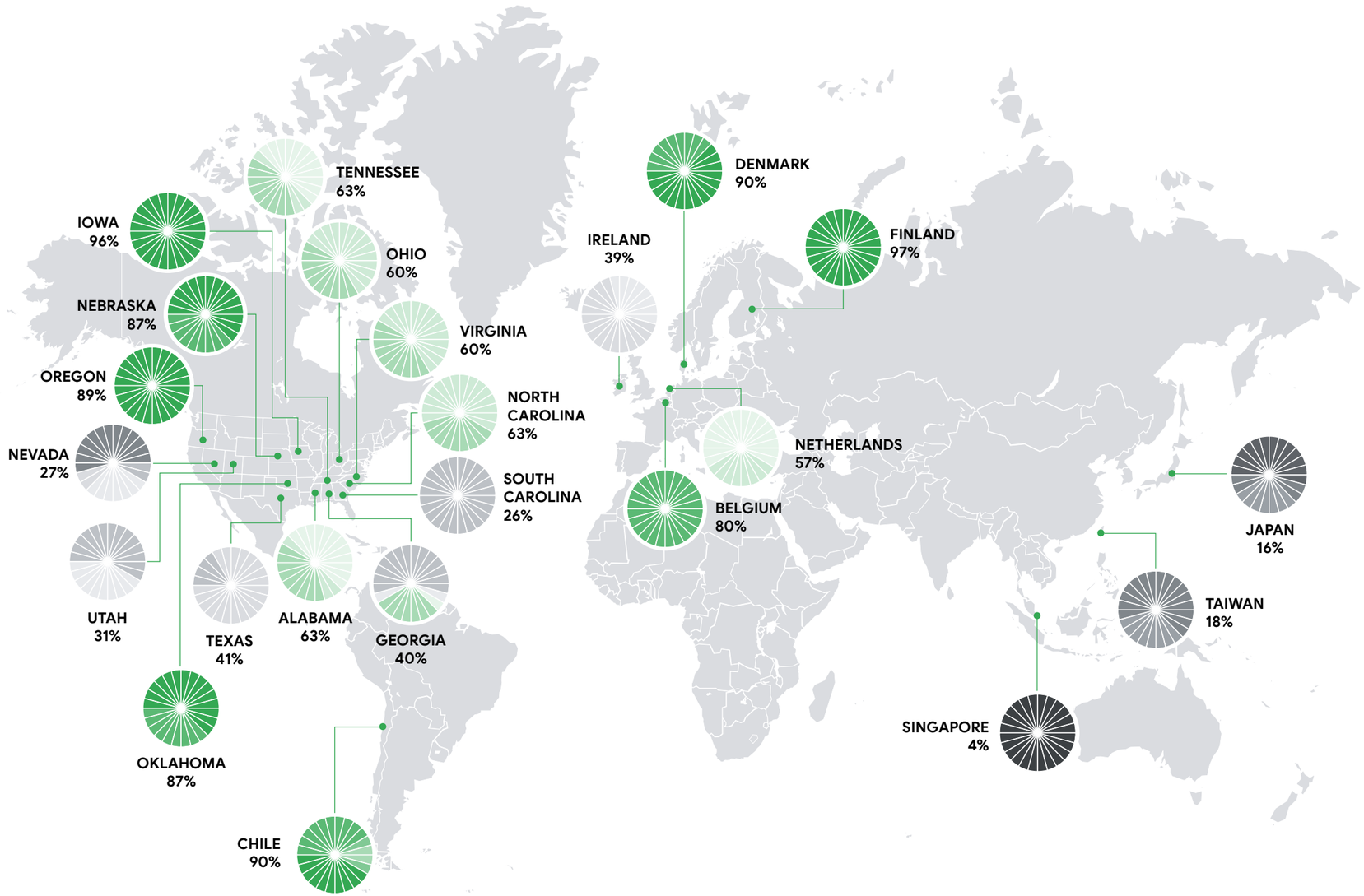
CFE for commercial real estate faces different challenges, including variability in building characteristics, work patterns, and geographic locations with a broad range of electricity grid carbon intensities. In addition to helping us achieve our own climate goals, pursuing CFE for our offices can help expand clean energy options in the cities we call home.

Golden Hills wind farm in California (43 MW for Google)

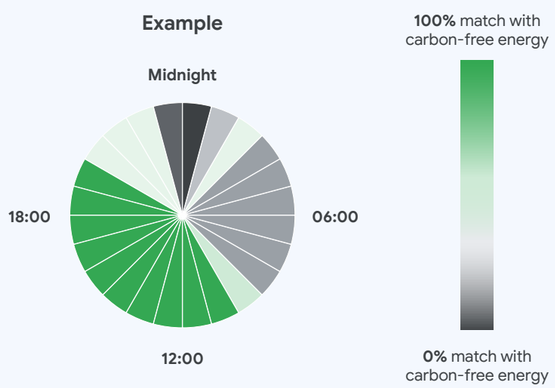
FIGURE 18

Global data center carbon-free energy map

In 2022, Google reached 64% carbon-free energy globally on an hourly basis. This performance varied widely by region, with seven of our regions achieving at least 90% carbon-free energy, and thirteen achieving at least 85%.



How to read clocks



Innovative purchasing models

Our early adoption and long-term support of clean energy projects has coincided with the rapid growth of the industry and remarkable declines in the cost of solar and wind power.[92] Along the way, we've pioneered innovative new contracting models and industry partnerships to help accelerate the adoption of corporate clean energy practices and make clean energy more accessible to a wider range of corporate buyers.

New contracting approaches

In 2022, we published a white paper outlining details of the **CFE Manager model**, a new approach to clean energy procurement that can help a wide range of energy buyers streamline their clean energy purchasing. We share three case studies where Google recently signed CFE Manager agreements—in Virginia, Germany, and California—and discuss some contractual terms and issues that buyers pursuing these agreements should consider.

In addition to the CFE manager model, in 2022 we piloted a new approach to clean energy requests for proposals that can reduce the time to negotiate and execute a clean energy PPA by up to 80%. We're hopeful this new approach will give clean energy buyers and sellers useful new options for negotiating PPAs, and enable all organizations that want to decarbonize their electricity use to join us on the journey to 24/7 CFE.

Helping local communities

Finally, we believe that our clean energy procurement shouldn't only benefit the climate, but also the local communities that host our facilities—in particular, **historically underserved communities** that haven't typically benefited from the clean energy transition. Three years ago, we started a journey to better understand how we can help lower barriers to an equitable clean energy transition, culminating in two additions to our clean energy procurement approach that respond to those challenges.

The first program extends clean energy's financial benefits to local communities. Through a first-of-its-kind partnership with EDPR NA Distributed Generation, we'll create a 500 MW community-based solar portfolio, adding clean energy to the regional U.S. PJM power grid and providing Google with Renewable Energy Credits that contribute to 24/7 CFE. At least 10% of the portfolio's revenues will be redirected annually for up to 15 years as utility bill credits to more than 25,000 households facing a high energy burden.

The second program aims to spur long-term investments to improve housing infrastructure. Through a partnership with Sol Systems, we're providing funding to three rural electric cooperatives and one regional organization with deep roots in North Carolina and South Carolina to undertake critical home pre-weatherization and safety upgrades for low- and moderate-income households. Alongside this investment, the partnership will deliver new solar energy and battery storage resources, moving us closer to 24/7 CFE and bringing clean energy to one of the most challenging grids to decarbonize.

Both of these programs are based on discussions with U.S. government officials, national NGOs, and policy advocates about challenges to an equitable energy transition in their communities. We'll continue to build on these programs to extend the benefits of our investments to underserved communities.

Accelerating new and improved technologies

Wind and solar power have played a critical role in enabling Google's clean energy progress, but meeting 24/7 CFE—and maximizing our contribution to global decarbonization—will require expanding our technology toolkit. In 2022, we continued to work on a wide range of projects to demonstrate, scale, and maximize the climate impact of carbon-free energy technologies, using Google's engineering capabilities and purchasing demand to accelerate the commercialization of new clean energy technologies:

- **Optimizing generation from existing CFE technologies:** To reduce the carbon footprint of our new Bay View and Charleston East campuses, we designed and installed "dragonscale," a new solar roofing technology that helps us power our facilities through on-site generation. Learn more in our Bay View spotlight.
- **Managing energy demand across our global operations:** We developed a "carbon-intelligent computing platform" that optimizes the timing and location of computing tasks based on local CFE availability. This allows us to shift some of our data centers' computing tasks to the times of day when local solar and wind power are most plentiful, and to shift tasks geographically across data centers so that we can do more computing in regions where CFE is abundant.
- **Accelerating next generation energy sources:** In 2021, we signed the first corporate agreement to develop a next-generation geothermal power project, and in 2022, we installed the first-ever battery-based backup power system for a data center at our facility in St. Ghislain, Belgium. This application will enable Google to optimize the carbon footprint of backup power, buying local, low-carbon power for backup when available rather than relying on diesel generators.
- **Improving energy data and clean energy tracking:** Google is driving the development of advanced methods for tracking clean energy, including time-based energy attribute certificates. We're also working to improve the quality, consistency, and granularity of grid electricity data through active collaborations with organizations including EnergyTag, Electricity Maps, FlexiDAO, and more.

We're deploying machine learning solutions to optimize wind power forecasting and project economics.

For our Bay View campus, a first-of-its-kind building-integrated solar panel called "dragonscale" was developed to create a seamless design. (Photo: Iwan Baan)

Transforming the energy system through partnerships and advocacy

Global search interest in "sustainable energy" reached an all-time high in March 2022.[93] Our 24/7 CFE efforts are designed to maximize our contribution to the decarbonization of power grids worldwide. That's why we're supporting others to join us on the journey to 24/7 CFE, by sharing insights and lessons we're learning and new approaches we're developing.

One such example is the **United Nations 24/7 Carbon-free Energy Compact**, which we helped launch with Sustainable Energy for All and other partners in 2021. The Compact is a global community dedicated to building the technologies, policies, tools, ideas, and advocacy needed to accelerate the decarbonization of electricity grids. In Europe, we work with the European 24/7 CFE Hub, a collaboration with Eurelectric to create a platform where energy buyers, suppliers, and policy makers can meet to learn more about 24/7 CFE and receive technical training and implementation guidance.

Public policy and advocacy

In addition to corporate action, we recognize that the clean energy transition also requires strong actions from governments, and we call for ambitious public policies aimed at decarbonizing electricity grids worldwide. In 2022, we published a first-of-its-kind policy roadmap sharing our recommendations for energy policy and market reforms to accelerate electricity decarbonization, informed by our experiences as a large energy user and clean energy buyer around the world. As we advance toward our goal of 24/7 CFE, we're committed to working with others and advocating for clean energy policies that can enable 24/7 CFE for all energy consumers by decarbonizing electricity grids at the scale and pace required to meet the world's climate challenge.

We also recognize that accurate, comprehensive, and actionable corporate GHG inventories are essential to help companies understand their carbon footprints and determine how to mitigate emissions. That's why we recently submitted comments in response to an open survey on the future of the **Greenhouse Gas Protocol** (GHGP). Updating the GHGP will drive continued improvements in the accuracy of companies' GHG inventories, providing useful information that enables them to make decisions and take actions that drive real, measurable GHG reductions.

For more information on our public policy and advocacy, see the Governance and engagement section.

CFE investments

Google works with suppliers around the world. The electricity grids in many countries where our suppliers operate lack sufficient carbon-free energy capacity to support rapidly growing demand, and may even face energy shortages that affect not just manufacturing but also the communities and livelihoods of the people in these regions. Our long-term vision is that all of our suppliers—for hardware manufacturing, transport, logistics, and indirect services—and their communities have access to reliable, cost-effective, carbon-free energy. And we'll get there only through significant global investment in new wind, solar, and other clean energy capacity, as well as more robust grid systems.

In addition to purchasing renewable energy for our own operations, we also make targeted investments in renewable energy. Investment in renewable capacity is a scalable approach to creating system-level change by driving grid decarbonization and enabling greater access to carbon-free energy. This is especially significant in markets where credible procurement mechanisms for clean energy are nascent or nonexistent. We aim to invest in clean energy projects that reduce emissions and serve manufacturing operations across our supply chain.

Google aims to **enable 5 GW of new carbon-free energy through investments in our key manufacturing regions by 2030.** In 2022, we signed agreements to invest approximately $350 million to support 0.5 GW of renewable energy projects towards this 5 GW total. This builds on our long-standing track record in this space; From 2010 to 2022, we entered into agreements to invest nearly $2.9 billion in renewable energy projects with an expected combined generation capacity of approximately 4.2 GW.

Towards our 5 GW goal, Google's investments will be targeted to support bringing additional carbon-free energy capacity online in key manufacturing regions around the globe, including in North America, Latin America, Europe, and Asia Pacific. Such projects may reduce Google's carbon footprint directly, may reduce a Google supplier's carbon footprint, or may simply help decarbonize the local grid.

Asia Pacific—a critical region for our suppliers—is one of the most challenging regions for contracting or investing in carbon-free energy projects.[94] Making carbon-free energy investments in key Asia Pacific regions is, and will continue to be, an area of deep focus for Google moving forward. Google has identified several promising carbon-free energy investment opportunities in the region, all of which are in various stages of due diligence.

CFE for supplier operations

More of our suppliers are using renewable energy. Of the suppliers invited to report to Google via CDP Supply Chain, 26% (58 suppliers) said they have renewable energy targets, and 12% (26 suppliers) have targets that are part of the RE100 initiative. To accelerate decarbonization of our supply chain, we're engaging with our key suppliers to encourage them to commit to procuring 100% renewable energy for their operations.

Our work in increasing supplier access to renewable energy is intentionally inclusive. We aim for our investments in renewable energy and energy efficiency to drive better manufacturing across Google's supply chain and—importantly—to reduce the environmental impact of manufacturing for people and communities around the world.

Looking ahead, we're working to:

- Close our first renewable energy investment deal in a key Asia Pacific manufacturing region, working toward our broader goal to enable 5 GW of new carbon-free energy in key regions by 2030.
- Increase access to cost-effective renewable energy at scale for supply chain partners in key manufacturing regions through direct supplier and public policy engagements.
- Participate in advocacy efforts related to supply chain renewable energy and carbon mitigation, working collaboratively with industry-leading institutions to research solutions and share best practices.

Managing residual emissions

We aim to avoid or reduce GHG emissions to reach our absolute emissions reduction target, but there are some emissions that will remain difficult to abate. We're taking multiple approaches to address these residual emissions and are aiming to play an important role in advancing the development and deployment of nature-based and technology-based carbon removal solutions.

As we continue to build out these efforts, we'll share an annual disclosure of our use of carbon credits and removals on our path to net-zero emissions. This will include information about our criteria, approach, and portfolio, including details on project purchases and any relevant certifications.

2022 HIGHLIGHT

We contributed $200 million to Frontier, an advanced market commitment that's accelerating the development of carbon removal technologies, as one of five companies that made a $925 million total pledge.

Carbon removal solutions

While permanent carbon removal solutions aren't yet economically viable or deployed at scale, the IPCC stated in 2022 that "the deployment of carbon dioxide removal (CDR) to counterbalance hard-to-abate residual emissions is unavoidable if net-zero emissions are to be achieved."[95] That's why we're supporting the development and commercialization of emerging carbon removal technologies, as well as the development of initiatives to ensure the integrity and climate impact of CDR solutions.

Starting in 2022, we began funding the development of nature-based and technology-based carbon removal solutions. At the World Economic Forum Annual Meeting in 2022, Google joined the **First Movers Coalition**. As a champion for the Carbon Dioxide Removal sector, Google committed to contract for durable and scalable net carbon dioxide removal to be achieved by the end of 2030.

In 2022, we contributed $200 million towards a $925 million total pledge to **Frontier**, an advanced market commitment that's accelerating the development of carbon removal technologies by guaranteeing future demand. As a founding member of Frontier, we're signing our first offtake deals in 2023, with removals expected to be delivered starting in 2024. Already, Frontier has announced its first deal, a partnership with the start-up Charm Industrial to remove 112,000 tons of CO_2 between 2024 and 2030.

Strengthening carbon markets

While CDR technologies are being proven and scaled over the short to medium term, we believe that carbon credits can play a valuable role in keeping the world on track for a 1.5ºC future. Since 2007, we've supported the capture and destruction of highly potent greenhouse gasses through the procurement of high-quality carbon credits.

Google and clean-energy startup Fervo signed the world's first corporate agreement to develop a next-generation geothermal power project.

Since we began procuring high-quality carbon credits, we've learned a lot from our experience—including the importance of developing and following guiding principles related to credit quality, implementing robust validation processes, and establishing long-term partnerships with project owners and developers. We're now working to help strengthen carbon credit markets through engagement with other companies and stakeholders in the scientific, academic, and NGO communities. We're partnering on improving measurement, reporting, and verification and developing tools to support robust, well-functioning markets. For example, Google.org has contributed more than $6 million to efforts to strengthen carbon markets, digitize their infrastructure, and set standards for high-quality carbon credits.

As we move forward on our path to net-zero emissions, we'll continue to evolve our approach to counterbalancing our residual emissions.

El Romero solar farm in Chile (80 MW for Google)

The journey ahead

As we move forward on our journey to reduce our emissions, we'll continue to focus both on our own footprint and on the larger systems that serve us—from electricity grids to transportation networks to materials supply chains.

We've made great progress in procuring clean energy, but we still have a long way to go to meet our 2030 net-zero target. We recognize we'll face many challenges along the way, for example:

- Meeting our growing energy needs
- Availability of carbon-free energy
- Cost and limited volumes of carbon removals

For more details, see the Challenges to address section above.

We also know we can't get there alone. To scale our work, we've created tools, white papers, and case studies to help others adopt some of the approaches that have worked for us.

- The CFE manager: A new model for driving decarbonization impact
- Time-based energy attribute certificates

The clean energy transition also requires strong actions from governments, and we call for ambitious public policies aimed at decarbonizing electricity grids worldwide.

- Policy recommendations to accelerate carbon-free energy

Ultimately, achieving a carbon-free future for all requires rapid and far-reaching transformations to these systems, and as we grow our efforts towards net-zero emissions for our own footprint, we'll prioritize actions where we can make unique contributions and maximize our impact on larger systems change.

LEARN MORE

- Accelerating climate action at Google and beyond: A progress update
- 24/7 carbon-free energy: Methodologies and metrics

Water stewardship

We aim to replenish more water than we consume and help improve water quality and ecosystem health in the communities where we operate

Our ambition

Our approach

Advancing responsible water use

Benefiting watersheds and communities

Supporting water security with technology

The journey ahead

Our ambition

The world is facing an unprecedented water crisis, with global freshwater demand predicted to exceed supply by 40% by 2030.[96] Climate change has exacerbated water stress, causing destabilizing droughts and unpredictable flooding around the world.

In 2021, we announced our commitment to water stewardship: we aim to replenish 120% of the freshwater[97] volume we consume, on average, across our offices and data centers by 2030, and help restore and improve the quality of water and health of ecosystems in the communities where we operate. This ambition is bold, particularly when considering both the growth of our business and the challenges and complexities of global water stewardship work. Understanding the most impactful intervention requires local context, and water replenishment is still a maturing field with some limitations to identifying ready-to-implement project opportunities.

We're working to achieve this replenishment target through continued and scaled investments in projects that are located within the watersheds we rely on to provide water to our data centers and offices. We work with external partners to implement these projects, which deliver both volumetric water benefits and improve other locally relevant aspects of watershed health, such as water quality, community water access, and biodiversity.

Our approach

At Google, we use water to help cool our data centers, and in our offices around the world. Water is also used throughout our value chain, in the manufacturing of both consumer hardware products and data center equipment.

We work to drive water efficiency and reuse across our global operations, from reducing our potable water use intensity at our San Francisco Bay Area headquarters to using seawater for cooling at our data center in Hamina, Finland.

Our **water stewardship strategy** is centered on assessing and addressing water-related risks to our business and the opportunities we have to not just mitigate those risks, but also create solutions that can be scaled beyond our own corporate footprint. We also strive to partner with others to address this shared challenge.

When it comes to addressing shared water challenges, technology can be a useful tool to bring visibility to these challenges to enable smarter, more informed decision-making. We're building tools to make water data and technology universally accessible, enabling effective water stewardship and improving the resilience of watersheds and ecosystems.

Advancing responsible water use

We're committed to advancing and enhancing our water management practices across our operational footprint at Google's offices and data centers around the world. We continue to collaborate, test, and share our learnings on responsible water use. This includes accelerating water reuse practices across our offices and data centers, and tailoring **site-specific solutions** based on facility types, locations, and local water contexts.

In 2022, total water consumption at our data centers and offices was 5.6 billion gallons—the equivalent of what it takes to irrigate 37 golf courses annually, on average, in the southwestern United States.[98] Wherever feasible, we try to use non-potable sources of freshwater and alternatives to freshwater.

As part of our commitment to using water responsibly, we evaluate and take into account local water stress when deciding where to locate our facilities, how to design them, and how to operate them—from water systems in our offices to cooling systems in our data centers. That's why, in 2022, **82%** of our freshwater withdrawals came from regions with low water stress.[99] In locations facing water stress, we're actively exploring new partnerships and opportunities to improve overall watershed health and resilience. By working to replenish more than we consume, we're striving to help address the water scarcity gap.

FIGURE 19

Our water stewardship focus areas

Advance responsible water use

Enhance our stewardship of water resources across Google office campuses and data centers

Benefit watersheds and communities

Collaborate to replenish our freshwater consumption and improve watershed health while supporting ecosystems and water-stressed communities

Support water security with technology

Share technology and tools that enable everyone to predict, prevent, and recover from water stress

These colorful pipes in our Douglas County, Georgia data center send and receive water for cooling our facility.

Data centers

To minimize the net-climate impact at each of our data center campuses, both today and in the future, we consult with local experts and make regionally appropriate cooling technology decisions that balance the availability of carbon-free energy and responsibly sourced water.

In many places, water is the most efficient means of cooling. When used responsibly, water cooling can play an important role in reducing emissions. We've found that our water-cooled data centers use about 10% less energy and emit roughly 10% less carbon emissions than our air-cooled data centers.[100]

At our data centers, we aim to implement technologies and solutions that reduce freshwater consumption when feasible, and use alternative sources such as reclaimed wastewater and even seawater. We withdraw reclaimed or non-potable water at 25% of our data center campuses. Due to these solutions, 23% of our total data center water withdrawal (excluding seawater) is reclaimed wastewater and other non-potable water. For example, at our data center in Douglas County, Georgia, we redirect local sewer water that would otherwise be discharged in the Chattahoochee River and use it to cool our facility. Additionally, our data center in Hamina, Finland, uses seawater for cooling rather than withdrawing freshwater. Additionally, at our data center in Eemshaven, the Netherlands, we partnered with the community to bring in industrial canal water to cool our data center, leaving potable water for other uses.

In 2022, we described our **climate-conscious data center cooling strategy**, in which we both championed responsible water use and explained how this work complements our efforts to run on 24/7 CFE on every grid where we operate by 2030. In this blog, we published our 2021 annual water metrics for our U.S. data center locations, and committed to sharing annual water metrics for additional global locations beginning with this report. See our Environmental data tables for our 2022 water data—disclosed both globally and by data center location.

Offices

Around the world, our offices use water for a variety of needs including preparing food, cleaning and hygiene, irrigating campus landscapes, and keeping our workspaces cool. We take a variety of approaches to manage water responsibly and drive responsible water use in our real estate operations through increased efficiency and by sourcing water from non-potable supplies.

One of the main ways we conserve water in Google workplaces is by adopting **design standards** aligned with leading third-party certifications, including LEED and the LBC. Our building design requirements for new construction include the incorporation of water-efficient fixtures, such as faucets, toilets, and irrigation systems. These design standards also address replacing old fixtures with highly efficient ones in any space we move into, and installing water meters with automatic leak detection. In multiple offices around the world, we've achieved Alliance for Water Stewardship certification, a leading third-party standard that helps us develop best-in-class, regional strategies for responsible water use, and to engage with local partners on watershed health projects.

Beyond these standards, we drive water stewardship in our workplaces by **developing innovative solutions** that strive to be replicable and scalable. For example, our new Bay View campus, which opened in 2022, is on track to be the largest development project in the world to achieve Water Petal certification from the LBC, with an on-site stormwater and wastewater treatment system that can serve as a model for others. Learn more in our Bay View spotlight.

Supply chain

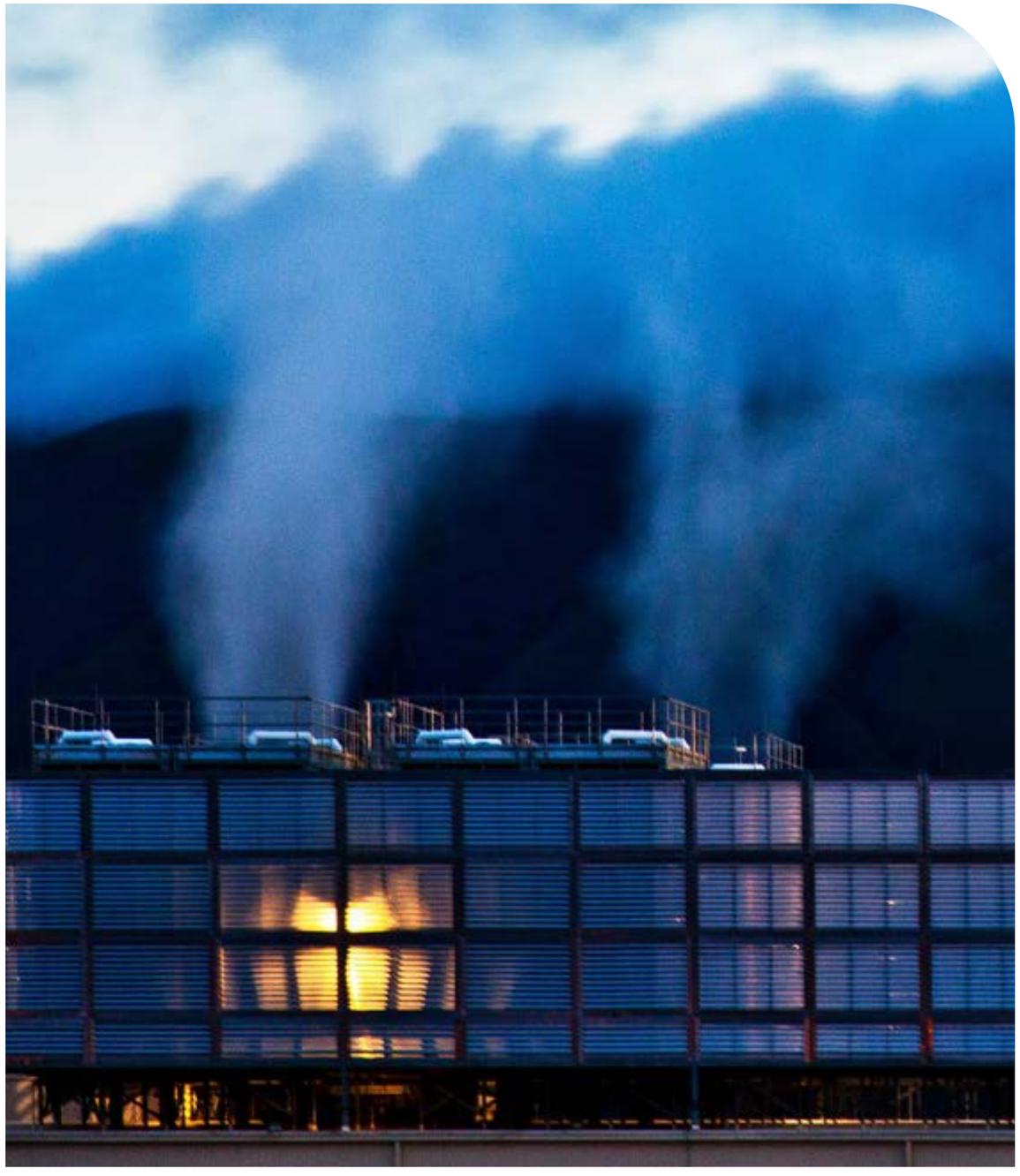
Addressing water challenges requires accurate water use data throughout our supply chain. By monitoring this data, we can focus our water stewardship efforts on supplier facilities with the greatest opportunities for improved management. To measure water use and assess water risk in our value chain, we ask suppliers to **disclose water-related data** via the CDP supply chain platform and complete and disclose water risk assessments of their direct operations and value chain.

In 2022, 177 of the 186 suppliers (95%) that were invited to participate in the Water Security portion of the CDP Supply Chain survey responded. This reporting includes data on water withdrawal, consumption, and discharge—all water withdrawn from all sources (e.g., surface water, groundwater, rainwater, municipal water supply, and trucked water), the portion of water permanently lost in the withdrawal (e.g., evaporated or incorporated into products from cooling, irrigation, and production processes), and the water effluents discharged to all locations (e.g., subsurface and surface waters, sewers, and groundwater).

To learn more about how we assess and manage our water-related risks, see the Governance and engagement section.

2022 HIGHLIGHT

As of the end of 2022, we estimate our 38 replenishment projects had the capacity to replenish over 1.3 billion gallons of water annually once fully implemented. [101]



Steam rises above the cooling towers at our data center in The Dalles, Oregon.

Benefiting watersheds and communities

Many watersheds around the world are degrading in health, with each location facing unique challenges. Improving watershed and ecosystem health is a critical part of our strategy, which allows us to focus on solutions to shared water challenges that are impacting watersheds the most, whether they're related to water quantity and availability, water quality, ecosystem and habitat degradation, loss of biodiversity, or community access to water.

In addition to focusing on responsible water use within our operations, we aim to **replenish 20% more freshwater** than we consume each year, on a global average basis. We'll focus our replenishment efforts in watersheds that Google offices and data centers rely on. The additional volume of water we replenish at each location will vary depending on the local conditions, and we'll prioritize replenishment projects in water-scarce regions to help ensure that we're positively impacting the areas that need it most.

As of the end of 2022, the first full year since we launched this strategy and target, our contracted watershed projects have replenished 271 million gallons of water[102]—equivalent to more than 400 Olympic-sized swimming pools. This represents 6% of our 2022 freshwater consumption. As of the end of 2022, we estimate that these 38 replenishment projects had the capacity to replenish over 1.3 billion gallons of water annually once fully implemented.

Water replenishment projects

In support of our water stewardship strategy, we've made progress in helping to restore and improve the quality of water and health of ecosystems in the watersheds we rely on. We've intentionally designed our strategy to prioritize a range of watershed health issues, enabling us to invest in a diverse set of impactful watershed health projects that are appropriate for each local context.

We conduct regular water risk assessments of our global assets to identify priority basins. Within each priority basin, we assess local water context and shared water challenges through data analysis and engaging with local partners and stakeholders.

As of the end of 2022, we've supported **38 water stewardship projects** in 26 watersheds (see Figure 20). In 2022 alone, we added 25 projects to our portfolio.

This marked a strong first year of implementation of our water replenishment strategy, and while we still have a long way to go to meet our 2030 target, we're proud of the impactful partnerships that we've already engaged in around the world. We're excited to continue working alongside our existing partners and to find new partners in water-stressed geographies where we'll work over the next few years.

TARGET

Replenish 120% of the freshwater volume we consume, on average, across our offices and data centers by 2030

2022 PROGRESS

As of the end of 2022, our contracted watershed projects have replenished 271 million gallons of water, or **6%** of our 2022 freshwater consumption

DETAILS

Year set: 2021 | Base year: N/A | Target year: 2030

Scope: Freshwater replenished annually (excluding seawater and reclaimed wastewater), as a percentage of the amount of freshwater we consume each year at our offices and data centers. Replenishment benefits are counted from projects that are active within the watersheds that our operations rely on and that have confirmed volumetric benefits from the reporting year.

A rainwater retention pond outside our data center in Berkeley County, South Carolina.

FIGURE 20

Global water replenishment project map

This map shows all 38 water stewardship projects we've supported as of the end of 2022, with highlights of specific projects and partnerships:

CALIFORNIA

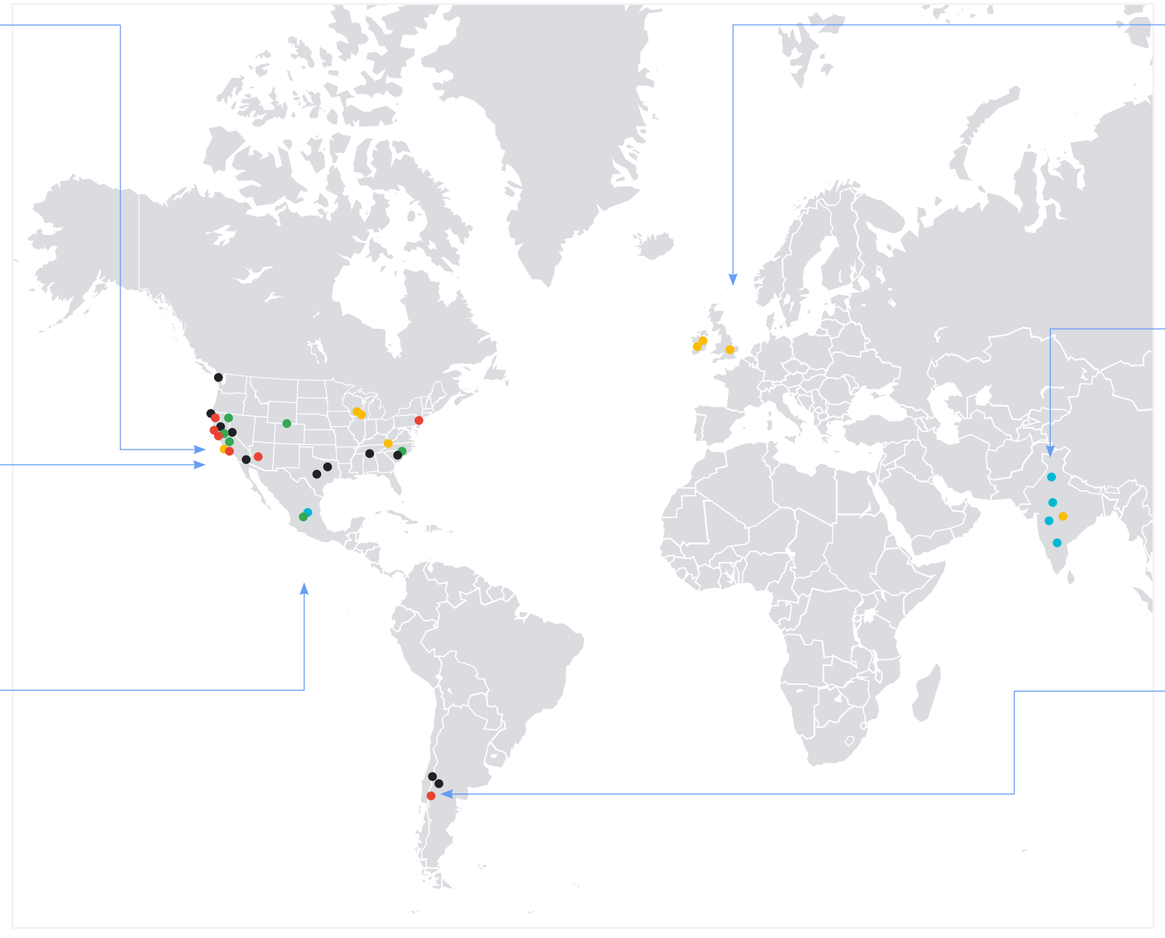
We recently co-funded a pilot project to **install water-saving technology** in three multi-family buildings in Los Angeles. The technology takes aim at behind-the-scenes leaks, like malfunctioning toilets, that are capable of leaking thousands of gallons of water in a single day. The pilot is on track to save a total of 6.4 million gallons of water a year in the L.A. watershed where we operate. We're also funding work to bring this approach to parts of San Francisco and New York City.

ARIZONA

Surface water diversions from the Colorado River make up the primary source of irrigation water supply for the Colorado River Indian Tribes (CRIT) reservation and CRIT farms. We're working with the Bonneville Environmental Foundation to fund the CRIT to **support irrigation infrastructure efficiency** by lining a leaky earthen irrigation canal—reducing seepage loss and water diversion demands in the Colorado River watershed.

MEXICO

In Mexico City, Google partnered with Isla Urbana to provide households that don't currently have reliable potable water connections to their homes with a source of easily accessible potable water via **rainwater harvesting** and **potabilization systems**. We also partnered with Pronatura to support a comprehensive watershed study along with the implementation of multiple **water management practices**, including reforestation, the creation of a percolation pond to increase groundwater infiltration, and restoration activities to improve soil health.



UNITED KINGDOM

We partnered with the Bonneville Environmental Foundation to fund Thames21 to support the creation of a **system** of wetlands that will intercept and filter water at Chinbrook Meadows park before it enters the River Quaggy and the greater Thames River watershed, improving water quality with the added benefits of flood protection, climate adaptation, and recreation opportunities.

INDIA

We're working with United Way of Hyderabad to **restore the Mullakathuva Lake** in northwest Hyderabad, with CLEAN International to **reopen 20 wells** across three cities, and with WaterAid to **provide water, sanitation, and hygiene access** to nearly 9,000 local residents in Hyderabad communities. These projects not only support our replenishment and water security goals, they also help strengthen public health in the communities that make up an important part of our global workforce.

CHILE

Google partnered with the Bonneville Environmental Foundation on two initiatives to improve watershed health in Chile's Maipo Basin. We provided funding to our implementation partner, Kilimo, to **scale up precision irrigation using AI** to support increased agricultural productivity, maintain or improve natural pest control, protect groundwater and surface water resources, and reduce water demand across 260 hectares of farmland. Google also supported The Nature Conservancy's efforts to **monitor, protect, and improve the management of the High Andean wetlands**, which offer many climate and water resilience benefits, as well as advocate for its large-scale protection.

Legend

- Land conservation and restoration (7 projects)
- Water supply reliability (7 projects)
- Water, sanitation, and hygiene (WASH) (5 projects)
- Aquatic habitat restoration (11 projects)
- Water quality (8 projects)

Supporting water security with technology

Supporting global water security needs collective action. Global search interest in "water security" more than doubled in 2022,[103] reaching a 15-year high in 2022.[104] That's why we're putting Google's products and technology in service of helping others study and respond to water security challenges. We work on getting environmental information on the world's forests, fisheries, watersheds, and air into the hands of decision-makers, in support of our aims to both address a key need for informed decision-making, and to support efforts to scale models and solutions that make water resource information visible and actionable.

Google.org has also awarded millions of dollars in grants to promising water stewardship solutions, including:

- **BlueConduit**, to develop publicly accessible tools to quantify and map hazardous lead service lines for vulnerable communities, a critical first step to replacing unsafe water infrastructure.
- **Global Water Watch**, which aims to democratize information on water resources. This information will empower policymakers, conservation organizations, and communities to better manage water resources collectively.
- **American University of Beirut**, to apply machine learning to weather and agricultural data to improve irrigation for resource-strapped farmers in Africa and the Middle East, providing farmers with near-real-time water use data predictions to conserve the region's dwindling water resources.

Additional details can be found in the Empowering individuals and Working together sections.

The journey ahead

While we have a history of responsible water use, 2022 marks our first full year of operationalizing our strategy and our water replenishment target. We've deployed innovative solutions to responsibly manage our water footprint, developed internal data infrastructure and governance models for our replenishment efforts with internal operational teams, and identified new, impactful organizations to partner with in specific watersheds.

While we still have a long way to go to meet our 2030 target, we're proud of our progress this year—replenishing 6% of our 2022 freshwater consumption. We know challenges lie ahead, including:

- Navigating the local complexities of watershed health.
- The limited supply of replenishment projects in many geographies.

To scale impact, we've created tools and case studies to help others adopt some of the approaches that have worked for us, from data center cooling strategies to achieving LBC Water Petal certification.

- Climate-conscious data center cooling
- How to achieve LBC Water Petal certification

We're excited about the future of our water stewardship efforts and the impact we'll have within our own operations, in the communities where we operate, and for everyonewho relies on clean, fresh water.

LEARN MORE

- Google water stewardship: Accelerating positive change at Google, and beyond
- 3 ways we're tackling water challenges in India
- Saving water in L.A., one leaky toilet at a time

Cooling towers at our data center in St. Ghislain, Belgium.

Circular economy

We aim to maximize the reuse of finite resources across our operations, products, and supply chains

Our ambition

Our approach

Reducing data center waste

Building circular workplaces and stores

Designing more sustainable consumer hardware products

Working with suppliers

Enabling others

The journey ahead

Our ambition

Humans are consuming natural resources and generating waste at alarming rates. We need 1.75 Earths to sustain our current rate of natural resource consumption, but we only have one planet.[105] The circular economy aims to minimize waste and maximize reuse of existing materials. An important component of this is promoting safer materials for human and environmental health, to maximize their reuse potential. The circular economy offers a tremendous opportunity for new business and innovation, capable of generating an estimated $4.5 trillion in new economic output by 2030.[106]

The world can't achieve net-zero carbon emissions without accelerating the circular economy. Roughly 45% of global GHGs come from embodied carbon emissions, generated from creating new goods and infrastructure.[107] We can reduce up to 10 GT of carbon by 2050 through circular strategies, such as using recycled materials and low-carbon building approaches.[108]

To support the transition to a circular economy, we aim to become a **circular Google**—maximizing the reuse of finite resources across our operations, products, and supply chains and enabling others to do the same.

Our approach

Our impact on the circular economy cuts across all our core business operations. It includes the data centers we build and operate to power our products, the workplaces where Googlers come together to create the next breakthrough technology, and the consumer hardware products that people use every day. Our impact also spans the entire value chain, including **data centers**, **workplaces and stores**, **products**, and our **suppliers**, and we've set goals to measure our progress in each area.

Our circularity principles focus on designing out waste from the start, keeping materials in use for as long as possible, and promoting healthy materials—for our data centers, workplaces, and products (see Figure 21).

FIGURE 21

Our circularity principles

We design out waste and pollution

We design for circularity from the start, making it easier for the materials used in the creation of our products, workplaces, and data centers to be reused in the future

We keep materials in use as long as safely possible

We pursue strategies to extend the life of our products, workplaces, and data centers for as long as safely possible to maximize the use of materials that went into their creation

We promote safe and healthy materials

We design products, workplaces, and data centers with healthy materials that are safe for people and for the environment, enabling them to be safely reused in the future

A Google Nest Audio is disassembled.

Reducing data center waste

Storage at Google's Singapore data center.

TARGET

Achieve Zero Waste to Landfill for our global data center operations

2022 PROGRESS

38% of Google-owned and -operated data centers have achieved Zero Waste to Landfill

DETAILS

Year set: 2016 | Base year: N/A | Target year: N/A

Scope: Annual operational waste for all Google-owned and -operated data centers globally.

"Zero Waste to Landfill" means that more than 90% of waste is diverted from landfill. When possible, we strive to align measurement of waste diversion at our data centers with the UL Environment Standard 2799 Environmental Claim Validation Procedure for Zero Waste to Landfill.

Zero waste to landfill

In 2016, we announced our aim to achieve Zero Waste to Landfill for our global data center operations. As of the end of 2022, 10 out of 26 (38%) Google-owned and -operated data centers have met this Zero Waste to Landfill target (see Figure 22). For example, our data center in Fredericia, Denmark, achieved Zero Waste to Landfill from day one. Our data center waste footprint increases as we increase the number of our data centers, so we continue working towards our target as we grow. In 2022, across our global fleet of Google-owned and -operated data center operations, we diverted 86% of operational waste away from landfills.

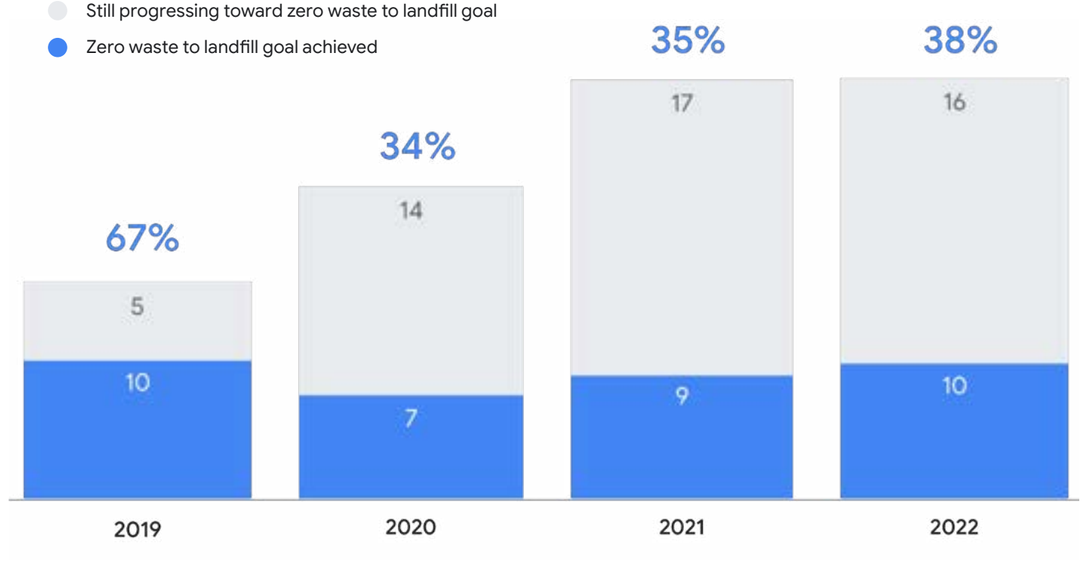
Beyond these goals for landfill waste, our approach to circularity for data center equipment is to maintain servers for as long as possible, refurbish components for future reuse, reuse or resell components following a rigorous security process, and recycle any components that can't be reused.

Since 2015, we've resold more than **37 million hardware components** from our data centers into the secondary market for reuse by other organizations, including nearly 5 million resold components in 2022 alone. As of the end of 2022, **21% of components** used for server deployment, maintenance, and upgrades were refurbished inventory.

Looking forward, we continue to face challenges for waste diversion at a local level due to the lack of availability of recycling infrastructure in some of the rural communities where we operate and inconsistencies in what's accepted for recycling.

FIGURE 22

Data centers achieving zero waste to landfill



Building circular workplaces and stores

Building design and construction is one of the largest sources of global waste—roughly 30% of all global annual waste comes from building construction and demolition.[109] When we design and build Google workplaces and stores around the world, we strive to deliver on our commitment to accelerating the circular economy.

When the right opportunity comes up, we pursue adaptive reuse projects, renovating existing buildings to serve a new purpose rather than demolishing them for new builds. These reuse projects tend to use fewer materials, produce less construction waste, and have lower embodied carbon. They also preserve community history, giving historic structures new life as Google workplaces and, in some cases, community spaces, too.

Some examples include our **Playa Vista**, **California**, office—a repurposed 1943 airplane hangar, and our **Pier 57 office** in New York City—a historic cruise terminal and transit depot that sat vacant for 20 years before Google reimagined it into an office and community space.

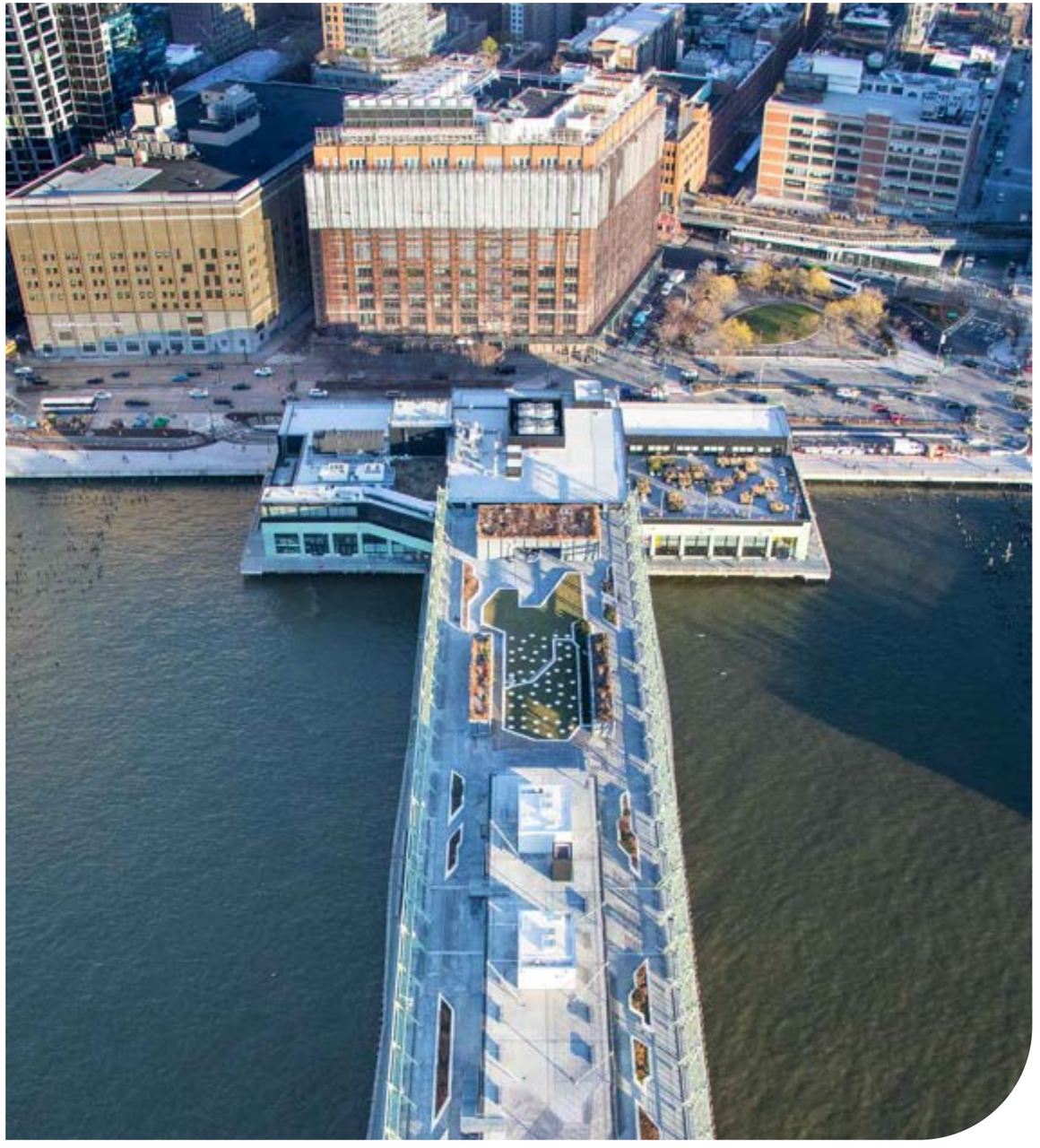
We also consider adaptive reuse for our data centers, such as for our data center in Hamina, Finland, which was formerly an abandoned paper mill.

Circular design and construction

To make our workplaces more circular, we design adaptable spaces that can be adjusted over time using fewer renovation materials, we incorporate reuse and material salvage practices, and we provide a rigorous model for healthy materials that can be adopted by others. For example, our **Bay View** and **Charleston East** campuses both incorporate salvaged materials into the building design, and both aim to reduce future renovation waste through highly flexible and reconfigurable work areas.

For more than a decade, we've prioritized building materials that demonstrate safer chemistry to create healthy indoor environments and advance our circularity goals. One way we promote healthy materials is by leveraging third-party standards like the LBC, one of the most ambitious green building certifications in the world. Our focus on transparency aims to encourage stronger standards in the building industry at large, paving the way for others to purchase healthier materials.

We recently opened or advanced several workplace and store projects that reflect these core principles of circular design and construction (see Figure 23). Our Bay View campus—opened in 2022—also incorporates our circularity principles of designing out waste from the start, keeping materials in use for as long as possible, and promoting healthy materials. Learn more in our Bay View spotlight.



Pier 57, which served as a historic cruise terminal and transit depot, sat vacant for 20 years before Google reimagined it into an office and community space.

FIGURE 23

Examples of circular design and construction at our workplaces and stores

237 Moffett Park Drive
in Sunnyvale, California, U.S.A.

Our newest addition to Google's Sunnyvale campus—237 Moffett Park Drive—is the world's largest LBC Materials Petal Certified Renovation Typology project. The existing building was transformed into a workplace that embodies regenerative design and promotes well-being. Materials were given a second chance throughout the building—from still-functioning components of the original mechanical systems to roughly 300 interior doors made with veneer from oak trees salvaged from recent California wildfires. In total, nearly 3,400 tons of waste (or 91% of total waste generated) was diverted from landfill during its construction.

Charleston East
in Mountain View, California, U.S.A.

In 2022, we advanced construction for our Charleston East campus, with the goal of expanding the boundaries of sustainable design, including around healthy and reclaimed materials. Charleston East is on track to achieve LEED-NC v4 Platinum certification and be one of the largest new construction projects ever to attain the LBC Materials Petal Certification, which helps ensure the health of the building occupants, the local community, and the broader supply chain. Using the LBC Red List as a framework, thousands of materials on the project went through a rigorous sourcing and review process. The design of Charleston East also incorporates salvaged materials and Forest Stewardship Council (FSC)-certified wood products.

Google store
in Chelsea, New York, U.S.A.

In 2021, we opened our first flagship retail store in New York City's Chelsea neighborhood, which achieved LEED-ID+C Retail v4 Platinum status. Every element of the Google Store—the materials, building processes, mechanical systems and more—was painstakingly considered and selected. For example, the veneer on the walls is a soft gray, responsibly-sourced hickory, and our custom cork and wood furniture was created with a local craftsman from Greenpoint, Brooklyn. We even attached our carpeting (which was manufactured with recycled materials) in a sustainable way. In 2022, we opened our second retail location in Brooklyn, New York, which also earned a LEED-ID+C Retail v4 Platinum rating.

Bolands Mills
in Dublin, Ireland

Our Bolands Mills office is the reincarnation of a 150-year-old flour mill, repurposed as a workspace for Googlers. There are plans for a public ground-floor food market that will reforge visitors' connection to food. With Bolands Mills, we have the opportunity to preserve an iconic heritage site while creating a place that will support Google and the neighborhood for years to come.

Workplace Operations

We take a holistic approach to circularity in our offices, starting with designing buildings for zero-waste operations. Not only do we strive to divert solid waste from landfills and incinerators for office operations, but we also aim to minimize the amount of materials we use and maximize their lifespan within our ecosystem and the surrounding community. We have ambitious targets for food loss and waste, and we're working to reduce single-use plastics in our operations.

In 2022, the global landfill diversion rate for our offices was **75%**. To ensure that what we keep out of landfills can actually be recovered, we prioritize diverting high-quality materials and only count non-contaminated recyclable material.[110]

Food waste

Global searches for "how to reduce food waste" have more than doubled over the most recent five-year period compared to the previous five-year period,[111] reaching a 15-year high in 2022.[112] When food waste ends up rotting in landfills, it generates methane—a greenhouse gas that's 25 times more potent than carbon dioxide.[113]

What's more, when food goes to waste, so do all of the water, energy, and other resources that went into producing it.

To achieve a low-carbon circular economy, we need to collectively cut back on food waste. At Google, that means doubling down on our efforts to reduce waste in our kitchens, cafes, and overall food operations.

Our goal

In 2022, we announced our food waste goal: by 2025, we aim to send zero food waste to the landfill. Towards this goal, we aim to cut food waste in half for each Googler, compared to a 2019 baseline.

We're on track to cut food waste in half for each Googler and send zero food waste to the landfill by 2025. In 2022, we diverted 85% of food waste from landfill, and and we've reduced food waste per Googler by 18% since 2019.[114] We're seeing progress across all operations in all regions, across different types of cafes, and by using different intervention levers to spark necessary behavior and operational change.

From 2014 through 2021, we prevented nearly 10 million pounds of food from entering landfills.

Our focus areas

To further reduce food waste, we're strengthening our efforts in three key areas across our food program:

- In our **kitchen and cafe operations**, we're preventing waste from the moment we receive ingredients all the way through to serving a finished dish.
- At the **sourcing and procurement** stage, we're working with our suppliers, distributors, and vendors to prevent waste before it happens.
- When there's **excess food**—whether as prepared dishes or plate waste—we're ensuring it's donated or properly composted.

TARGET

Divert all food waste from landfill by 2025

2022 PROGRESS

85% of food waste diverted from landfill

DETAILS

Year set: 2022 | Base year: N/A | Target year: 2025

Scope: Annual food waste diverted from landfill in kitchens and cafes at Google's offices globally. "Zero food waste to landfill" is defined as 99% diversion of food waste from landfill via composting, anaerobic digestion, or other on-site processing.

In our kitchen and cafe operations, we're focused on ways to stop food waste before it starts.

Kitchen and cafe operations

We're making measurable reductions across back-of-house operations through improved culinary practices and demand planning to ensure our production levels are consistent with user dining patterns.

For example, in the United States, we recorded a 22%–30% reduction in egg waste by cooking smaller batches, and in India we recorded a 50% reduction in per-plate waste following a multi-channel waste reduction campaign.

Sourcing and procurement and excess food

Additional progress will rely heavily on continued engagement of our vendor partner operations teams, further enabling Googlers to join in, and expanding partnerships with municipal and community organizations to accelerate the pace of food donations and develop compost infrastructure.

In 2022, to activate industry-wide change, Google provided $1 million in anchor funding to kickstart the ReFED Catalytic Grant Fund. The ReFED Catalytic Grant Fund provides nonprofit and for-profit organizations with recoverable and non-recoverable grants to de-risk and scale high-impact solutions to food waste.

Single-use plastics

The world's plastic pollution problem is a large and complex challenge—more than 91% of plastic isn't recycled, and the majority is left sitting in landfills or littering our oceans and communities.[115] Reducing plastic waste requires entire industries to come together and take more meaningful action. At Google, that means rethinking our approach to the way we source products, serve food, and reduce our waste.

Improving our plastics footprint isn't as simple as not buying single-use plastics. To reduce single-use plastics (upstream) and bridge the infrastructure gaps for recycling and composting (downstream), we need to activate the entire food ecosystem, from manufacturers to distributors to waste management companies.

We do this by working with vendors and suppliers to avoid or phase out products with single-use plastics; rethinking how we handle, store, prepare, and serve food and beverages; and using fully recoverable materials that are recyclable or compostable.

We're piloting and scaling **plastic-free processes** and products in our kitchens, cafes, and overall food operations. For example, we're installing beverage dispensers to replace single-use beverages. We're redefining what we serve—and how we serve it—to eliminate single-use plastics and ensure durable, washable dishware and cutlery are easy to choose.

Looking to the future, we're also planning to create food spaces that design out waste from the start.

Designing more sustainable consumer hardware products

Our ambition is to create consumer hardware products that leave people, the planet, and our communities better than we found them. Our **consumer hardware products** include Pixel, Nest, Chromecast, and Fitbit devices.

Since launching our first hardware products, we've integrated sustainability considerations into materials sourcing and science, engineering and supply chain operations, carbon emissions reductions, waste reduction, packaging products, and designing our retail stores.

We aim to increase the circularity of our hardware products and operations by decreasing our use of mined materials and signaling our demand for a more circular economy in our procurement of recycled materials. This is in addition to extending the life of our products through software updates and expanded repair options.

We support greener electronics standards and certifications, including UL 110, IEEE 1680.1, and the UL ECOLOGO Program.[116]

The aluminum in the phone enclosures of Pixel 5, 6, 6 Pro, 7, and 7 Pro is made with 100% recycled content, reducing the carbon footprint of the aluminum portion of the enclosures by over 35% compared to 100% primary aluminum.[117]

Recycled materials

Reducing how much waste we generate as a company and minimizing the demand for new raw materials starts with how we source materials that go into our products.

In 2019, we announced our aim to include recycled materials in 100% of Google consumer hardware products launching in 2022 and every year after.[118] We hit our goal early—in 2020—and have maintained it each year since for Nest, Pixel, and Chromecast devices.[119] In 2020, we shared our next steps on this journey.

We committed to use recycled or renewable material in at least 50% of **plastic** used across our consumer hardware product portfolio by 2025, prioritizing recycled plastic everywhere we can. 41% of the plastic Google used in products manufactured in 2022 was recycled content.[120]

Approximately 30% of the material Google used in its new products launched and manufactured in 2022 was recycled content.[121] This includes recycled material used in our devices' **aluminum**, **stainless steel**, **rare-earth magnet**, **glass**, and **plastic** parts.

2022 HIGHLIGHT

The aluminum in the phone enclosures of Pixel 5, 6, 6 Pro, 7, and 7 Pro is made with 100% recycled content, reducing the carbon footprint of the aluminum portion of the enclosures by over 35% compared to 100% primary aluminum.[122]

Using recycled materials can also lower the carbon footprint of our product manufacturing. For example, the **aluminum** in the phone enclosures of Pixel 5, 6, 6 Pro, 7, and 7 Pro is made with 100% recycled content, reducing the carbon footprint of the aluminum portion of the enclosures by over 35% compared to 100% primary aluminum.[123] For more information on recycled material content for each of our products, see our **Product Environmental Reports**.

While many waste materials can technically be recycled, whether or not they're actually recycled depends on market demand. This is why we've strategically prioritized sourcing recycled materials for our products, in hopes that increased demand will help maximize the utility of materials we already use.

TARGET

Use recycled or renewable material in at least 50% of plastic used across our consumer hardware product portfolio by 2025

2022 PROGRESS

41% of the plastic used in products manufactured in 2022 was recycled content[124]

DETAILS

Year set: 2020 | Base year: N/A | Target year: 2025

Scope: Includes the minimum percentage of recycled or renewable plastic content calculated as a percentage of total plastic (by weight) in Google's consumer hardware portfolio for products manufactured in a given year.[125]

Since the launch of our first hardware products, we've worked to improve the sustainability of how we make our products and the services we create around them.

Sustainable packaging

Product packaging typically contains many materials—like the plastic film materials you often see on electronic packages—which can be difficult to recycle.

That's why we're committed to eliminating plastic from our hardware product packaging by 2025. By focusing on **fiber-based materials**, we're enabling consumers to more easily recycle our packaging and ensure that the materials will be accepted in as many recycling systems as possible.

We design Nest, Pixel, and Fitbit packaging to minimize the use of plastic. For new Google products launched and manufactured in 2022, our packaging was at least 96% plastic-free,[126] and packaging for Pixel 7 and 7 Pro uses 99% plastic-free materials,[127] getting us closer to this goal. For more information on packaging for each of our products, see our **Product Environmental Reports**.

2022 HIGHLIGHT

Packaging for Pixel 7 and 7 Pro uses 99% plastic-free materials.[128]

Transitioning packaging away from plastic is challenging because many plastic-free alternatives are often not available for specific packaging needs. We'll continue to work with suppliers to create plastic-free solutions that provide durability, protection, and aesthetics.

TARGET

Make product packaging 100% plastic-free by 2025

2022 PROGRESS

For new Google products launched and manufactured in 2022, our packaging was at least **96%** plastic-free[129]

DETAILS

Year set: 2020 | Base year: N/A | Target year: 2025

Scope: Based on the total weight of new Google Pixel, Nest, Chromecast, and Fitbit retail packaging globally (excluding adhesive materials) for products launched and manufactured in a given year, as shipped by Google.

A Sorta Sunny color Pixel 6 Pro lies face-down on a table next to a variety of spare parts and iFixit-branded repair tools. (Photo courtesy Andy Miller of iFixit)

Product longevity

Creating truly sustainable electronics includes crafting experiences that guide consumers through the care, repair, reuse, and recycling of their products. While there's much more work to do, we've taken some initial steps in understanding consumers' and organizations' needs and creating new services for them.

It all starts with making sure products last long to begin with. Enabling security updates and bug fixes helps promote product longevity. For Google Nest, we issue critical bug fixes and patches for at least five years after launch. Pixel 6 and later Pixel phones will get security updates for five years from when they first become available on the Google Store in the United States.[130] And new Chromebooks are built with sustainability in mind, with automatic updates for up to eight years that keep them running fast and secure.

Repairing electronics

Providing new ways to repair electronics is an important way to extend their lives. In 2022, we announced our partnership with iFixit to provide genuine Pixel spare parts, tools, and documentation on models as far back as Pixel 2 for users who are skilled in repair and independent service providers. This partnership, alongside our other mail-in

and authorized service provider repair channels, lowers costs and expands the choices customers have in Pixel phone repair. In tandem with our **trade-in program**, this extends the usable life of Pixel phones.

In 2022, we announced **ChromeOS Flex** and the **Chromebook repair program**, which aim to extend the useful life of laptops, PCs, and Chromebooks alike. ChromeOS Flex helps extend the life of aging Macs, PCs, and Linux devices by converting them to the ChromeOS ecosystem and reducing the amount of e-waste that's generated. In addition to providing up to eight years of software updates for Chromebooks, schools can easily identify which Chromebooks have commonly repaired components—like the keyboard, display, and palmrest—through our new repair program site. This is just the first step, and we're looking forward to hearing feedback to help grow and improve the program.

We partner with device manufacturers (OEMs) to help increase the number of new Chromebooks that are made with recycled materials and are easy to customize, repair, and upgrade. For example, the new Framework Laptop Chromebook Edition, made of 50% post-consumer recycled aluminum, is the most customizable Chromebook yet. It's durable, powerful, thin, light, and designed to last. Individuals can upgrade the laptop's memory and storage; replace key parts like the screen, battery, and webcam; and swap out the bezel with different colors, all without needing to replace their entire laptop.

E-waste recycling

Since all products will eventually become obsolete, availability of and participation in e-waste recycling programs is important to help keep electronics out of landfills and reuse the critical minerals within them.

We're focused on sourcing recycled and sustainable materials from our supply chain, and we recognize that the supply chain is only able to provide recycled materials when robust recycling collection, processing infrastructure, and technologies are available. For devices at the end of their service life, we offer free recycling in every country where we ship consumer hardware products.[131]

While e-waste recycling programs are generally available, they often have low consumer participation rates. That's why, in 2022, we joined forces with industry peers and electronics recycling startup Retrievr on a **new e-waste recycling pilot** designed to address the behavioral reasons that stop consumers from recycling. Unlike recycling household items like food packaging or shipping boxes, electronics have unique barriers to overcome before consumers feel comfortable taking action. The goal of the pilot is to study how the industry can reduce barriers and increase participation in e-waste recycling.

The Framework Laptop Chromebook Edition is easy to upgrade and repair.

Working with suppliers

Manufacturing waste

Material that's lost during the product manufacturing process (often called "yield losses") generates waste in our supply chain, so it's important to ensure that these waste streams are also captured and recycled. In 2020, we announced our target to achieve UL 2799 Zero Waste to Landfill certification at all final assembly manufacturing sites for our consumer hardware products by 2022.

In 2022, we certified 90% of our established consumer hardware final assembly sites to the **UL 2799 Zero Waste to Landfill standard**. These sites achieved at least Silver certification level (representing a minimum 90% landfill diversion), with half of our sites achieving Platinum level (representing 100% landfill diversion). We plan to certify the remaining sites in the future. We also aim to maintain certification for 100% of our final assembly sites, including new sites as they're added.

2022 HIGHLIGHT

Half of our consumer hardware final assembly sites achieved 100% landfill diversion.

We've completed a new waste-reduction pilot program focused on the packaging materials used to ship product parts from suppliers to final assembly sites. We worked with some suppliers to replace shipping materials with reusable and recyclable alternatives and to redesign packaging to use less material overall. For example, for Nest Wifi Pro, we partnered with multiple part suppliers in 2022 to replace an estimated 30 metric tons of plastic with corrugated cardboard, which is easier to recycle. Building on these early successes, we're now engaging more suppliers and comprehensively reviewing packaging for many more parts across our portfolio, in hopes of identifying more opportunities to achieve even bigger waste reductions.

TARGET

Achieve UL 2799 Zero Waste to Landfill certification at all final assembly consumer hardware manufacturing sites by 2022[132]

2022 PROGRESS

We achieved UL 2799 Zero Waste to Landfill certification at Silver or higher for **90%** of our established final assembly sites

DETAILS

Year set: 2020 | Base year: N/A | Target year: 2022

Scope: All final assembly manufacturing sites globally for Google consumer hardware products with at least one year of data.

Safer chemistry

We're protecting people and the planet through safer chemistry and responsible management across our hardware products. The chemical safety of materials plays a role in the impact they can have on natural ecosystems, supply chain workers, and users.

Through our Product Restricted Substances Specification and Manufacturer Restricted Substances List, we restrict many hazardous substances and ensure our suppliers have processes in place to detect and prevent them from entering the manufacturing process. We've laid a solid foundation as we pursue our next level goals in safer chemistry.

In 2022, we shared more details about our comprehensive Responsible Chemical Management program that includes assessments, guidance, and training resources to help suppliers better mitigate occupational and environmental risks related to the chemicals they use. Recent initiatives have included in-depth assessment programs with greater levels of detail and transparency, extensive supplier training and guidance materials to more proactively manage risk, and new industry partnerships that allow us to share best practices intended to advance the industry at large.

We continue to enroll suppliers into e-learning courses, which more than 250 manufacturing suppliers have completed as of the end of 2022—a number that continues growing as we extend trainings to more supplier personnel.

We're working to **eliminate antimicrobials** and use **safer flame retardants and solvents** across our consumer electronics product portfolio. We're also collaborating across the industry to find and promote the understanding of safer flame retardants available for the electronics sector. In 2022, we partnered with ChemFORWARD, a trusted nonprofit source for chemical hazard data and alternatives, on a proactive approach to assessing chemical safety beyond existing regulatory and industry norms. We've commissioned over 100 chemical hazard assessments and are working to make them available to others through the ChemFORWARD platform.

The Nest Thermostat is now made with fewer parts for a less complicated design.

A Googler swaps out a motherboard at our data center in The Dalles, Oregon. When server parts break, we first try to repair them. If we can't, we break them up into raw materials and recycle the components.

Enabling others

The circular economy requires everyone to participate to reach its fullest potential. That's why we're focused on sharing insights about our efforts so others can adopt them, and why we invest in creating technologies that enable everyone to have an impact.

For example, in 2022, we introduced product features that help people and businesses recycle clothing and other goods, and that help hardware customers keep their products in use longer. We're also helping to improve recycling through accurate measurement and data-led insights using machine learning. In 2022, we shared details about CircularNet, a set of models that lowers barriers to using AI technology for waste identification. Our goal with CircularNet is to develop a robust and data-efficient model for waste/recyclables detection, which can support the way anyone in the waste management ecosystem can identify, sort, manage, and recycle materials.

We also support our partners to help discover, accelerate, and scale ecosystem solutions that can benefit everyone tackling waste and reuse challenges. In 2022 and early 2023, we worked to jumpstart partner innovation by launching multiple accelerators focused on circular economy solutions. Additional details can be found in the Working together and Empowering individuals sections.

The journey ahead

At Google, we believe that realizing a sustainable world means that we must accelerate the transition to a circular economy where people, the planet, and businesses thrive. This is a large and complex global challenge, but we've always viewed a challenge as an opportunity to be helpful and make things better for everyone.

While we're excited about our journey to a circular economy, we recognize that we'll face many challenges along the way. For example:

- Recovering and diverting resources from landfills requires robust collection and recycling infrastructure around the world, beyond what exists today.
- The lack of financially healthy end markets and local reuse infrastructure for salvaged resources often prevents or prohibits materials from making their way back into the economy.
- The circular economy requires better data to enable markets to identify, manage, and value available resources. More and higher-quality data is needed to inform capital investments, infrastructure priorities, business plans, policies, and other interventions.
- Accelerating the switch from using single-use plastics to more reusable solutions requires additional innovation with the potential to scale across large real estate portfolios.
- We're exploring the connection between low-GHG construction materials and the circular economy, recognizing that recycled materials often have lower carbon footprints than virgin resources.[133]

The challenge is large, but so is our ambition. We seek to enable others to embrace circularity, which is why we share knowledge and insight through research, product examples, and case studies with our partners, customers, and billions of users around the world. Examples include:

- Closing the plastics circularity gap
- Understanding barriers to electronics recycling
- Accelerating commercial deconstruction and reuse

Our goal with this work is to accelerate progress towards a fully sustainable technology industry and real estate footprint operating on clean, efficiently used energy and made with safe and circular materials.

LEARN MORE

- How Google is supporting the circular economy
- A new accelerator for circular economy startups and nonprofits
- Restricted substances specification

Nature and biodiversity

We strive to protect and enhance nature and biodiversity through our campuses and technology

Our ambition

Our approach

Building for biodiversity

Protecting nature and making it more accessible

Sourcing responsibly

Developing technology to address biodiversity loss

The journey ahead

Our ambition

The world has seen an average loss of 69% of mammal, bird, fish, reptile, and amphibian populations since 1970,[134] and climate change, water stress, and resource depletion are only accelerating the stress on our natural environment. Roughly half of global GDP—or $44 trillion—depends on nature and its services, such as healthy soils, flood prevention, clean water, nutrient cycling, pollination, and a stable climate.[135]

Preserving nature is critical both to mitigating climate change and adapting to it. We want nature and people to flourish together in the communities that Google calls home, as well as the ecosystems where we source food for the hundreds of cafes we operate.

Our approach

We strive to protect and enhance nature and biodiversity through our campuses and technology.

Google has offices in nearly 60 countries around the world (as of year-end 2022). In these locations, we aim to protect and enhance nature and biodiversity through a four-pillar approach that starts with building biodiversity at our own office and campus developments, as well as protecting nature and making it more accessible in the surrounding communities where we operate (see Figure 24).

Our approach further focuses on sourcing responsibly across our supply chain. And our billions of users have the potential to have a positive impact on their environments if given the information and tools to do so, so we're also developing technology to help increase nature's resilience to climate change.

FIGURE 24 **Our approach to nature and biodiversity**

Building for biodiversity

We build for biodiversity on-site at Google offices and campuses by designing for ecology and bringing nature back to cities.

Protecting nature and making it more accessible

In the Bay Area and elsewhere across our portfolio where appropriate, we nurture the environment and connect people to nature, both on our campuses and in the surrounding communities.

Sourcing responsibly

We're focused on sourcing responsibly across our supply chain by procuring sustainable building and hardware materials and supporting biodiverse food systems.

Developing technology to address biodiversity loss

We're creating platforms, open tools, and geospatial and AI-powered solutions that help to increase nature's resilience to climate change and address the causes of nature loss.

Building for biodiversity

Centuries of agricultural intensification and urbanization have transformed landscapes and native habitats around the world, including a loss of over 99% of native habitats in Silicon Valley.[136] Google is working to bring nature back into the built environment—in part, by restoring critical habitats like oak woodlands and willow groves across our Bay Area campuses. Our aim is to revive the area's ecological heritage and bolster the human experience while creating thriving, functional landscapes for a biodiverse constellation of species. In the Bay Area and beyond, wherever possible, we strive to build biodiversity on-site at Google offices and campuses by designing for ecology and bringing nature back to cities.

Designing for ecology

We increase native, biodiverse habitats on our development sites through both large- and small-scale efforts that prioritize local species. For example, we contributed to the restoration of the **Charleston Retention Basin** near our Bay Area campuses, including nearly 6 acres[137] of new and enhanced freshwater marsh, native upland, and riparian communities, and we continue to protect a rookery that's regionally important for the local egret population. In 2022, we created nearly 5 acres of new habitat on our campuses for monarch butterflies and other pollinators.

As of the end of 2022, we've created and restored more than 40 acres of habitat on Google's campuses and the surrounding urban landscape, primarily in the Bay Area—including 17 acres at our Bay View campus. We've also planted roughly 4,000 native trees on our Bay Area campuses. In collaboration with local NGOs, ecology experts, and government agencies, this work spans from creating welcoming habitat patches for pollinators to partnering on larger projects like restoring the Charleston Retention Basin. Together, these efforts drive landscape-scale restoration of historical ecosystems like oak woodlands, willow groves, and creek and wetland habitats (see Figure 25).

We've established **landscape design practices** that ensure ecologically-designed landscapes thrive over the long term, primarily through our internal Habitat Design Guidelines.

2022 HIGHLIGHT

As of the end of 2022, we've created and restored more than 40 acres of habitat on Google's campuses and the surrounding urban landscape, primarily in the Bay Area.

The guidelines help landscape designers leverage plant choices and layout to maximize wildlife habitat value. They include detailed guidelines on native plant palettes, planting structure and density, plant requirements, maintenance requirements, and bird-safe practices. To promote wider use and impact of these guidelines, we sponsored the publication of a **public version** that's freely available for landscape managers in public, private, and NGO settings. In addition, our ecology team also issues guidelines on native landscape maintenance, pollinator habitats, bird bath and nest design, plant pathogen prevention, and recycled water use for native plants. All Bay Area ground-up construction projects completed in 2022 incorporated bird-friendly design elements to reduce the risk of window collisions.

In 2022, we opened Bay View, the first major campus designed by Google, and the most comprehensive example yet of our approach to designing for ecology. Bay View features over 17 acres of high-value natural areas—including wet meadows, woodlands, and a marsh—designed to reestablish native landscapes and rehabilitate **Bay Area wetlands**. Learn more in our Bay View spotlight.

FIGURE 25

How we're restoring native habitats in Silicon Valley

Restoring habitat for monarch butterflies

We're taking steps to help address the threat facing California's monarch butterflies—pollinators that are important to our ecosystem. In 2020, California only saw 2,000 monarch butterflies during the winter: a more than 90% decline from the millions of monarchs that visited the state in the 1980's and 1990's.[138]

Given our significant presence in California, in 2021, we announced our aim to support the creation, restoration, and/or enhancement of **600 acres of habitat for monarchs** and other pollinators across California, including creating more habitat on our campuses. We've put $500,000 toward this effort on our campuses, and Google.org granted another $500,000 to the Xerces Society and Peninsula Open Space Trust for habitat work across the state.

To date, this has helped to restore and enhance more than 500 acres of monarch and pollinator habitat across California, including creating nearly 5 acres of new habitat on our campuses in 2022.

2022 HIGHLIGHT

We've provided grants to help restore and enhance more than 500 acres of monarch and pollinator habitat across California.

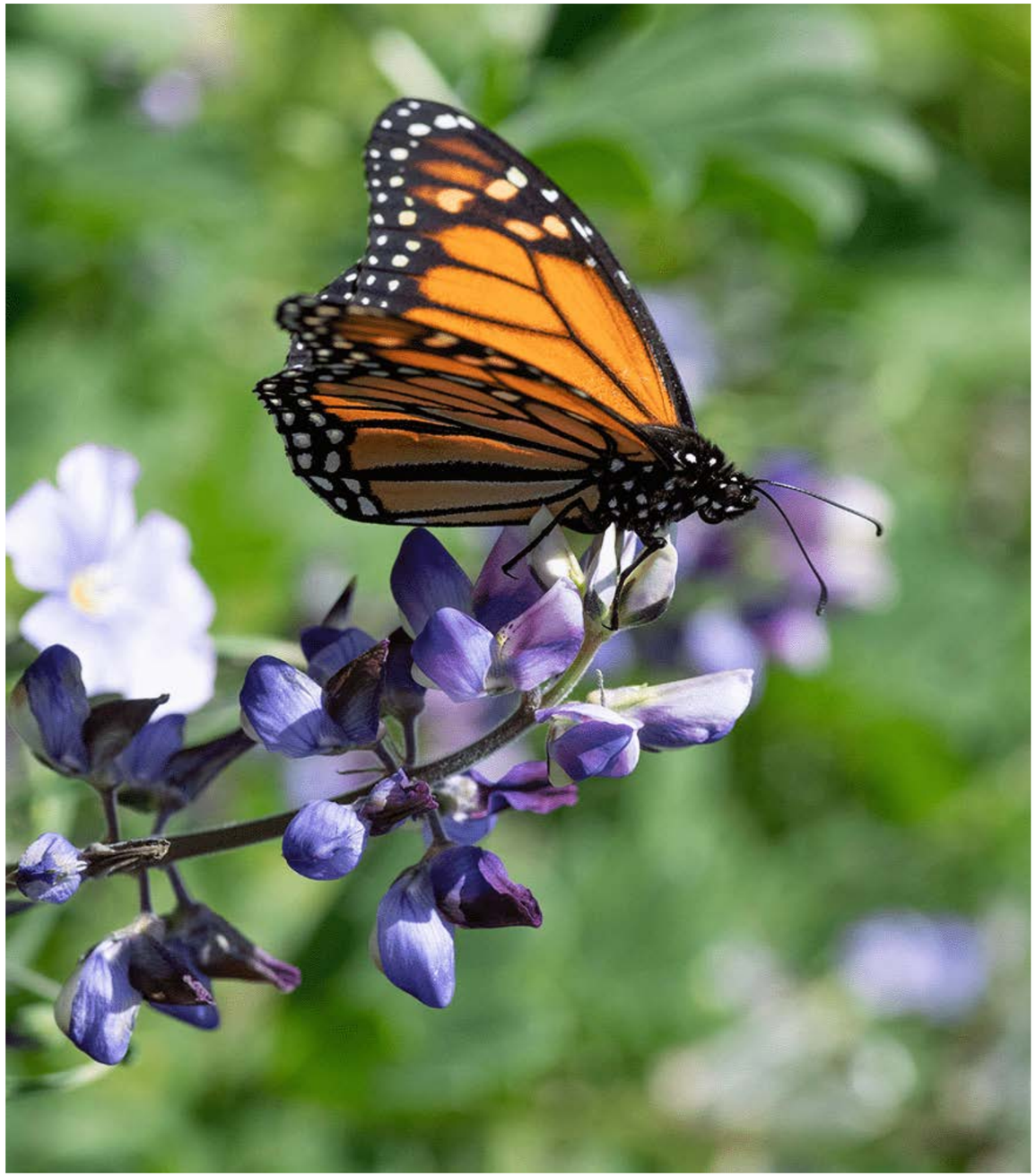
Bringing nature back to cities

We're also bringing nature back to many cities where we operate. Global search interest in "pollinators" and "tree planting" reached all-time highs in 2022.[139]

In urban areas around the world, we're designing nature into the built environment to improve urban biodiversity and connect people to nature. For example, our Platform G building in London's King's Cross neighborhood will include a biodiverse green roof and planting palette designed to support native birds, bats, bees, and insects, designed in collaboration with the London Wildlife Trust. A densely planted outdoor roof garden with a rainwater irrigation system will provide a **habitat for protected species** of bats and birds, as well as offering a quiet green space for breaks during the work day. We're collaborating with the London Wildlife Trust as part of a wider initiative to protect our native species and improve local biodiversity.

In city centers lacking greenspace, the urban heat island effect produces higher temperatures, leading to increased energy needs, air pollution, and heat-related illness.[140] Google is helping to **abate the urban heat island effect** by prioritizing plantings, green open spaces, and tree canopy cover on our campuses, as well as reducing impermeable surfaces like concrete.

We published insights from some of this work in an academic paper, aiming to inspire others and provide them with tools and techniques for integrating nature into dense urban areas.



A monarch butterfly at our Charleston East campus. (Photo: Rick Miskiv for Google)

Protecting nature and making it more accessible

We recognize that our campus landscapes exist as part of greater natural ecosystems, so it's important that we work to protect and support nature—and make it more accessible to people—both on our campuses and across the broader communities where we operate. In the Bay Area and elsewhere across our portfolio where appropriate, we nurture nature by supporting restoration efforts beyond our campuses and by planning for resilience. We also connect people and nature by providing community access to nature and improving worker health through biophilic design.

Nurturing nature across ecosystems

We invest in restoration projects outside of Google's campuses to build health across the wider ecosystem and accelerate our water stewardship goals. In addition to grants mentioned above to create and maintain pollinator habitat, we also support efforts to strengthen the ecological resilience of critical natural systems like the **San Francisco Bay**. In 2022, we partnered with the San Francisco Estuary Institute to create the Shoreline Resilience Framework for Wildlife Support, which is being used by regional agencies to identify, map, and enhance functions that contribute to shoreline resilience. These functions may include protecting the shoreline from erosion, supporting threatened and endangered species, and maintaining critical landscape processes like marsh migration with sea-level rise.

Connecting communities and nature

We invest for the long term, so we want to care for the environments and communities where we operate. We engage with local communities and leading programming that extends the benefits of nature to all. For example, in partnership with the Santa Clara Valley Audubon Society, the City of Mountain View, and other organizations, Google hosts "Egret Office Hours" at the Shorebird Way rookery so the public can safely see moments throughout the egret breeding cycle.

As another example, we created the Green Loop, a publicly accessible pedestrian and cycling trail connecting some of our buildings in **Mountain View**. The Green Loop was designed with native vegetation to enhance habitats for pollinators and other wildlife (including nearly 100 native trees), as well as to help manage stormwater.

We ensure that **Googlers** have access to the benefits of high-quality biodiverse nature through incorporating exterior landscapes and access to nature on our campuses, as described above. We also focus on bringing attributes of natural environments into our interior spaces by applying biophilic design practices, such as nature-inspired architecture, interior, and landscape design. To further this, we collaborated on an initiative with the ILFI to make a Biophilic Design Toolkit that was launched in 2022 and is freely available for anyone to use.

Some recent buildings that reflect this approach to biophilic design include:

- **Bay View (Mountain View, CA):**
  With an abundance of biophilic design elements from natural light to accessible trails, our Bay View campus was a finalist for the 2023 Stephen R. Kellert Biophilic Design Award, presented by ILFI to recognize leading examples of biophilic design in the built environment. Learn more in our Bay View spotlight.
- **Pier 57 (New York, NY):**
  In 2022, we opened Pier 57 in New York City, which incorporates water views and plantings throughout the building to support biophilic design.
- **Moffett Park (Sunnyvale, CA):**
  In Sunnyvale, we're building our first ground-up mass timber building, which will incorporate biophilic design principles by exposing the natural timber structure to building occupants, and by providing abundant views and daylight throughout the interior.

The Shorebird Way rookery on our Mountain View, California campus reflects a broader effort to design and build our offices with local environments, ecology, and animal habitats in mind.

Sourcing responsibly

We're focused on sourcing responsibly across our supply chain by procuring sustainable building and hardware materials and supporting biodiverse food systems.

We procure building materials for development projects and hardware materials for products aiming to minimize negative impacts on global biodiversity. For example, for new campus developments, we've incorporated timber certified by the **Forest Stewardship Council** (FSC)—the world's leading forest certification system for sustainable wood building materials. The first time Google led the concept and construction of our own major campuses, Google and our development partners prioritized FSC certification of all new wood purchased and installed, achieving over 96% FSC-certified wood at Bay View.[141] Our efforts earned us a 2021 FSC Leadership Award, which recognizes excellence in responsible forest management and conservation.

We work to ensure our food operations contribute positively to global biodiversity. Across our cafes, our Food team is focused on increasing the proportion of **agrobiodiverse crops** featured on our menus. We leverage procurement practices and menu design to replace monocrop commodities with climate-resilient crops, and jump-start local markets to support agrobiodiversity. In addition to agrobiodiversity, we also support **regenerative agriculture practices**. This work builds on the Food team's vision of helping to feed the world responsibly and sustainably.

Developing technology to address biodiversity loss

We build tools and technology that enable partners, NGOs, governments, and academics around the world to help address nature and biodiversity loss. Our most impactful technology in this area is **Google Earth Engine**, a leading technology platform for planetary-scale environmental monitoring such as land use change, the most significant driver of biodiversity loss. Additionally, we've helped launch other platforms that help protect nature, such as **TraceMark**, a sustainable sourcing solution that improves supply chain transparency. We also use AI to help partners unlock new advances, such as our machine learning model that helps the scientific community in detecting humpback whale sounds, or in finding hopeful signs of wildlife recovery after wildfires.

While supporting expert partners is important, we also believe technology should help everyone do their part for nature and biodiversity. That's why many of our products aim to engage our users in nature-related tools, product features, and information. For example, Google Shopping restricts the sale and trade of endangered species via content moderation policies. Additionally, we provide free API access to our Maps and Places products for some nature-related uses, such as the **iNaturalist app**, which helps people learn more about their local environment.

Additional details on how we're developing breakthrough technologies to address nature and biodiversity loss can be found in the Working together and Empowering individuals sections.

We've incorporated timber certified by the Forest Stewardship Council (FSC) in our new campuses developments.

The journey ahead

Our approach to protecting nature has important co-benefits. Protecting nature helps sequester carbon, and sequestering carbon helps preserve nature. Water stewardship helps nature thrive, and thriving ecosystems support water stewardship. By promoting circularity, we're reducing the extraction of natural resources, which in turn protects against environmental degradation—a direct driver of biodiversity loss. For that reason, we'll seek to evaluate these efforts with a more holistic view.

While we're excited about our work to protect and enhance nature and biodiversity through our campuses and technology, we recognize that we face some challenges, including:

- Navigating the local complexities of biodiversity and ecosystem health, as well as forging a broad set of partners to ensure collective action.
- Feeding a global workforce responsibly and sustainably while supporting agrobiodiversity and regenerative agriculture practices.
- Procuring healthy materials for our campuses and products while encouraging manufacturing partners to embrace responsible material sourcing practices.
- Expanding the nature and biodiversity practices that work in one region to more of the areas where we operate around the world.
- Effectively measuring nature and biodiversity.

Our research papers, articles, and toolkits are intended to help others adopt some of the approaches that have worked for us, from restoring native habitats to integrating nature into cities.

- Habitat design guidelines
- Biophilic Design Toolkit
- Toolkit for supporting nature in cities
- Integrating nature into urban areas

Moving ahead, we'll continue to build partnerships with others, using lessons from our own efforts alongside new tools and technology to help everyone take action.

LEARN MORE

- Seeding resilience with ecology
- Doing our part for California's monarch butterflies
- AI reveals signs of recovery in areas devastated by bushfires
- Map of Life Indicators adopted in UN Biodiversity Framework

In 2022 we opened Pier 57 in New York City, which incorporates water views and plantings throughout the building to support biophilic design.

SPOTLIGHT

Building a more sustainable campus in Mountain View

An interior photo of the canopy ceiling at our Bay View campus. (Photo: Iwan Baan)

In 2022, we opened Bay View in Mountain View, California, the first major campus developed by Google. From the start, we had big ambitions for this project: re-envisioning the workplace with a focus on prioritizing the human experience and community-centered development.

Bay View has now achieved LEED Platinum certification and is on track to be the largest project to attain LBC Water Petal Certification, two of the world's most ambitious building standards. These achievements reflect our goal of building sustainability into everything at Bay View: it integrates low-carbon design, helps regenerate local ecosystems, incorporates circularity principles, and is on track to achieve net water-positive status.

Net-zero carbon

Bay View is a fully electric campus with on-site solar energy and nearby wind farms that are expected to help it operate on 90% clean energy. It features a first-of-its-kind dragonscale solar roof across all three buildings, which use the latest building-integrated photovoltaic technology. Unlike a flat roof, where each panel generates peak power at the same time of the day, the roof's unique shape enables it to generate power during an extended number of daylight hours.

To heat and cool the buildings, Bay View houses an innovative geothermal energy system, which is expected to help reduce the building's carbon emissions compared with a conventional, code-compliant baseline, per our predictive models. This integrated geothermal pile system also enabled us to electrify the building's overall systems more effectively, because recycling ground heat requires less energy than creating new heat. Bay View also features our largest electric kitchen, through which we're learning lessons that will inform the transition of all our kitchens to electric cooking.

Water stewardship

To help address local water scarcity, Bay View is on track to meet the LBC's definition of "net water positive," meaning it's designed to produce more recycled water than the site requires. Predictive models estimate that the on-site geothermal energy system is expected to help reduce about 90% of the water needed for cooling, compared with a traditional cooling tower system. To further reduce water use, we designed the campus landscapes with native plants and drought-tolerant species that don't require as much watering.

We're also capturing and reusing water on-site when possible. Stormwater retention ponds and constructed wetlands for wastewater treatment were integrated into the site landscape. A central plant treats stormwater gathered from retention ponds and wastewater collected from buildings, producing recycled water that can be used for cooling towers, flushing toilets, and irrigation.

Circular economy

Bay View incorporates our circularity principles of minimizing waste, keeping materials in use for as long as possible, and promoting healthy materials that are safe for people and the environment. We've diverted 76%

of construction waste from landfill, and over 96% of all new timber used in the campus is certified by the FSC,[142] earning us a 2021 FSC Leadership Award. We designed flexible workspaces, including easily adjustable partition walls, reducing the need for new materials as our needs evolve. And we vetted thousands of materials against the LBC's "Red List" to avoid toxins and create the healthiest environment possible, from the carpet tiles and paints to the plywood and furniture.

Nature and biodiversity

Bay View is the most comprehensive example yet of our approach to designing for ecology. The site was designed to integrate with the native landscape and regenerate local ecosystems such as wetlands. It features over 17 acres of high-value natural areas—including wet meadows, woodlands, and a marsh.

The significant amount of open space was thoughtfully designed to echo pre-development water flows through stormwater treatment areas, which include open-water ponds that provide a habitat for aquatic wildlife. New willow groves provide a critical habitat for local wildlife and migrating songbirds, which have almost entirely disappeared from the South Bay. Additionally, pollinator gardens help the campus meet the LBC's urban agriculture criteria, recognizing the key role of native pollinators—such as bees—in local food production and ecosystem health.

Bay View provides Googlers and community members with access to nature through landscape restoration and accessible trail networks. We also applied biophilic design principles to the interior spaces, aiming to capture proven health benefits for workers through approaches such as clerestory windows, which provide access to natural light from every work area. Due to these efforts, Bay View was a finalist for the 2023 Stephen R. Kellert Biophilic Design Award.

Replicable solutions

From the start of this project, we aimed to create shared value through replicable solutions and innovations that could benefit others and drive innovation forward. The dragonscale roof taught us how to integrate solar panels into a building skin in ways that we believe can help standardize this practice. The on-site wastewater treatment system can hopefully make it easier for others in the area to design similar systems by paving the way for local codes to evolve. And our strategies to minimize construction waste involved working closely with manufacturers to reduce packaging, an effort we believe could help others with similar goals. To share our learnings and help raise awareness across the development industry, we released a book outlining all these innovations, in the hopes of ultimately expanding the impact of this project around the world.

LEARN MORE

- Bay View and Charleston East
- Pathways: Unlocking innovation at Bay View and Charleston East

The outdoor courtyard between two primary buildings at our Bay View campus shows Google's focus on connecting employees with nature. (Photo: Iwan Baan)

Governance and engagement

About Google

Sustainability governance

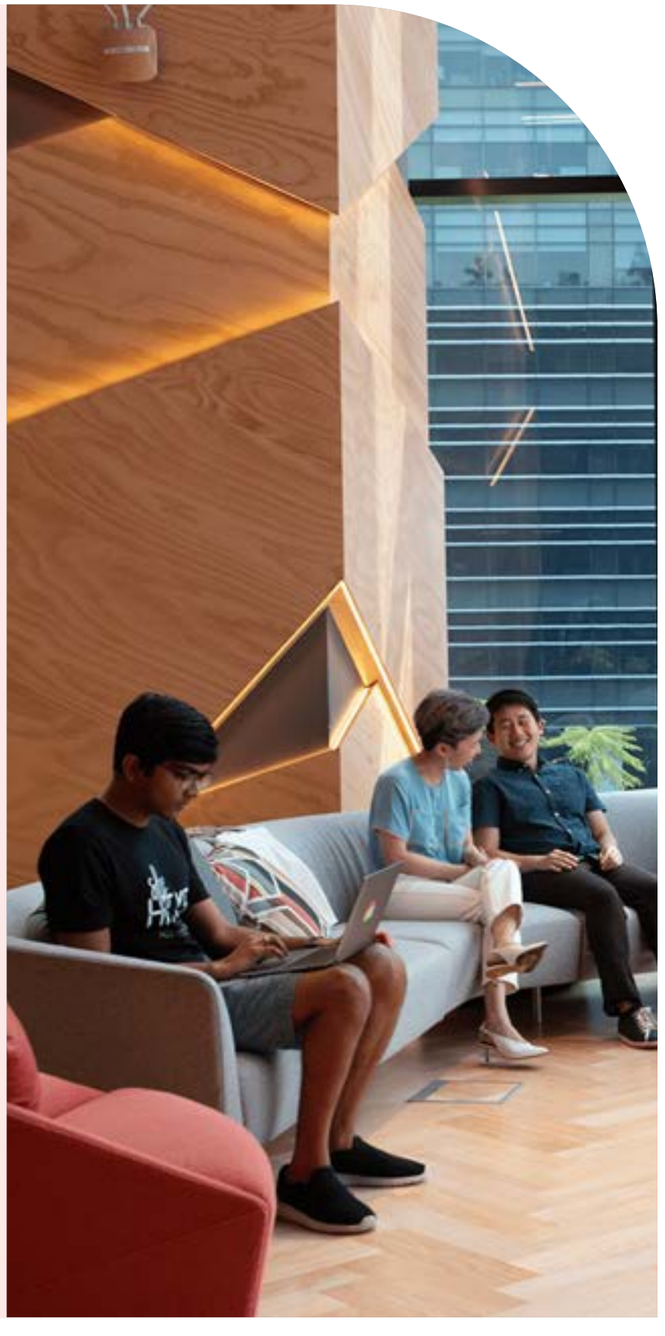
Risk management

Stakeholder engagement

Public policy and advocacy

Partnerships

Awards and recognition



About Google

As our founders explained in their first letter to shareholders, Google's goal is to "develop services that significantly improve the lives of as many people as possible."

We believe in technology's potential to have a positive impact on the world. That unconventional spirit has been a driving force throughout our history, inspiring us to tackle big problems and invest in moonshots, such as our long-term opportunities in AI. We continue this work under the leadership of Alphabet and Google CEO Sundar Pichai.

Alphabet is a collection of businesses—the largest of which is Google. Google comprises two segments: Google Services and Google Cloud. Google Services' core products and platforms include ads, Android, Chrome, hardware, Gmail, Google Drive, Google Maps, Google Photos, Google Play, Search, and YouTube. Our consumer hardware includes Fitbit wearable devices, Google Nest home products, and Pixel devices. Our Google Cloud offerings include Google Cloud Platform and Google Workspace.

Our headquarters are located in Mountain View, California. We own and lease office facilities and data centers around the world, primarily in North America, Europe, and Asia. To learn more, see our data center locations and our office locations.

The Googleplex in Mountain View, California

Sustainability governance

Alphabet's Board of Directors has delegated to the Audit and Compliance Committee the primary responsibility for the oversight of many of the risks facing our businesses. The Audit and Compliance Committee reviews and discusses with management any major risk exposures, including sustainability risks, and the steps that Alphabet takes to detect, monitor, and actively manage such exposures.

In 2022, Google evolved its approach to sustainability governance by creating a Sustainability Focus Area, an internal team led by our SVP of Learning and Sustainability that provides centralized management oversight of sustainability and climate-related issues.

The Sustainability Focus Area includes the Chief Sustainability Officer and executives from across the company with diverse skills, from teams such as operations, products, finance, marketing, legal, communications, and policy, among others. Through the Sustainability Focus Area, sustainability and climate ambitions are built into our company-wide goals, plans of action, management policies, performance objectives, and how we monitor progress.

Risk management

Our Enterprise Risk Management (ERM) team is responsible for identifying, assessing, and reporting risks related to the company's operations, financial performance, and reputation. As with financial, operational, and strategic risks, the team assesses environmental risks as part of the company's overall risk management framework. The risks and opportunities identified through this process support public disclosures and inform Google's environmental sustainability strategy. Our Chief Sustainability Officer and sustainability teams work to address risks by identifying opportunities to reduce the company's environmental impacts from its operations and value chain, and through improving climate resilience.

Climate-related risks

Climate-related risks and opportunities have long time horizons with high uncertainty regarding how climate trends, policy, and socio-economic factors might evolve in the future. Google continues to build on qualitative and quantitative risk assessments to identify climate-related risks and opportunities, and to understand their associated impact.

In 2015, Google developed a set of Principles of Climate Resilience, which support our definition of climate risk and resilience. From there, we created a framework that prioritizes the impact on people (including communities, users, and Googlers), so that it represents the different aspects of climate resilience within Google, as well as the internal and external actors who either influence or are influenced by Google's climate resilience decisions. These ideas continue to inform how we think about addressing long-term climate risk.

In 2020, Google conducted a climate risk assessment, which included a low and high emissions climate scenario analysis. This assessment modeled the impact of flooding, water stress, extreme heat, and wildfires on 26 priority office sites and 23 data center locations. The key result of this scenario analysis was that increased exposure to extreme heat and flooding is likely to impact many of our global offices and data centers as early as 2030, if not sooner. We consider these results when planning Google's overall development strategy.

In 2022, Google increased its efforts to align our climate risk assessment process more closely with the recommendations of the **Task Force on Climate-Related Financial Disclosures** (TCFD), leveraging the TCFD categories of risks and opportunities and conducting climate scenario analyses. In an effort to drive completeness and consistency when reviewing these categories, we adopted our ERM rating scales (i.e., impact, frequency, likelihood, control effectiveness) to identify and prioritize areas of focus.

In 2022, climate-related risks and opportunities were analyzed in three time horizons—short term (through 2030), medium term (through 2040), and long term (through 2050)—for financial, operational, legal, and strategic risks. We considered acute and chronic physical risk perils such as heat stress, water stress, hail, tropical cyclones, tornadoes, droughts, wildfires, and wind gusts. We also considered risks associated with transitioning to a low-carbon economy (e.g., energy costs, future regulations, technology, market, and reputational risks, among a few). We also assessed numerous climate-related opportunities such as building and expanding climate solutions to support users' journeys to a low-carbon world, improving office and data center efficiency, and advancing new energy efficient technologies.

Water-related risks

To identify and assess water-related risks in our direct operations, Google annually undertakes a water risk assessment to identify priority locations with potential water-related risks that may present opportunities for water stewardship action. Indicators from available risk assessment tools, including WRI Aqueduct Water Risk Atlas 3.0 and WWF Water Risk Filter 6.0, are blended with other metrics to evaluate risks related to scarcity, flooding, water quality, sanitation and hygiene, reputation, and regulatory stressors.

For our data center operations specifically, in 2022 Google finalized the development and application of a context-based water risk and impact methodology to generate more granular insights than can be provided by water risk screening tools. It provides a framework to measure and evaluate site-level water risks, and the potential watershed impact, to inform our decision-making process for new site selection, water cooling design, and ongoing operations.

To identify and assess water-related risks in our supply chain, we've conducted a supply chain water use analysis and a supplier risk assessment using WRI's Aqueduct Water Risk Atlas, WWF's Water Risk Filter, and WULCA AWARE. The key risks identified included baseline water stress, flood risk, access to safe drinking water, and the level of sanitation and hygiene services. This assessment enabled us to identify priority locations for supplier engagement in Central America, Asia, and the United States.

To safeguard the health of local waterways, we stipulate that suppliers "[treat water] as required prior to discharge or disposal of all wastewater." To support the health and wellbeing of those in the communities we operate in, suppliers must "provide workers with ready access to clean toilet facilities [and] potable water." We conduct regular supplier audits to monitor adherence to our code of conduct. Additionally, we've engaged our suppliers through the CDP Supply Chain Water Security questionnaire, inviting them to disclose their water management efforts.

The cooling towers at our Mayes County, Oklahoma data center help keep our servers running efficiently.

Stakeholder engagement

We believe in the importance of outside perspectives to help inform our business decisions. We actively engage with our stakeholders (e.g., employees, NGOs, policymakers, customers, researchers, academics, and investors) throughout the year on a broad range of environmental topics.

Our engagement enables us to better understand our stakeholders' perspectives, elaborate on our environmental strategy, and progress against key targets, and it creates a vital two-way dialogue that informs our approach to the work.

See below for more information on how we engage with employees, suppliers, policymakers, and partners. For additional information on how we collaborate with customers, researchers, academics, and NGOs, see the Working together section.

Employee engagement

Sustainability is part of our culture, and we give our employees opportunities to engage on environmental issues and put their passions into practice.

To celebrate Earth Day, we host an annual virtual event for employees to learn more about what Google is doing to empower people to make more sustainable choices, support our partners and customers, and operate our business more sustainably. Throughout the year, we invite thought leaders and experts to speak about the latest sustainability trends, and we post some of these talks publicly on our Talks at Google YouTube channel. Employees can also access online sustainability courses and can join global and local internal community groups focused on sustainability topics. Some employees also take on a **20% project**—an opportunity to work on something outside of their primary role—related to sustainability. One great example of this is Project Sunroof, which began as a 20% project back in 2015. Lastly, employees have the opportunity to learn about sustainability through internal newsletters and education campaigns.

Supplier engagement

Through our **supplier responsibility program**, we're working to build an energy-efficient, low-carbon, circular supply chain that makes smart use of the Earth's resources, protects ecosystems, and helps to combat climate change. We focus on the areas where we can make an immediate and lasting impact, such as helping our suppliers improve their environmental performance and integrate inclusivity, climate resilience, water stewardship, and circular design into our supply chain. We believe these principles can play a key role in reducing environmental impact and protecting human rights and community health.

Google's Supplier Code of Conduct includes requirements that enable us to ensure that those we partner with are responsible environmental stewards. Along with having suppliers evaluate their operations, we perform our own ongoing due diligence and audits to verify compliance and to understand our supply chain's current and potential risks.

When we find that a supplier isn't complying, we expect that supplier to provide a corrective action plan (CAP) that outlines the root cause of the finding, how and when that company will resolve the issue, and what steps it will take to prevent recurrence. We determine whether the plan is acceptable based on the severity of the noncompliance and the effort and time required to resolve the issue. We expect suppliers to demonstrate improvements to continue working with us. Our goal is to resolve the most severe issues immediately. We expect all other findings to be resolved in accordance with our guidelines as quickly as is practical. While we work with our suppliers to help them address our findings, in some instances, we may decide to no longer pursue a relationship or to terminate our current relationship.

In 2022, we audited a subset of our suppliers to verify compliance for the following environmental criteria: implementation of environmental management systems, environmental permits and reporting, product content restrictions, and resource efficiency, as well as management of hazardous substances, wastewater, solid waste, and air emissions.

Googlers chat among indoor plants at our Pier 57 office in New York City.

Public policy and advocacy

We know that strong public policy action is critical to creating prosperous, equitable, and resilient low-carbon economies around the world.

The United Nations Framework Convention on Climate Change (UNFCCC)'s 2015 Paris Agreement states that humanity must "keep global temperature rise this century well below 2°C above pre-industrial levels."[143] Google remains unwavering in our commitment to the Paris Agreement, because climate scientists are clear: we have until 2030 to chart a sustainable course for our planet, or we'll face the worst consequences of climate change.[144]

In 2022, we saw major steps forward on climate policy in the United States, Europe, and other regions. New policy measures and corporate commitments will continue to play an important role in driving emissions reductions in the next decade. See Figure 26 for our position on climate policy.

FIGURE 26

Our position on climate policy

At Google, we support public policies that:

- **Strengthen global climate action efforts** through the Paris Agreement, G20, and other multilateral forums to enhance international cooperation on climate.
- **Establish emissions reduction targets and technology-neutral pathways** to achieve a low-carbon economy in line with the IPCC's guidance and scientific consensus.[145]
- **Use competitive, interconnected energy markets to empower consumers** and speed up the transition to a clean economy.
- **Accelerate the development and deployment of next generation low-carbon technology**, including harnessing digital technologies like AI and machine learning to support climate action across businesses, cities, governments, and civil society.
- **Foster partnerships and deepen collaboration** across public and private actors to enable progress on climate mitigation and adaptation by harnessing the full potential of climate solutions.
- **Empower everyone to participate in the transition to a sustainable economy and ensure that the clean energy economy provides economic growth for all**—spurring a new generation of green jobs, benefiting the communities most impacted by a changing climate, and leaving no one behind in the transition.

Policy engagement

Engagement on sustainability policy has been a top priority at Google for many years. Most recently, we were an official partner at **COP-27** in 2022, where we participated in over 50 events and moments throughout the conference with public sector leaders from the United States, Europe, Africa, the Middle East, and Asia to call for amplified ambition on climate and to showcase the role that the technology sector can play in enabling climate mitigation and adaptation.

We've consistently supported strong climate policies around the world in our public policy engagement and advocacy. In 2020, we published a climate change public policy position statement, Realizing a carbon-free future: Google's Third Decade of Climate Action, expressing our support for public policies that strengthen global climate action efforts through the Paris Agreement, establish emissions reduction targets and technology-neutral pathways to achieve a carbon-free economy, and accelerate the development and deployment of next generation low-carbon technology, among other provisions. In the United States, our federal lobbying report covering Q4 2022 includes our lobbying efforts with regard to U.S. federal climate and energy policy, including the Clean Energy for America Act, the CLEAN Future Act, the Infrastructure Investment and Jobs Act, and the energy provisions of the Inflation Reduction Act, all of which align with our advocacy for ambitious federal climate and clean energy policies.

In Europe, our CEO Sundar Pichai shared virtual remarks at our inaugural **Google European Sustainability Summit** in Brussels, which brought together policymakers, industry, and civil society to discuss how to accelerate climate action. He said, "At Google, we share the EU's commitment to action, and want to be a helpful partner in that progress." In the Asia-Pacific region, we provided a public submission and statement of support for Australia's Climate Change Bill 2022 to enable the country to meet its Paris Agreement goals and reach net-zero emissions by 2050.

We've led significant public policy engagement to support strong sustainability outcomes. For instance, in the United States last year, we provided **comments to the SEC's proposed rule** on enhanced climate-related disclosures. In Europe, we shared input with the European Commission to support policy measures to make smartphones and tablets, along with other devices, more repairable and sustainable. We also advocated for measures in the EU Renewable Energy Directive to support 24/7 carbon-free energy supply models that enable companies to source clean energy for their operations.

See Figure 27 for a detailed list of our sustainability policy engagements in 2022.

A green wall at our inaugural Google European Sustainability Summit in Brussels.

FIGURE 27

Google's policy engagements in 2022

Global and cross-cutting initiatives	
Policy Roadmap for 24/7 Energy Policy	Google launched a policy roadmap for 24/7 CFE, laying out a vision for policies that we believe are critical to accelerating electricity grid decarbonization, informed by our experience as a large energy consumer and clean energy purchaser in many different markets around the world. The paper puts forward a detailed policy agenda with three key pillars: 1) rapidly developing and deploying clean energy technologies, 2) expanding and reforming markets to value carbon-free energy and drive innovation, and 3) empowering energy consumers.
Google at COP-27 UNFCCC Conference	Google was a financial sponsor of the 2022 Conference of the Parties of the UNFCCC, in partnership with the Egyptian government and the United Nations, and sent a delegation led by Chief Sustainability Officer Kate Brandt and VP of Engineering & Research Yossi Matias, along with a number of senior subject matter experts. Googlers participated in over 50 events and moments throughout the conference with public sector leaders from the United States, Europe, Africa, the Middle East, and Asia to call for amplified ambition on climate, and to showcase the role that the technology sector can play in enabling climate mitigation and adaptation.

United States	
Engagement on U.S. federal sustainability, climate, and energy policy	
Legislative branch engagement	As detailed in Google's lobbying disclosure filings, we conducted lobbying efforts regarding U.S. federal sustainability, climate, and energy policy, including on the Clean Energy for America Act, the CLEAN Future Act, the Infrastructure Investment and Jobs Act, the Clean Electricity Performance Program provisions of the Build Back Better Act, the wholesale market expansion and reform provisions of the Energy and Water Development and Related Agencies Appropriations Act 2022, and the energy provisions of the Inflation Reduction Act (IRA), all of which align with our advocacy for ambitious federal climate and clean energy policies. Google executives expressed support for the clean energy and climate provisions in the IRA.
Executive branch engagement	Google had multiple engagements with staff and leadership in the U.S. Environmental Protection Agency (EPA), including 3 Google hosted events with EPA Administrator Michael Regan on environmental justice, how Google products promote recycling within the circular economy, and using AI to identify lead pipes. At the U.S. Department of Energy, Nest continued dialog with both the Loans Program Office about designation as an innovative product, and Office of the Under Secretary for Science and Innovation. We also met with the White House on multiple projects, and received invitations to summits for our work on lead pipe reduction and home electrification.
U.S. SEC comments on proposed rule on Enhancement and Standardization of Climate-Related Disclosures for Investors	In partnership with nine other peer technology companies, Google provided comments to the Securities and Exchange Commission's (SEC) proposed rule on enhanced climate-related disclosures. The comments state our support for regular and consistent reporting of climate-related matters; note that investors need consistent, comparable, and reliable information on the material risks and impacts of climate-related events and transition activities on a registrant's consolidated financial position; and provide guiding principles and recommendations for the SEC to consider as it designs a final rule.
U.S. Federal Energy Regulatory Commission comments on improving generator interconnection	Google filed comments (initial and reply) in Improvements to Generator Interconnection Procedures and Agreements (interconnection) Notice of Proposed Rulemaking. Our comments emphasize the importance of reforms that allow independent power producers to continue to thrive and deploy new clean energy resources to meet customer demand. In particular, we advocate for greater transparency in non-RTO (Regional Transmission Organization) regions and penalties for delays to interconnection studies.
U.S. Department of Energy comments on Clean Hydrogen Production Standard	Google filed comments on the Clean Hydrogen Production Standard draft guidance. In particular, we highlighted the need for strong quality criteria—hourly temporal correlation, geographic correlation, and additionality—to ensure that grid-based clean hydrogen is produced using clean electricity.
Engagement with coalitions and sustainability initiatives	
Supporting the U.S. State Department's Clean Energy Demand Initiative (CEDI)	Google.org provided a philanthropic grant to support the establishment of the Secretariat of the U.S. State Department's Clean Energy Demand Initiative within the Clean Energy Buyers Association. CEDI is an initiative led by the U.S. government that aims to connect countries with companies seeking to rapidly deploy clean energy, enabling companies to send demand signals for clean energy and advance policy measures that enable corporate clean energy procurement.
Electricity customer coalitions	Together with business partners, Google helped launch three trade groups and campaigns to support the creation of customer-centric wholesale electricity markets across the United States, with the goal of enabling rapid decarbonization of electricity grids while reducing costs. These include Western Freedom, Coalition for Energy Market Reform, and Electricity Customers Alliance.
U.S. state engagement	
Utility regulation	Google intervened in over 30 regulatory dockets across the United States with coalition partners to promote the cost-effective adoption of clean energy resources.
Regulatory frameworks for decarbonization	Google led discussions with the National Association of Regulatory Utility Commissioners and the National Association of State Energy Officials to discuss how Google's 24/7 CFE goal can be a supportive framework to drive cost-effective grid decarbonization.

Europe

Engagement on European sustainability, climate, and energy policy	
Energy Efficiency Directive	Google engaged with EU policy makers through Digital Europe to inform the development of a standardized energy and sustainability reporting framework for data centers, and establish measures to encourage greater reuse of waste heat.
Renewable Energy Directive	Google worked through Digital Europe and RE-Source to advocate for the inclusion of time-stamping for Guarantees of Origin in the EU Renewable Energy Directive, enabling hourly carbon-free energy matching and greater transparency of clean energy claims. Google also organized an industry letter encouraging the European Commission to issue strong rules that maintain the environmental integrity of grid-based hydrogen production.
Circular economy ecodesign regulations on smartphones and tablets	Google responded to public consultation in September 2022, providing technical feedback on the EU ecodesign regulations on smartphones and tablets.
Sustainable consumption of public goods (e.g., "right to repair")	Google submitted comments to the European Commission's public consultation regarding the promotion of repair and reuse of goods. We shared our views on the core principles to consider when introducing policy measures to promote repair and reuse horizontally, and for smartphones and tablets specifically.
Body of European Regulators for Electronic Communications (BEREC)	Google responded to a questionnaire by BEREC in view of the development of key performance indicators to characterize the environmental impact of electronic communications, networks, devices, and services. We provided information about our environmental reporting practices and suggestions to help identify which indicators would provide relevant environmental information.
Engagement with coalitions and sustainability initiatives	
RE-Source Platform	Google is a strategic partner and steering committee member of the RE-Source Platform, the European platform for corporate renewable energy sourcing. Through its policy advocacy and resources for renewable energy buyers, RE-Source seeks to remove barriers to corporate purchasing of renewable energy in support of Europe's climate and energy goals.

Asia-Pacific

Asia Clean Energy Coalition (ACEC)	As a founding member, Google helped launch ACEC at COP-27 to work together with other companies and organizations to accelerate corporate clean energy sourcing and help decarbonize electrical grids in the region.
Asia-Pacific Economic Cooperation (APEC)	Google supported an APEC Energy Working Group project, sponsored by the U.S. Department of Energy and the Pacific Northwest National Laboratory. The project led to a report that summarized key insights and recommendations shared during two workshops, highlighting ways governments and the private sector can lead and partner to accelerate power system decarbonization across the region.
Australia - Clean Energy Demand Initiative Memorandum of Understanding	Google signed onto an MOU between Australia Climate Change and Energy Minister Chris Bowen and U.S. Special Presidential Envoy for Climate John Kerry, focused on breaking down barriers to enable corporate clean energy procurement in Australia.
Australia - AI and blue carbon collaboration	Google partnered with the Australian Government's national science and research agency, the Commonwealth Scientific and Industrial Research Organisation, and the Department of Foreign Affairs and Trade on a project to explore novel applications of AI to measure, with greater efficiency and accuracy, the capacity of seagrass ecosystems to absorb and sequester carbon in the Indo-Pacific.
Australia - Climate Change Bill	Google provided a public submission and statement of support on the Climate Change Bill 2022 and the Climate Change (Consequential Amendments) Bill 2022, which passed the Australian Parliament on September 8th, 2022. The former outlines Australia's GHG emissions reduction targets of 43% reduction from 2005 levels by 2030, and net zero by 2050. The latter makes consequential amendments to incorporate Australia's GHG emissions reduction targets under the Paris Agreement into legislation for relevant Commonwealth entities and schemes.

Trade associations and third-party groups

We belong to many sustainability-focused third-party groups through which we engage on sustainability policy issues around the world—for example, organizations like the American Clean Power Association, the European Climate Neutral Data Center Pact, RE100, the Asia Clean Energy Coalition, and many more. In addition, we've helped to found organizations such as the Clean Energy Buyers Association and the United Nations 24/7 Carbon-Free Energy Compact. See Figure 28 for more details.

We're also members of the U.S. Chamber of Commerce, Business Roundtable, and other business trade associations, where we're engaged in climate and energy policy issues. For example, we're founding members of the Chamber's Task Force on Climate Actions, and we've engaged within the Task Force since its inception to support constructive engagement by the Chamber on climate policy to create a zero-carbon economy. We also participate in staff-level discussions on the Business Roundtable's Energy and Environment committee.

We respect the independence and agency of trade associations and third parties to shape their own policy agendas, events, and advocacy positions. Our sponsorship or collaboration with a third-party organization doesn't mean that we endorse the organization's entire agenda, its events or advocacy positions, nor the views of its leaders or members. We assess the alignment of our trade association participation with the goals of the Paris Agreement, and engage within organizations to support advocacy for climate policies needed to limit warming to 1.5°C and create a prosperous and competitive zero-carbon economy. We're in dialogue with our trade associations to encourage alignment between our core public policy objectives and their policy advocacy activities, including on climate change.

FIGURE 28

Google's sustainability-focused trade associations and memberships

- Advanced Energy United
- Advanced Energy Buyers Group
- Advanced Power Alliance
- Alliance to Save Energy
- American Clean Power Association
- American Council on Renewable Energy
- Americans for a Clean Energy Grid
- Asia Clean Energy Coalition
- Business Alliance to Scale Climate Solutions
- Carolinas Clean Energy Business Association
- Business Environment Leadership Council of the Center for Climate and Energy Solutions
- Clean Energy Buyers Association
- Clean Energy Demand Initiative
- Clean Grid Alliance
- Conservation Voters of South Carolina
- Digital Europe
- Energy Alabama
- Energy Tag
- Glasgow is Our Business
- Japan Climate Leaders Partnership
- Marktoffensive Erneuerbare Energien
- North Carolina Sustainable Energy Association
- RE100
- RE-Source
- Resources for the Future
- Renewable Northwest
- Smart Electric Power Alliance
- SolarPower Europe
- We Are Still In
- WindEurope

With our Bay View campus, we paid careful attention to the characteristics of the spaces you can see and feel, like materials and daylight, but also to aspects that are harder to see, like air quality, thermal comfort, and acoustics.

Partnerships

Google partners with many organizations to accelerate progress towards shared sustainability goals.

Examples of some key partnerships are in Figure 29.

FIGURE 29

Organization	Details
24/7 Carbon-Free Energy Compact	In 2021, we helped launch the 24/7 Carbon-Free Energy Compact in partnership with Sustainable Energy for All and UN-Energy to help grow the movement to enable zero-carbon electricity. In 2022, the compact surpassed 100 signatories.
Bonneville Environmental Foundation (BEF)	Google has partnered closely with BEF since 2019 to kick off the implementation of our water strategy. In support of our 2030 replenishment and watershed health goals, it helped us to identify and support impactful water replenishment and watershed health projects globally, with a variety of local organizations and partners.
Business for Social Responsibility (BSR)	Google has been a member of BSR for many years and is one of a few select Spark members. We participate in a number of BSR collaboration initiatives, and one of our senior leaders sits on its board.
C40 Cities	C40 and Google launched the 24/7 Carbon-Free Energy for Cities program to empower cities around the world to run entirely on clean energy, and the program will soon be expanded into Africa with grant support from Google.org. C40 is a strategic partner of Google's Environmental Insights Explorer, using its environmental data and insights to help support its network of nearly 100 world-leading cities collaborating to deliver urgent action to confront the climate crisis.
Coalition to End Wildlife Trafficking Online	In 2018, 21 companies joined Google in launching the Coalition to End Wildlife Trafficking Online, collectively creating a wildlife policy framework for online trade and an industry-wide approach to reduce online wildlife trafficking. The coalition unites the tech industry to standardize prohibited wildlife policies, better detect illicit wildlife products, enhance automated detection filters, and empower users to report suspicious listings.
CDP (formerly known as the Carbon Disclosure Project)	In addition to reporting our carbon footprint to CDP since 2009, we've partnered with CDP to host its annual conference, a hack-a-thon, and to launch CDP scores in Google Finance, making corporate carbon disclosure information more widely available.
Clean Energy Buyers Association (CEBA)	Google was actively involved in the creation of CEBA in 2018, chairing the Interim Board of Directors during its transition from an NGO-led effort into a corporate-led trade association. A Google representative continues to serve as the Board Chair of this organization. Google provided initial financial support for the development of the organization and in 2022, Google.org provided a $1 million grant to support CEBA's international expansion.
Climate Neutral Data Centre Pact (CNDCP)	Google helped establish the Climate Neutral Data Centre Pact, a coalition of European data center operators who commit to a set of voluntary sustainability targets to set them on a path toward climate neutrality.
Ellen MacArthur Foundation (EMF)	Google is a partner of the Ellen MacArthur Foundation, having joined the foundation's network in 2015, and has co-authored a number of thought leadership white papers and case studies in areas such as safer chemistry, the deconstruction and reuse of commercial office buildings, electronics, and AI.
Environmental Defense Fund (EDF)	Google has partnered with EDF to map air quality using Street View cars in the U.S., Europe, and Southeast Asia, and to detect methane leaks in cities since 2011.
European 24/7 Hub	Google supported the launch of the European 24/7 Hub with Eurelectric, which provides education on the "what, why, and how" of 24/7 carbon-free energy buyers and suppliers in Europe. Google spoke at the launch event during European Sustainable Energy Week.
European Climate Pact	Google was among the leading businesses that joined the European Climate Pact in its inaugural year to share our commitment to help achieve a climate neutral Europe.
European Green Digital Coalition (EGDC)	Google is an active member of the EGDC—a group of technology companies committed to supporting the green and digital transformation of the EU. As a member, Google participates in the initiative, designed to harness the emission-reducing potential of digital solutions for all other sectors, and support green and digital transformations in the EU.
Exponential Roadmap Initiative	In 2021, we joined the Exponential Roadmap Initiative and the U.N. Race to Zero Campaign, the largest ever alliance committed to halving emissions before 2030 towards net-zero emissions by no later than 2050.
First Movers Coalition	At the World Economic Forum Annual Meeting in 2022, Google joined the First Movers Coalition. As a champion for the Carbon Dioxide Removal sector, Google committed to contract for durable and scalable net carbon dioxide removal to be achieved by the end of 2030.
Frontier	In 2022, we committed $200 million to Frontier, an advanced market commitment that will accelerate the development of carbon removal technologies by guaranteeing future demand. We were one of five companies that made a $925 million total pledge to Frontier. As one of its founding members, we're helping to guide overall strategy and governance.
Global Covenant of Mayors for Climate & Energy (GCoM)	Google's Environmental Insights Explorer was developed in partnership with GCoM through a shared vision to support city climate action with useful and accessible data and insights. Today, GCoM is a strategic partner, sharing EIE data with its alliance of cities and local governments to accelerate climate action.
ICLEI Africa ICLEI Europe ICLEI USA	Google is a partner of the regional secretariats of ICLEI—Local Governments for Sustainability—in Africa, Europe, and the U.S. Through these partnerships, ICLEI regional teams support sustainable city development projects with data and insights from Google's Environmental Insights Explorer. Additionally, in 2022, Google.org provided a $10 million grant to ICLEI to support 10 nonprofit-led projects in the United States and Europe that help cities accelerate their sustainable transition through data-driven environmental and climate action at the local level.
iMasons Climate Accord	Google is a founding member and part of the governing body of the iMasons Climate Accord, a coalition united on carbon reduction in digital infrastructure.
ReFED	In 2022, to activate industry-wide change, Google provided anchor funding to kickstart the ReFED Catalytic Grant Fund, with the goal of accelerating and scaling food waste solutions.
The Nature Conservancy (TNC)	In 2022, Google supported three of the Nature Conservancy's watershed projects in Chile and the United States, and Google.org supported a three-phased approach to catalyze active reforestation of kelp at impactful scales. Google.org also provided a grant to TNC to develop a machine-learning-powered timber-tracing API to stop deforestation in the Amazon at scale; a team of Google engineers is working full-time for six months with TNC to develop this product as part of the Google.org Fellowship Program.
United Nations Food and Agriculture Organization (FAO)	Since 2015, Google and the U.N. Food and Agricultural Organization have partnered on the monitoring of forests, natural resources, livelihoods, and the environment. FAO uses Google Earth Engine for satellite remote sensing and geospatial data science towards groundbreaking science and operational workflows used by practitioners around the globe.
United Nations Environment Program (UNEP)	In collaboration with UNEP and the European Commission Joint Research Centre, Google launched a new platform—the Freshwater Ecosystems Explorer—enabling all countries to freely measure and monitor freshwater resources (towards Sustainable Development Goal 6.6.1), and when and where surface water is changing.
World Business Council for Sustainable Development (WBCSD)	Google has been a member of the WBCSD for several years and participates in a number of its initiatives. We're actively involved in initiatives related to improving well-being for people and the planet, including shifting diets, consumer behavior changes, and regenerative agriculture.
World Resources Institute (WRI)	Google has a 13-year long relationship with WRI for impact-focused collaboration. Some key projects include developing a near-real-time land cover dataset (Dynamic World), deforestation monitoring and alerts (Global Forest Watch), ending commodity-driven deforestation and accelerating restoration (Forest Data Partnership), measuring and mitigating extreme heat (supported by Google.org), and educating stakeholders on 24/7 CFE.

Awards and recognition

2022 CDP Climate Change A List

Alphabet has been named to CDP's Climate Change A list, demonstrating our continued commitment to transparency and climate reporting. Since 2014, Alphabet has been included on CDP's Climate Change A List eight times.

2022 CDP Supplier Engagement Leader

Alphabet achieved an A-rating, making it onto CDP's Supplier Engagement Rating Leaderboard.

EPA Green Power Leadership Award (2022)

Google was recognized by the EPA for its exemplary use of green power and commitment to innovation and market guidance through leadership in the green power markets.

ENERGY STAR Excellence Award in Product Design (2022)

In 2022, Google Nest won an ENERGY STAR Excellence Award in Product Design for the product's best-in-class smart technology, enabling increased energy efficiency.

2021 FSC Leadership Award

Google earned a 2021 leadership award from the Forest Stewardship Council (FSC), which recognizes excellence that advances responsible forest management and conservation, for our efforts to incorporate FSC-certified timber at our Bay View and Charleston East office campuses.

RE100 Changemaker Award (2021)

Google won RE100's Changemaker Award for our innovative 24/7 clean power strategy.

Center for Resource Solution Green Power Leadership Award Winner (2021)

Together, Google and M-RETS won a Green Power Leadership Award for Market Development for piloting their concept of time-based energy attribute certificates at Google data centers.

2022 Carbon Clean200

Alphabet achieved a #2 ranking on the 2022 Carbon Clean200 list.

2022 Corporate Knights' 100 Most Sustainable Companies

Alphabet was ranked #37 out of the world's 100 most sustainable corporations.

Appendix

Reporting approach and methodology

Report scope

Data measurement and uncertainty

Assurance

Methodology

Forward-looking information

Environmental data tables

Environmental reporting frameworks index

Endnotes

Glossary

Reporting approach and methodology

Report scope

This report includes data covering our fiscal year January 1, 2022 through December 31, 2022. Most of our environmental data covers Alphabet Inc. and its subsidiaries, the largest of which is Google. All reported data is global and annual unless otherwise specified.

Data measurement and uncertainty

All reported values represent the best data available at time of publication. Where actual data isn't available, we may use estimates. We base our estimates and methodologies on historical experience, available information, and on various other assumptions that we believe to be reasonable.

All environmental data found in this report is subject to measurement uncertainties resulting from limitations inherent in the nature and the methods used for determining such data. The selection of different but acceptable measurement techniques can result in materially different measurements. The precision of different measurement techniques may also vary.

As we improve our methodologies and as new information becomes available, we may continue to revise our estimates and assumptions. Methodology changes may include changes in a calculation, improvements in the quality of data, new activity types for greater data granularity, and updates to available supplier-reported data. Such updates may result in material changes to our calculations and may also result in adjustments made to the current and previous periods, including our base year. Where material, we've disclosed these changes and whether previous periods have been adjusted to reflect these updates.

Assurance

We obtain limited third-party assurance from an independent auditor for certain environmental data, including select GHG emissions, energy, and water metrics as indicated in our Environmental data tables below. Ernst & Young LLP reviewed these metrics for the fiscal year ended December 31, 2022. For more details, see our 2022 Independent Accountants' Review Report.

Prior to fiscal year 2019, another third party verified the following emissions: Scope 1, Scope 2 (market-based), Scope 2 (location-based), Scope 3 (business travel and employee commuting), and biogenic. For more information, see our prior annual Environmental Reports.

Methodology

The below methodologies apply to our GHG emissions, as well as certain other carbon, energy, and water metrics as presented in our Environmental data tables, focused primarily on those where we have obtained third-party limited assurance. These metrics have been rounded as described below. Due to rounding applied to all reported years of data in our 2023 Environmental Report, some of our reported values for prior years don't directly match the related Independent Accountants' Review Reports from those years.

Greenhouse gas emissions

GHG emissions reporting standards

GHG emissions are calculated according to the Greenhouse Gas Protocol standards and guidance developed by the WRI and the WBCSD, including A Corporate Accounting and Reporting Standard (Revised Edition), Scope 2 Guidance, and Technical Guidance for Calculating Scope 3 Emissions (collectively, "the Greenhouse Gas Protocol").

Our inventory

We use the operational control approach to define our organizational boundary, which means that we account for all emissions from operations over which we have control. We define operational control as having the authority to introduce and implement operational policies over an asset, and we report all energy and emissions for Alphabet Inc. and its subsidiaries' data centers, offices, and other assets under our operational control ("Global Facilities"). In September 2022, Google acquired Mandiant, and Mandiant's emissions are included in our organizational boundary for fiscal year 2022.

Our Scope 1 and Scope 2 emissions include four of the seven GHGs addressed by the Kyoto Protocol—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFCs). Other GHGs, including perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3), aren't included in our inventory, as they're not emitted as a result of our operations. Further, in 2022, CO_2 alone represented over 98% of our total Scope 1 and Scope 2 market-based emissions. We convert all emissions to metric tons of carbon dioxide equivalent (tCO_2e) for reporting. All reported values are rounded to the nearest hundred, unless otherwise noted.

We source the global warming potentials (GWP) for each GHG from the IPCC Fourth Assessment Report, Appendix A: Global Warming Potentials.

Scope 1 GHG emissions

Scope 1 GHG emissions are direct emissions from sources such as company vehicles or generators at our offices and data centers. They represent direct emissions from owned Global Facilities, including fuel use from back-up generators, fuel consumption from our operated vehicles and aircraft, methane and nitrous oxide from biogenic fuel sources, natural gas usage, and refrigerant leakage. Where actual data isn't available, estimated natural gas consumption is calculated using square footage of Global Facilities and internally-developed natural gas intensity

factors by office type, based on data from the current fiscal year.

Beginning in 2022, in an effort to continuously implement best practice methodologies, we included fugitive emissions from refrigerant leakage in our operational boundary. These emissions represented approximately 17% of our 2022 Scope 1 GHG emissions. Where actual refrigerant leakage data isn't available, we estimate refrigerant leakage using an internally-developed global warming potential and a leakage rate. We didn't recalculate our Scope 1 GHG emissions for prior years to include refrigerant leakage.

The emission factors used to calculate Scope 1 emissions include the 2017 WRI/WBCSD GHG Protocol Emission Factors from Cross Sector Tools, the 2023 EPA Center for Corporate Climate Leadership GHG Emission Factors Hub, and the 2022 Department for Environment, Food and Rural Affairs (DEFRA) U.K. Government GHG Conversion Factors.

Scope 2 GHG emissions

Scope 2 GHG emissions are indirect emissions from purchased electricity, the production of space heating for our leased offices, and refrigerant leakage at our leased offices. The location-based method reflects the average carbon intensity of the electric grids where our operations are located and thus where our electricity consumption occurs. The market-based method incorporates our procurement choices, namely our renewable energy purchases via contractual mechanisms like power purchase agreements (PPAs).

Actual data, such as third-party invoices, is used to calculate Scope 2 emissions. Where actual data isn't available, estimated electricity and natural gas consumption is calculated using square footage of Global Facilities and internally developed electricity and natural gas intensity factors by office type, based on data from the current fiscal year.

Beginning in 2022, emissions from estimated refrigerant leakage were calculated using an internally-developed global warming potential and leakage rate. Refrigerant leakage included in Scope 2 GHG emissions is immaterial. We didn't recalculate prior year Scope 2 GHG emissions to include refrigerant leakage.

The emission factors used to calculate Scope 2 (location-based) emissions include the 2017 WRI/WBCSD GHG Protocol Emission Factors from Cross Sector Tools, the 2022 IEA Emission Factors, the 2023 EPA eGRID Emission Factors, and the 2022 Climate Registry Default Emission Factors.

The emission factors used to calculate Scope 2 (market-based) emissions include the 2017 WRI/WBCSD GHG Protocol Emission Factors from Cross Sector Tools, the 2022 IEA Emission Factors, the 2022 Association for Issuing Bodies European Residual Mixes, the 2023 EPA eGRID Emission Factors, the 2022 Climate Registry Default Emission Factors, and emission factors specific to energy attribute certificates. The adjusted emission factors from the Association for Issuing Bodies European Residual Mixes are used for European facilities. Outside of Europe, adjusted emission factors aren't available to account for voluntary purchases.

Scope 3 GHG emissions

Scope 3 GHG emissions are indirect emissions from other sources in our value chain, such as our suppliers, use of our consumer hardware products, and business travel. We estimate our Scope 3 GHG emissions using the the Greenhouse Gas Protocol's Technical Guidance for Calculating Scope 3 Emissions (version 1.0), in the following categories identified as relevant:

- Category 1: Purchased goods and services
- Category 2: Capital goods
- Category 4: Upstream transportation and distribution
- Category 6: Business travel
- Category 7: Employee commuting, including teleworking
- Category 11: Use of sold products
- Category 12: End-of-life treatment of sold products

In our Environmental data tables, we present certain emissions from Category 1, Category 2, Category 11, nd Category 12 as an aggregated subtotal—"Other categories"—for business reasons, as described further below.

Our Operational Scope 3 emissions are made up of Category 6 and Category 7, and are third-party assured. All reported Scope 3 emissions values are rounded to the nearest thousand.

Category 1: "Purchased goods and services" includes emissions generated from manufacturing consumer hardware and our food program. To estimate full supply chain emissions generated from manufacturing consumer hardware, we perform third-party-verified Life Cycle Assessments (LCAs) in accordance with ISO 14040 and 14044. For our food program, we use LCA emission factors from WRI and annual Bay Area procurement volumes to estimate emissions, which we extrapolate to our global operations using building admittances.

In our Environmental data tables, emissions from manufacturing consumer hardware products are presented in Category 2: "Capital goods." Emissions from our food program are presented in "Other categories."

Category 2: "Capital goods" includes upstream emissions from the production of capital goods we've purchased, including computing and storage hardware used in our data centers. This category also includes emissions from data center construction. For manufacturing of capital goods, we collect supplier Scope 1 and 2 GHG emissions data directly from our hardware contract manufacturers, component suppliers, and fabless suppliers through the CDP Supply Chain Program; these suppliers represent our key "Tier 1" hardware manufacturing suppliers with whom we have a direct relationship. Where supplier emissions data isn't available, we estimate with industry-average GHG intensities by commodity type and spend data. Data center construction emissions are estimated by using an LCA analysis to derive construction emissions data and then applying this to our construction activity.

In our Environmental data tables, emissions from our Tier 1 hardware manufacturing suppliers are presented in Category 2: "Capital goods," and emissions beyond our Tier 1 hardware manufacturing suppliers are presented in "Other categories." Data center construction emissions are presented in "Other categories."

Category 4: "Upstream transportation and distribution" includes emissions generated primarily from transportation and warehousing of our consumer

products and data center equipment. We collect consumer products and data center equipment transportation emissions from our logistics providers. These well-to-wheel (WTW) GHG emissions are calculated based on fuel use or weight-distance data and routing associated with a shipment. Where logistics provider emissions data isn't available, we use weight and distance data by shipment collected from the providers to estimate WTW emissions, using emissions factors from the 2019 Global Logistics Emissions Council (GLEC) framework. Where logistics provider data isn't available, emissions are estimated based on reported data from other transportation providers and the number of units shipped. For warehousing emissions, we collect energy data directly from the warehouses and estimate emissions using LCA electricity and fuel factors from the 2022 Sphera LCA for Experts database. Where warehouse energy data isn't available, we estimate using the 2018 Commercial Buildings Energy Consumption Survey (CBECS) data and the warehouse square footage allocated to Alphabet.

Category 6: "Business travel" includes emissions from air, rail, and car rental travel. Distance and fuel-based travel data is collected through our online booking system or through a third-party travel agency for all sources. Data obtained from our value chain partners isn't used at this time. Emissions are calculated using 2022 DEFRA U.K. Government GHG Conversion Factors for air travel, the 2017 WRI/WBCSD GHG Protocol Emission Factors from Cross Sector Tools for rail travel, and the 2023 EPA Center for Corporate Climate Leadership GHG Emission Factors Hub for car rental travel.

Category 7: "Employee commuting, including teleworking" includes emissions from the transport of our full-time employees between their homes and their worksites by private vehicle, public transit, motorcycle, and gas-powered scooter commuting trips. To determine the number of commuting trips by mode made in 2022, we surveyed our employees to determine typical commuting patterns and applied these commuting patterns to our global employee population. The calculation uses an average commuting distance for passenger vehicles obtained from the U.S. Department of Transportation's 2017 National Household Travel Survey and an average fuel efficiency for passenger vehicles obtained from the U.S. Department of Transportation's Transportation Statistics Table 4–23. Data obtained from our value chain partners isn't used at this time. Emissions are calculated using 2022 DEFRA U.K. Government GHG Conversion Factors for passenger vehicles. This category also includes teleworking emissions, which we began to estimate and report in 2020, when teleworking became prevalent due to the global pandemic. Teleworking represents emissions generated by employees working remotely from their homes. We apply the estimation methodology outlined in EcoAct's 2020 Homeworking Emissions white paper to our annual average workforce in 2022.

Category 11: "Use of sold products" includes emissions generated by all of Google's flagship consumer hardware products sold in 2022. Flagship consumer hardware products are products that can provide their main functionality without connection to another product. For example, this doesn't include accessories, such as cases. Use impact was calculated using laboratory power draw measurements, data on use patterns, common industry assumptions on product lifetimes, and LCA electricity emission factors from the 2022 Sphera LCA for Experts database. In our Environmental data tables, emissions from use of sold products are presented in "Other categories."

Category 12: "End-of-life treatment of sold products" includes GHG emissions associated with the end-of-life treatment of all of Google's flagship consumer hardware products sold in 2022. End-of-life impact was calculated through our LCA process using emission factors from the 2022 Sphera LCA for Experts database. Our initial assessments identify this category to be one that doesn't have significant life-cycle impact. We continue to develop programs to extend the life of our sold products and also to ensure efficient management of end-of-life materials. In our Environmental data tables, emissions from end-of-life treatment of sold products are presented in "Other categories."

In 2022, we revised our methodology to calculate emissions related to our consumer hardware manufacturing, as we updated from a spend-based methodology to a Life Cycle Assessment-based methodology. We also made improvements to the quality of data used in estimating our emissions associated with manufacturing our data center hardware, as well as the LCAs and LCA emission factors used to calculate emissions related to data center construction. We didn't recalculate prior year Scope 3 GHG emissions to reflect these changes.

Biogenic emissions

In accordance with the Greenhouse Gas Protocol, biogenic emissions are reported separately from other Scope 1 GHG emissions. These CO_2 emissions are generated from our operated vehicles consuming biofuels. Biogenic emissions are calculated using emission factors from the 2023 EPA Center for Corporate Climate Leadership GHG Emission Factors Hub.

Emissions reductions and compensations

We calculate our total operational emissions by summing Scope 1, Scope 2 (market-based), Scope 3 (Category 6: Business travel), and Scope 3 (Category 7: Employee commuting, including teleworking), per the criteria described above. This market-based subtotal has been reduced by the impact of renewable energy procurement via PPAs and market-based emission factors.

Our operational emissions are then further compensated for by high-quality carbon credits enabled through contracted carbon offset projects, which capture and destroy highly potent GHGs. A carbon offset project is an activity that reduces GHG emissions or captures GHG emissions from the atmosphere, ultimately represented by a carbon credit. The carbon credit signifies that GHG emissions are lower than if no one had invested in the project. One carbon credit equals one metric ton of carbon dioxide equivalent prevented from entering the atmosphere. We assess these projects against four standards before investing: additionality, leakage prevention, permanence, and verifiability.

We primarily enter into long-term purchase agreements with carbon credit suppliers to secure future deliveries. Once carbon credits from a project under contract are verified by a third-party and issued by a carbon registry, per the agreement terms, ownership of the carbon credits is transferred from the project owner to Google. Our carbon credits are verified under the Climate Action Reserve (CAR), American Carbon Registry (ACR), Verified Carbon Standard (VCS), or the UNFCCC Clean Development Mechanism.

All carbon credits are retired on a public registry after they're delivered to us. Due to the timing of third-party verifications, delivery and retirement for some 2022 carbon credits occurs after the year ended December 31, 2022. The Greenhouse Gas Protocol states that a GHG target can be met through using credits that are generated from GHG reduction projects at sources external to the (company's) boundary. They're designed to be interchangeable globally and deliverable from a variety of project types. Refer to our Google's Carbon Offsets: Collaboration and Due Diligence white paper for additional information. The quantity of carbon credits enabled through contracted projects is subject to the limited assurance procedures noted above; however, the quality of our projects and the related due diligence isn't subject to the limited assurance procedures.

Other carbon and energy metrics

Our **carbon intensity metrics** are calculated as defined by GRI Disclosure 305-4a-c. Carbon intensity metrics are based on gross global combined Scope 1 and Scope 2 (market-based) emissions. Reported carbon intensity per unit of revenue and per full-time equivalent (FTE) employee values are rounded to the nearest hundredth, and reported carbon intensity per MWh of energy consumed values are rounded to the nearest ten thousandth.

Total energy consumption is calculated as defined by GRI Disclosure 302-1e-f. Total energy consumption includes all fuel and natural gas consumption, purchased electricity, purchased heating, and all electricity generated on-site from renewable sources. Total electricity consumption is calculated as defined by GRI Disclosure 302-1c(i) and 302-1f, and includes both purchased and self-generated electricity. Where actual electricity consumption for facilities isn't available, we estimate consumption using company square footage and internally developed electricity intensity factors based on fiscal year 2022 data.

Electricity purchased from renewable sources (%) is calculated on a calendar-year basis, dividing the volume of renewable electricity (in megawatt-hours) procured for our global operations (i.e., renewable energy procured through our PPA contracts, on-site renewable energy generation, and renewable energy in the electric grids where our facilities are located) by the total volume of electricity consumed by our global operations. This metric includes all renewable energy purchased, regardless of the market in which the renewable energy was consumed.

Google currently purchases enough renewable energy to match our annual global electricity consumption. To achieve our **100% renewable energy match** goal, we first consider both our on-site renewable energy generation and the renewable energy that's already in the electric grids where our facilities are located, then procure renewable energy through PPA agreements and utility renewable energy tariffs. We have a few facilities located in geographies where we're not currently able to source large volumes of renewable energy, so we currently make up for this by buying surplus renewable energy in regions where it's abundant. For example, by buying larger amounts of wind energy in places like Europe, we compensate for our lack of renewable energy purchases in Asia. This approach results in our Scope 2 market-based emissions being greater than zero, per the Greenhouse Gas Protocol Scope 2 Guidance, despite us achieving our 100% renewable energy match globally.

Water metrics

We report all water metrics for Alphabet Inc. and its subsidiaries' data centers, offices, and other assets under our operational control. **"Water consumption"** is equal to (**"Water withdrawal"** – **"Water discharge"**). Our reported water consumption, water withdrawal, and water discharge metrics don't include seawater. Water metrics are rounded to the nearest hundred thousand gallons and are reported in million gallons.

Water withdrawal data is based on actual metered or invoiced data when it's available. At offices where metered or invoiced data isn't available, water withdrawal is estimated using facility square footage and internally developed water withdrawal intensity factors by office type based on fiscal year data. In all instances where actual potable water discharge isn't available, we apply a 90% discharge flow factor to the facility water withdrawal to estimate water discharge. For irrigation water, we apply a 0% discharge flow factor to the facility water withdrawal to estimate water discharge. This estimation process is applicable to all offices and to potable and irrigation water withdrawal at data centers used for domestic purposes (i.e., water not used for IT cooling) where actual discharge isn't available.

Forward-looking information

References to information in this report should not be construed as a characterization regarding the materiality of such information to our financial results or our operations. While certain matters discussed in this report may be significant, any significance should not be read as necessarily rising to the level of materiality used for the purposes of complying with applicable securities laws and regulations. The information in this report may contain projections, future estimates, plans, expectations, goals, and other forward-looking statements. Forward-looking statements are based on current expectations and assumptions that are subject to certain risks and uncertainties, which could cause our actual results to differ materially from those reflected in the forward-looking statements. Any changes in methodology may result in material changes to our calculations and may result in the current and previous periods, including our base year, to be adjusted. Except as required by law, we undertake no obligation to correct, revise, or update any information included in this report.

Environmental data tables

GHG EMISSIONS	Unit	2018	2019	2020	2021	2022
Emission inventory[146]						
Scope 1	**tCO_2e**	**63,500**	**66,700**	**38,700**	**45,100**	**91,200**[147] ✓
Scope 2 (location-based)	tCO_2e	4,344,700	5,116,900	5,865,100	6,576,200	8,045,400 ✓
Impact of PPAs and market-based emissions factors	tCO_2e	-3,660,500	-4,322,700	-4,953,700	-4,753,100	-5,553,200 ✓
Scope 2 (market-based)	**tCO_2e**	**684,200**	**794,300**	**911,400**	**1,823,100**	**2,492,200**[148] ✓
Scope 3 (Category 2: Capital goods)[149]	tCO_2e	3,709,000	2,157,000	1,809,000	1,676,000	2,096,000
Scope 3 (Category 4: Upstream transportation and distribution)	tCO_2e	475,000	459,000	504,000	484,000	556,000
Scope 3 (Category 6: Business travel)	tCO_2e	312,000	369,000	110,000	26,000	211,000 ✓
Scope 3 (Category 7: Employee commuting)	tCO_2e	150,000	173,000	101,000	111,000	151,000[150] ✓
Scope 3 (Other categories)[151]	tCO_2e	8,252,000	8,509,000	6,848,000	7,206,000	4,586,000
Scope 3 (total)	**tCO_2e**	**12,898,000**	**11,667,000**	**9,372,000**	**9,503,000**	**7,600,000**
Total emissions: Scope 1, 2 (market-based), and 3 (total)	**tCO_2e**	**13,645,700**	**12,528,000**	**10,322,100**	**11,371,200**	**10,183,400**
Total operational emissions: Scope 1, 2 (market-based), and 3 (business travel and employee commuting)	tCO_2e	1,209,700	1,403,000	1,161,100	2,005,200	2,945,400 ✓
Emissions compensated for by carbon credits	tCO_2e	-1,209,700	-1,403,000	-1,161,100	-2,005,200	-2,945,400 ✓
Total operational emissions after emissions reductions and compensations	**tCO_2e**	**0**	**0**	**0**	**0**	**0** ✓
Biogenic emissions	tCO_2	22,900	21,900	5,400	3,800	17,900 ✓
Carbon intensity						
Carbon intensity per unit of revenue	tCO_2e/million U.S.$	5.47	5.32	5.21	7.25	9.13 ✓
Carbon intensity per FTE employee	tCO_2e/FTE	8.36	7.96	7.49	12.87	14.76 ✓
Carbon intensity per megawatt-hour of energy consumed	tCO_2e/MWh	0.0707	0.0675	0.0615	0.1006	0.1159 ✓

✓ Assured for 2022

GHG EMISSIONS		2022		
GHG emissions by type[152]	**Unit**	**Scope 1**	**Scope 2 (market-based)**	**Scope 2 (location-based)**
CO_2	tCO_2e	74,700	2,458,200	7,978,700
CH_4	tCO_2e	200	3,400	15,100
N_2O	tCO_2e	200	8,100	29,100
HFCs	tCO_2e	16,100	22,500	22,500
Total	**tCO_2e**	**91,200**	**2,492,200**	**8,045,400**

GHG EMISSIONS		2022		
GHG emissions by region	**Unit**	**Scope 1**	**Scope 2 (market-based)**	**Scope 2 (location-based)**
North America	tCO_2e	62,100	1,228,900	5,990,900
Europe, Middle East, & Africa	tCO_2e	20,900	27,300	685,200
Latin America	tCO_2e	1,600	9,400	138,500
Asia Pacific	tCO_2e	6,600	1,226,600	1,230,800
Global total	**tCO_2e**	**91,200**	**2,492,200**	**8,045,400**

ENERGY		2022	
Electricity and renewable energy by region	**Unit**	**Total electricity**	**Total renewable energy allocated**[153]
North America	MWh	15,585,100	11,288,200
Europe, Middle East, & Africa	MWh	3,429,500	3,356,300
Latin America	MWh	366,400	307,700
Asia Pacific	MWh	2,395,200	10,800
Global total	MWh	**21,776,200**	**14,963,000**

ENERGY[154]	Unit	2018	2019	2020	2021	2022
Energy consumption						
Fuel	MWh	468,200	366,400	181,800	205,200	374,800
Purchased electricity[155]	MWh	10,094,900	12,226,200	15,125,700	18,238,400	21,685,300
Purchased heat	MWh	-	150,500	124,800	119,300	219,100
On-site renewable electricity	MWh	9,400	6,300	7,200	8,800	9,600
Total energy consumption	**MWh**	**10,572,500**	**12,749,500**	**15,439,500**	**18,571,700**	**22,288,800**
Electricity consumption						
Electricity consumption (U.S.)	MWh	7,085,600	8,489,200	10,789,200	12,903,400	15,501,200
Electricity consumption (international)	MWh	3,018,700	3,748,000	4,349,300	5,383,700	6,275,000
Total electricity consumption[156]	**MWh**	**10,104,300**	**12,237,200**	**15,138,500**	**18,287,100**	**21,776,200**
Renewable energy						
Renewable energy contracts (cumulative)	MW	3,800	5,400	5,700	7,200	11,600
Renewable electricity (PPAs)	MWh	8,240,600	9,715,000	12,069,200	14,109,400	16,693,600
Renewable electricity (on-site)	MWh	5,900	6,300	7,200	8,800	9,600
Renewable electricity (grid)	MWh	1,857,800	2,515,900	3,062,100	4,168,900	5,073,000
Total renewable electricity purchased	MWh	**10,104,300**	**12,237,200**	**15,138,500**	**18,287,100**	**21,776,200**
Percentage of electricity procured from renewable sources[157]	%	100	100	100	100	100

Assured for 2022

ENERGY EFFICIENCY (PUE)[158, 159]		Unit	2018	2019	2020	2021	2022
Country	**Location**						
Belgium	St. Ghislain	PUE	1.09	1.09	1.08	1.08	1.09
Chile	Quilicura	PUE	1.12	1.09	1.08	1.09	1.09
Denmark	Fredericia	PUE	-	-	-	-	1.12
Finland	Hamina	PUE	1.09	1.09	1.09	1.09	1.09
Ireland	Dublin	PUE	1.11	1.12	1.09	1.09	1.09
Netherlands	Eemshaven	PUE	1.11	1.09	1.09	1.08	1.07
Singapore	1st facility	PUE	1.18	1.15	1.14	1.13	1.13
Singapore	2nd facility	PUE	-	-	-	-	1.21
Taiwan	Changhua County	PUE	1.14	1.13	1.13	1.12	1.12
United States	Berkeley County, South Carolina	PUE	1.12	1.11	1.11	1.1	1.1
United States	Council Bluffs, Iowa (1st facility)	PUE	1.12	1.12	1.11	1.12	1.12
United States	Council Bluffs, Iowa (2nd facility)	PUE	1.09	1.09	1.09	1.09	1.08
United States	The Dalles, Oregon (1st facility)	PUE	1.13	1.11	1.1	1.11	1.1
United States	The Dalles, Oregon (2nd facility)	PUE	-	1.07	1.07	1.06	1.07
United States	Douglas County, Georgia	PUE	1.12	1.12	1.1	1.09	1.09
United States	Henderson, Nevada	PUE	-	-	-	-	1.11
United States	Jackson County, Alabama	PUE	-	-	-	1.13	1.12
United States	Lenoir, North Carolina	PUE	1.11	1.1	1.09	1.09	1.09
United States	Loudoun County, Virginia (1st facility)	PUE	-	-	-	1.1	1.09
United States	Loudoun County, Virginia (2nd facility)	PUE	-	-	-	1.13	1.09
United States	Mayes County, Oklahoma	PUE	1.1	1.10	1.12	1.1	1.1
United States	Midlothian, Texas	PUE	-	-	-	-	1.16
United States	Montgomery County, Tennessee	PUE	-	-	-	1.1	1.11
United States	New Albany, Ohio	PUE	-	-	-	-	1.14
United States	Papillion, Nebraska	PUE	-	-	-	-	1.13
Average annual fleet-wide PUE across Google-owned and -operated data center campuses		**PUE**	**1.11**	**1.10**	**1.10**	**1.10**	**1.10**

CARBON-FREE ENERGY (CFE)[160,161]	Unit	2019	2020	2021	2022
CFE across Google data centers (hourly)	%	61	67	66	64
CFE across Google offices (hourly)	%	-	-	-	56
CFE across Google data centers and offices (hourly)	**%**	**-**	**-**	**-**	**64**

DATA CENTER CARBON-FREE ENERGY			2022	
Country	**Regional grid[162]**	**Unit**	**Grid CFE**	**Google CFE**
Australia (New South Wales)	Australian Energy Market Operator (AEMO), Australia	%	27	27
Australia (Victoria)	Australian Energy Market Operator (AEMO), Australia	%	34	34
Belgium	Elia, Belgium	%	74	80
Brazil	Operador Nacional do Sistema Elétrico (ONS), Brazil	%	89	89
Canada	The Independent Electricity System Operator (IESO), Canada	%	90	90
Canada	Hydro-Québec, Canada	%	100	100
Chile	Sistema Interconectado Central, Chile	%	53	90
Denmark	Energinet, Denmark	%	82	90
Finland	Fingrid, Finland	%	86	97
France	Réseau de Transport d'Électricité (RTE), France	%	87	87
Germany	Germany	%	56	96
Great Britain	National Grid ESO, Great Britain	%	58	85
Hong Kong	Hong Kong	%	28	28
India	North India Regional Grid, India	%	23	23
India	West India Regional Grid, India	%	24	24
Indonesia	Perusahaan Listrik Negara (PLN), Indonesia	%	13	13
Ireland	EirGrid, Ireland	%	39	39
Israel	Israel Electric Corporation (IEC)	%	2	2
Italy	Terna, Italy	%	42	42
Japan	Kansai Electric Power Company, Japan	%	32	32
Japan	TEPCO Power Grid, Japan	%	16	16

DATA CENTER CARBON-FREE ENERGY			2022	
Country	**Regional grid[163]**	**Unit**	**Grid CFE**	**Google CFE**
Netherlands	Tennet, Netherlands	%	42	57
Poland	Polskie Sieci Elektroenergetyczne (PSE), Poland	%	24	24
Singapore	Energy Market Authority of Singapore, Singapore	%	4	4
South Korea	Korea Power Exchange (KPX), South Korea	%	31	31
Spain	Red Eléctrica, Spain	%	67	67
Switzerland	Swissgrid, Switzerland	%	85	85
Taiwan	Taiwan Power Company, Taiwan	%	18	18
United States of America	Bonneville Power Administration (BPA), U.S.	%	89	89
United States of America	California Independent System Operator (CAISO), U.S.	%	56	56
United States of America	Duke Energy Carolinas, U.S.	%	59	63
United States of America	Electric Reliability Council of Texas (ERCOT), U.S.	%	41	41
United States of America	Midcontinent Independent System Operator (MISO), U.S.	%	35	96
United States of America	Nevada Energy (NVE), U.S.	%	27	27
United States of America	PacifiCorp East (PACE), U.S.	%	31	31
United States of America	Pennsylvania, Jersey, Maryland Power Pool, (PJM), U.S.	%	40	60
United States of America	South Carolina Public Service Authority (Santee Cooper), U.S.	%	26	26
United States of America	Southern Company (SOCO), U.S.	%	28	40
United States of America	Southwest Power Pool (SPP), U.S.	%	47	87
United States of America	Tennessee Valley Authority (TVA), U.S.	%	52	63

WASTE	Unit	2018	2019	2020	2021	2022
Waste generation						
Waste generated[164]	Metric tons	57,100	48,100	28,900	28,200	38,200
Waste diversion						
Landfill diversion rate (data centers)	%	87	90	81	78	86
Landfill diversion rate (offices)	%	76	71	71	64	75[165]
Total landfill diversion rate	**%**	**80**	**77**	**77**	**77**	**84**
Data center hardware refurbishment and reuse						
Refurbished inventory used for server deployment, maintenance, and upgrades[166]	%	-	-	10	13	21
Components resold into the secondary market	Million components	3.5	10.0	8.2	4.9	5.0

WATER[167]	Unit	2018	2019	2020	2021	2022
Global operational water[168]						
Water consumption	Million gallons	-	3,412.4	3,748.9	4,561.8	5,564.7 ✓
Water discharge	Million gallons	-	1,748.3	1,939.8	1,734.8	2,034.9 ✓
Water withdrawal	**Million gallons**	**4,169.8**	**5,160.7**	**5,688.7**	**6,296.6**	**7,599.6** ✓
Water replenishment[169]						
Water replenished	Million gallons	-	-	-	-	271.0
Contracted water replenishment capacity over lifetime of projects	Million gallons	-	-	-	-	1,317.2

✓ Assured for 2022

WATER USE BY DATA CENTER LOCATION[170]		2022			Golf course equivalents (estimated)[174]
Location	**Unit**	**Withdrawal**	**Discharge**	**Consumption**	
Ashburn, Virginia Potable water	Million gallons	48.8 48.8	3.8	45.0	<1
Berkeley County, SC Potable water	Million gallons	732.4 732.4	70.3	662.1	4.4
Council Bluffs, IA Potable water	Million gallons	1,236.0 1,236.0	339.9	896.1	6.0
The Dalles, OR Potable water	Million gallons	352.2 352.2	78.0	274.2	1.8
Douglas County, GA Potable water Reclaimed wastewater[171]	Million gallons	378.3 72.4 305.9	73.1	305.2	2.0
Dublin, Ireland[172] Potable water	Million gallons	0.6 0.6	0.5	0.1	<1
Eemshaven, Netherlands Potable water Non-potable water[173]	Million gallons	336.7 2.0 334.7	109.9	226.8	1.5
Fredericia, Denmark Potable water	Million gallons	26.9 26.9	7.7	19.2	<1
Hamina, Finland Potable water	Million gallons	3.9 3.9	3.5	0.4	<1
Henderson, NV Potable water	Million gallons	133.2 133.2	51.1	82.1	<1
Jackson County, AL Potable water	Million gallons	113.4 113.4	19.4	94.0	<1
Leesburg, VA Potable water	Million gallons	155.2 155.2	26.3	128.9	<1
Lenoir, NC Potable water	Million gallons	349.5 349.5	29.0	320.5	2.1

WATER USE BY DATA CENTER LOCATION[175]		2022			Golf course equivalents (estimated)[178]
Location	**Unit**	**Withdrawal**	**Discharge**	**Consumption**	
Mayes County, OK Potable water	Million gallons	896.8 896.8	207.1	689.7	4.6
Middenmeer, Netherlands Potable water	Million gallons	6.7 6.7	2.0	4.7	<1
Midlothian, TX Potable water	Million gallons	117.3 117.3	24.0	93.3	<1
Montgomery County, TN Potable water	Million gallons	285.3 285.3	36.6	248.7	1.7
New Albany, OH Potable water	Million gallons	69.9 69.9	20.3	49.6	<1
Papillion, NE Potable water	Million gallons	68.4 68.4	21.8	46.6	<1
Quilicura, Chile Potable water	Million gallons	186.5 186.5	82.9	103.6	<1
St. Ghislain, Belgium Potable water Non-potable water[176]	Million gallons	382.4 14.2 368.2	111.8	270.6	1.8
Sterling, VA Potable water	Million gallons	74.9 74.9	19.5	55.4	<1
Storey County, NV[177] Potable water	Million gallons	2.1 2.1	1.9	0.2	<1
Other data center locations Potable water Non-potable water Reclaimed wastewater	Million gallons	664.3 172.0 136.3 356.0	61.4	602.9	4.0
Data centers total Potable water Non-potable water Reclaimed wastewater	**Million gallons**	**6,621.4** 5,120.6 839.1 661.9	**1,401.9**	**5,219.9**	**34.8**

Environmental reporting frameworks index

To determine what content to include in this report, we considered global sustainability reporting frameworks and guidelines, industry best practices, and stakeholder expectations.

We maintain an **ESG Index** which maps our public disclosures to the Sustainable Accounting Standards Board (**SASB**) and to the Task Force on Climate-Related Financial Disclosures (**TCFD**) frameworks. We've formally expressed support for the TCFD reporting framework and its seven principles for climate disclosure, and we believe that our voluntary disclosures on climate-related matters are consistent with the recommendations of the TCFD framework.

Every year since 2009, we've publicly reported our carbon footprint to **CDP** (formerly known as the Carbon Disclosure Project). Since 2014, Alphabet has been included on CDP's Climate Change A-list eight times, demonstrating our continued commitment to transparency and climate reporting. For our most recent CDP Climate Change Response, see our sustainability reports page.

Climate transition plan

In this report, we've outlined elements of our climate transition plan that will help us make progress toward our net-zero ambitions. This includes information about our GHG emissions, science-based emissions reduction target, emissions reduction initiatives, low-carbon products and services, value chain engagement, policy advocacy and engagement, climate risk assessment, and governance mechanisms.

To see where elements of our climate transition plan can be found, see report locations marked with (🌡) in the tables below.

GENERAL				Frameworks		
Environmental disclosure category	**Topic**		**2023 Environmental Report location**	**CDP Climate**	**TCFD**	**SASB**
Strategy and governance	Statement from senior decision-maker		• Introduction - Executive letters	C16. Signoff		
	Sustainability governance	🌡	• Governance and engagement - Sustainability governance	C1. Governance	Governance: A, B	
Reporting approach and methodology	Environmental accounting methodology		• Appendix - Reporting approach and methodology - Methodology	C5. Emissions methodology		
	Third-party assurance	🌡	• Appendix - Reporting approach and methodology - Methodology	C10. Verification		
External engagement	Approach to stakeholder engagement	🌡	• Governance and engagement - Stakeholder engagement	C12. Engagement		
	Value chain engagement		• Governance and engagement - Stakeholder engagement; Partnerships • Empowering individuals • Working together • Operating sustainably	C12. Engagement		
	Policy engagement	🌡	• Governance and engagement - Public policy and advocacy	C12. Engagement		
	Trade association membership	🌡	• Governance and engagement - Public policy and advocacy - Trade associations and third-party groups	C12. Engagement		
	Partnerships		• Governance and engagement - Public policy and advocacy; Partnerships	C12. Engagement		
	External initiatives		• Governance and engagement - Public policy and advocacy; Partnerships; Awards and recognition	C12. Engagement		

🌡 Denotes sections that contain elements of our climate transition plan

CLIMATE CHANGE				Frameworks		
Environmental disclosure category	**Topic**		**2023 Environmental Report location**	**CDP Climate**	**TCFD**	**SASB**
Governance and oversight	Our strategy	🌡	• Operating sustainably - Net-zero carbon	C3. Business strategy		
	Board and/or management oversight	🌡	• Governance and engagement - Sustainability governance	C1. Governance	Governance: A, B	
Management approach	Climate-related risks and opportunities over different time horizons	🌡	• Governance and engagement - Risk management - Climate-related risks	C2. Risks and opportunities	Strategy: A, B	
	Processes for identifying, assessing, and managing climate-related risks and opportunities for business strategy and financial planning	🌡	• Governance and engagement - Risk management - Climate-related risks	C2. Risks and opportunities	Strategy: B Risk management: A, B, C	
	Description of scenario analysis process, strategy, and results		• Governance and engagement - Risk management - Climate-related risks	C2. Risks and opportunities C3. Business strategy	Strategy: C	
	Integration of climate-related risks and scenario analysis into overall risk management and resiliency planning	🌡	• Governance and engagement - Risk management - Climate-related risks	C2. Risks and opportunities	Risk management: C	
	Integration of environmental risks in data center planning	🌡	• Operating sustainably - Net-zero carbon - Our approach - Reducing carbon emissions - Energy-efficient and low-carbon facilities - Data centers	C2. Risks and opportunities	Risk management: B	TC-IM-130a.3 TC-SI-130a.3
	Value chain engagement on climate change	🌡	• Operating sustainably - Net-zero carbon - Reducing carbon emissions - Supplier engagement; Advancing carbon-free energy - CFE investments	C12. Engagement		
	Engagement with external targets and initiatives related to net zero	🌡	• Operating sustainably - Net-zero carbon - Advancing carbon-free energy - Transforming the energy system through partnerships and advocacy • Working together - Our approach - Support partners - Cloud customers and commercial partners; Creating ecosystems for collaboration - Google.org; Google for Startups	C12. Engagement		
	Engagement with public policy and trade associations on climate change		• Governance and engagement - Public policy and advocacy	C12. Engagement		
Goals and targets	Energy- and emissions-related targets and progress against goals		• Introduction - Targets and progress summary	C4. Targets	Metrics and targets: A, C	
Performance indicators	Scope 1, 2, and 3 emissions	🌡	• Appendix - Environmental data tables • Operating sustainably - Net-zero carbon - Our approach - Reducing carbon emissions - Our emissions reduction goal	C7. Emissions breakdown	Metrics and targets: A, B	
	Average annual PUE		• Appendix - Environmental data tables • Operating sustainably - Net-zero carbon - Our approach - Reducing carbon emissions - Energy-efficient and low-carbon facilities - Data centers	C9. Additional metrics	Metrics and targets: A	
	Carbon intensity		• Appendix - Environmental data tables • Operating sustainably - Net-zero carbon - Our approach - Reducing carbon emissions - Our emissions reduction goal	C6. Emissions data	Metrics and targets: A	
	Carbon-free energy percentage	🌡	• Appendix - Environmental data tables • Operating sustainably - Net-zero carbon - Our approach - Advancing carbon-free energy	C1. Governance C4. Targets and performance C8. Energy	Metrics and targets: A, C	TC-IM-130a.1 TC-SI-130a.1
	Reduction of energy consumption within our organization	🌡	• Operating sustainably - Net-zero carbon - Net-zero carbon - Our approach	C2. Risks and opportunities	Metrics and targets: C	
	Development of low-carbon products and services	🌡	• Appendix - Environmental data tables • Operating sustainably - Net-zero carbon - Our approach	C4.5 Low-carbon products	Strategy: A	
	Emissions reductions, compensations, and removals for our operations	🌡	• Appendix - Environmental data tables • Operating sustainably - Net-zero carbon - Our approach - Reducing carbon emissions; Advancing carbon-free energy	C6. Emissions data C11. Carbon pricing	Metrics and targets: C	
	Renewable energy investments and contracts	🌡	• Appendix - Environmental data tables • Operating sustainably - Net-zero carbon - Our approach - Reducing carbon emissions; Advancing carbon-free energy	C2. Risks and opportunities C3. Business strategy C4. Targets and performance C6. Emissions data	Metrics and targets: C	

🌡 Denotes sections that contain elements of our climate transition plan

WATER			Frameworks		
Environmental disclosure category	**Topic**	**2023 Environmental Report location**	**CDP Climate**	**TCFD**	**SASB**
Governance and oversight	Our strategy	• Operating sustainably - Water stewardship			
	Board and/or management oversight	• Governance and engagement - Sustainability governance	C1. Governance		
Management approach	Processes for identifying, assessing, and managing water-related risks and opportunities for business strategy and financial planning	• Governance and engagement - Risk management - Water-related risks • Operating sustainably - Water stewardship - Our approach	C3. Business strategy		
	Water use from high-stress regions	• Operating sustainably - Water stewardship - Our approach - Advancing responsible water use; Benefiting watersheds and communities - Our water replenishment projects	C3. Business strategy		TC-IM-130a.2 TC-SI-130a.2
	Integration of environmental considerations into data center strategic planning	• Operating sustainably - Water stewardship - Our approach - Advancing responsible water use - Data centers	C3. Business strategy		TC-IM-130a.3 TC-SI-130a.3
	Interactions with water as a shared resource	• Operating sustainably - Water stewardship - Our approach - Benefiting watersheds and communities			
	Value chain engagement on water-related issues	• Operating sustainably - Water stewardship - Our approach - Advancing responsible water use - Supply chain	C12. Engagement		
	Engagement with external targets and initiatives related to water stewardship	• Operating sustainably - Water stewardship - Our approach - Benefiting watersheds and communities; Supporting water security with technology • Working together - Our approach - Supporting partners - Adaptation support for communities • Governance and engagement - Partnerships	C12. Engagement		
Goals and targets	Water-related targets and progress against goals	• Operating sustainably - Water stewardship - Our approach • Introduction - Targets and progress summary			
Performance indicators	Water consumption, withdrawal, and discharge	• Introduction - Targets and progress summary • Appendix - Environmental data tables			TC-IM-130a.2 TC-SI-130a.2

MATERIALS			Frameworks		
Environmental disclosure category	**Topic**	**2023 Environmental Report location**	**CDP Climate**	**TCFD**	**SASB**
Governance and oversight	Our strategy	• Operating sustainably - Circular economy			
	Board and/or management oversight	• Governance and engagement - Sustainability governance	C1. Governance		
Management approach	Approach to circular economy	• Operating sustainably - Circular economy - Our approach			
	Circularity throughout our data centers, products, operations, and workplaces	• Operating sustainably - Circular economy - Our approach - Reducing data center waste; Building circular workplaces and stores; Designing more sustainable consumer hardware products			TC-IM-130a.2 TC-SI-130a.2
	Circularity throughout our value chain	• Operating sustainably - Circular economy - Our approach - Working with suppliers			TC-IM-130a.3 TC-SI-130a.3
	Engagement with external targets and initiatives related to circular economy	• Working together - Our approach - Supporting partners - Cloud customers and commercial partners - Responsible sourcing • Governance and engagement - Partnerships • Operating sustainably - Circular economy - Our approach			
Goals and targets	Circular economy-related targets and progress against goals	• Introduction - Targets and progress summary • Operating sustainably - Circular economy - Our approach			

MATERIALS			Frameworks		
Environmental disclosure category	**Topic**	**2023 Environmental Report location**	**CDP Climate**	**TCFD**	**SASB**
Performance indicators	Data center hardware components refurbished or resold	• Operating sustainably - Circular economy - Our approach - Reducing data center waste - Zero Waste to Landfill • Appendix - Environmental data tables			
	LEED-certified office space	• Operating sustainably - Net-zero carbon - Our approach - Reducing carbon emissions - Energy-efficient and low-carbon facilities - Offices • Appendix - Environmental data tables			
	Zero Waste to Landfill progress and certifications	• Operating sustainably - Circular economy - Our approach - Reducing data center waste - Zero Waste to Landfill; Working with suppliers - Manufacturing waste			
	Landfill diversion rate for offices and data centers	• Operating sustainably - Circular economy - Our approach - Building circular workplaces and stores - Workplace operations; Reducing data center waste - Zero Waste to Landfill • Appendix - Environmental data tables			
	Food waste diverted from landfill	• Operating sustainably - Circular economy - Our approach - Building circular workplaces and stores - Workplace operations - Food waste			

NATURE AND BIODIVERSITY				Frameworks		
Environmental disclosure category	**Topic**		**2023 Environmental Report location**	**CDP Climate**	**TCFD**	**SASB**
Governance and oversight	Our strategy		• Operating sustainably - Nature and biodiversity	C2. Risks and opportunities C3. Business strategy		
	Board and/or management oversight		• Governance and engagement - Sustainability governance	C1. Governance		
Management approach	Integration of nature considerations into our buildings, operations, and supply chain		• Operating sustainably - Nature and biodiversity - Our approach - Building for biodiversity - Designing for ecology; Bringing nature back to cities; Sourcing responsibly	C2. Risks and opportunities C3. Business strategy		
	Nature-related adaptation and mitigation strategy and activities		• Operating sustainably - Nature and biodiversity - Our approach - Protecting nature and making it more accessible; Developing technology to address biodiversity loss • Working together - Our approach - Supporting partners - Governments and intergovernmental organizations - Environmental Insights Explorer; Adaptation support for communities; Investing in breakthrough innovation - Ocean ecosystems	C2. Risks and opportunities C3. Business strategy		
	Approach to managing progress against internal and external nature-related targets and expectations		• Operating sustainably - Nature and biodiversity - Our approach			
	Engagement with external targets and initiatives related to nature and biodiversity		• Working together - Our approach - Supporting partners - Governments and intergovernmental organizations; Researchers, academics, and NGOs • Governance and engagement - Partnerships	C15. Biodiversity		
Goals and targets	Nature- and biodiversity-related targets and progress against goals		• Introduction - Targets and progress summary	C15. Biodiversity		
Performance indicators	Native habitat restored and created on our Bay Area campuses		• Operating sustainably - Nature and biodiversity - Our approach - Building for biodiversity - Designing for ecology	C2. Risks and opportunities C3. Business strategy C15. Biodiversity		

Denotes sections that contain elements of our climate transition plan

SUPPLY CHAIN				Frameworks		
Environmental disclosure category	**Topic**		**2023 Environmental Report location**	**CDP Climate**	**TCFD**	**SASB**
Governance and oversight	Our strategy	🌡	• Operating sustainably - Our operations; Net-zero carbon - Reducing carbon emissions - Supplier engagement	C12. Engagement		
	Board and/or management oversight	🌡	• Governance and engagement	C12. Engagement		
Management approach	Approach to supply chain risk environmental assessments and audits		• Governance and engagement - Stakeholder engagement - Supplier engagement			
	Integration of environmental factors within procurement policies and supplier contracts		• Operating sustainably - Net-zero carbon - Our approach - Reducing carbon emissions - Supplier engagement • Governance and engagement - Risk management	C12. Engagement		
	Approach to supplier capacity building, training, and corrective action plans		• Operating sustainably - Net-zero carbon - Our approach - Reducing carbon emissions - Supplier engagement; Circular economy - Our approach - Working with suppliers - Safer chemistry • Governance and engagement - Risk management; Stakeholder engagement - Supplier engagement			
	Engagement with external targets and initiatives related to sustainable supply chains	🌡	• Working together - Our approach - Supporting partners - Cloud customers and commercial partners • Governance and engagement - Partnerships	C12. Engagement		
Goals and targets	Supplier environmental assessment-related targets		• Introduction - Targets and progress summary • Operating sustainably - Circular economy - Our approach - Working with suppliers			
Performance indicators	New suppliers that were screened using environmental criteria		• Governance and engagement - Risk management	C12. Engagement		
	Supplier renewable energy		• Operating sustainably - Net-zero carbon - Our approach - Advancing carbon-free energy - CFE investments	C2. Risks and opportunities		
	Negative environmental impacts in the supply chain and actions taken		• Operating sustainably - Circular economy - Supply chain • Governance and engagement - Risk management			

🌡 Denotes sections that contain elements of our climate transition plan

Endnotes

1 Throughout this report, we use the term "sustainability" to refer to environmental sustainability.

2 Our partners include governments and intergovernmental organizations; customers and commercial partners; and researchers, academics, and non-governmental organizations.

3 Google uses a high-quality ML prediction model to estimate the expected fuel or energy consumption for each route option when users request driving directions. We identify the route that we predict will consume the least amount of fuel or energy. If this route isn't already the fastest one and it offers meaningful energy and fuel savings with only a small increase in driving time, we recommend it to the user. To calculate enabled emissions reductions, we tally the fuel usage from the chosen fuel-efficient routes and subtract it from the predicted fuel consumption that would have occurred on the fastest route without eco-friendly routing and apply adjustments for factors such as: CO_2e factors, fleet factors, well-to-wheels factors, and powertrain mismatch factors. We then input the estimated prevented emissions into the EPA's Greenhouse Gas Equivalencies Calculator to calculate equivalent cars off the road for a year. The 2022 figure covers estimated emissions prevented after eco-friendly routing was launched, from October 2021 through December 2022. Enabled emissions reductions estimates include inherent uncertainty due to factors that include the lack of primary data and precise information about real-world actions and their effects. These factors contribute to a range of possible outcomes, within which we report a central value.

4 This estimated spend is based on contracts signed to purchase clean energy for our operations. Actual spend may vary from these estimates based on changes in renewable electricity output from operational projects, the number of contracts signed, and energy market prices.

5 See endnote 3 above.

6 Estimated energy savings are calculated based on the typical percentage of heating and cooling savings found in real-world studies of the Nest Learning Thermostat. To calculate the total Nest savings, we apply these savings percentages to the actual heating and cooling hours of all Nest thermostats.

7 "Portugal - Countries & Regions," IEA, 2021.

8 The enabled emissions reductions are calculated based on these energy savings, applying standard emission factors for fossil fuels, and using U.S. EPA AVERT marginal emissions for the 95% of electricity savings that occur in the U.S., with an adjusted value for the 5% of electricity savings outside the U.S.

9 For products launched in 2022: Pixel, Nest, and Chromecast devices are made with recycled materials ranging between 9% and 60% based on respective product weights.

10 Unique, signed-in Google users that were provided information to make a more sustainable choice by at least one sustainable product feature.

11 Due to a methodology change, we're not reporting a percent progress towards this target and have instead provided our total GHG emissions (Scope 1, 2 (market-based), and 3) in 2022.

12 In 2022, we expanded our carbon-free energy reporting from only Google-owned and -operated data centers to also incorporate offices and third-party data centers. The 2022 data center CFE number represents a 2% change from 2021 (66% CFE), as a result of including third-party data centers.

13 Based on Google Trends data as of December 2022, when comparing global Google Search interest since 2004.

14 See endnote 3 above.

15 See endnote 6 above.

16 See endnote 7 above.

17 See endnote 8 above.

18 Based on Google's analysis of traffic patterns before and after recommended adjustments to traffic signals that were implemented during tests conducted in 2022.

19 According to Google's own analysis of our more efficient servers, power infrastructure, and cooling systems, compared with data center industry averages.

20 According to Google's platform-neutral measurement for central processing unit (CPU) resources analyzed over a five-year period.

21 For more information on how we're reducing the environmental footprint of our operations, see the Operating sustainably section.

22 "Japan's Greenhouse Gas Emissions Rose 2% in FY21/22 as Economy Recovered," Reuters, April 2023.

23 See endnote 13 above.

24 "Net Zero by 2050 - A Roadmap for the Global Energy Sector," IEA, October 2021.

25 "CO_2 and Greenhouse Gas Emissions," OurWorldInData.org, 2020.

26 Based on Google Trends data as of December 2022, when comparing global Google Search interest since 2013.

27 See endnote 13 above.

28 See endnote 6 above.

29 See endnote 7 above.

30 See endnote 8 above.

31 See endnote 6 above.

32 Nest Renew Energy Shift usage reflects the total number of hours thermostats enrolled in Nest Renew ran Energy Shift features to prioritize cleaner or cheaper energy during 2022.

33 Nest Renew users include anyone in the continental U.S. with a 3rd generation Nest Learning Thermostat, the Nest Thermostat E, or the newest Nest Thermostat connected to a Google account.

34 See endnote 6 above.

35 Based on Google Trends data as of December 2022, when comparing global Google Search interest since 2008.

36 See endnote 13 above.

37 See endnote 35 above.

38 "Transport: Improving the Sustainability of Passenger and Freight Transport," IEA, 2022.

39 Based on Google Trends data as of April 2023, when comparing global Google Search interest from April 2022–April 2023 to that of April 2021–April 2022.

40 See endnote 3 above.

41 "Global EV Outlook 2023 Abstract," IEA, April 2023.

42 See endnote 13 above.

43 Based on Google Trends data as of April 2023, when comparing global Google Search interest from April 2020–April 2023 to that of April 2017–April 2020.

44 See endnote 13 above.

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47 See endnote 43 above.

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51 "Digital Decarbonisation: How the Digital Sector is Supporting Climate Action," Implement Consulting Group, 2022.

52 "68% of the World Population Projected to Live in Urban Areas by 2050, Says UN," United Nations Department of Economic and Social Affairs, May 2018.

53 SDG Indicators, United Nations: Unstats, 2022.

54 "Izmir Sustainable Energy Climate Action Plan," AECOM, 2020.

55 See endnote 18 above.

56 "Spreading Like Wildfire: The Rising Threat of Extraordinary Landscape Fires," UNEP, 2022.

57 Our "Deep Learning for High-Resolution Wildfire Modeling" research was presented at the 2022 International Conference for Forest Fire Research.

58 "Number of deaths due to floods worldwide from 1960 to 2020," Statista, April 2023.

59 "Partnering with Member States," UNEP, 2021.

60 Pitney Bowes Parcel Shipping Index, 2021.

61 "Retail Speaks," McKinsey & Company, 2021.

62 "Feasibility of Afforestation as an Equitable Nature-Based Solution in Urban Areas," *Sustainable Cities and Society*, vol. 81, June 2022.

63 Based on Google Trends data as of December 2022, when comparing global Google Search interest in 2022 to that of 2021.

64 See endnote 35 above.

65 Some of our locations have more than one data center campus, and others weren't yet operational during 2022.

66 "Climate Change 2022: Impacts, Adaptation and Vulnerability Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change," IPCC, 2022.

67 "Climate Commitments Not On Track to Meet Paris Agreement Goals as NDC Synthesis Report is Published," United Nations Climate Change, February 2021.

68 "Is Carbon Capture Too Expensive?" IEA, February 2021.

69 See the Environmental data tables for Carbon intensity per unit of revenue for 2022 (9.13 tCO_2e/million U.S.$). Our 2011 carbon intensity factor was reported in prior Environmental Reports as 38.8 (tCO_2e of gross global combined Scope 1 and market-based Scope 2 emissions/million U.S.$).

70 This third-party projection is based on a 2020 whole-building LCA, following the LEED v4 Building Life Cycle Impact Reduction requirements. The interior design was not factored into this LCA.

71 Refrigerants used in HVAC and refrigeration equipment are often synthetic compounds commonly referred to as super pollutants because their global warming potential is significantly higher than other GHGs like carbon dioxide.

72 "The Carbon Footprint of Machine Learning Training Will Plateau, Then Shrink," *Computer*, vol. 55, July 2022.

73 See endnote 20 above.

74 See endnote 19 above.

75 See endnote 20 above.

76 PUE is a standard industry ratio that compares the amount of non-computing overhead energy (used for things like cooling and power distribution) to the amount of energy used to power IT equipment. A PUE of 2.0 means that for every watt of IT power, an additional watt is consumed to cool and distribute power to the IT equipment. A PUE closer to 1.0 means nearly all the energy is used for computing.

77 According to the Uptime Institute's 2022 Global Data Center Survey, the global average PUE of respondents' data centers was around 1.55.

78 See endnote 19 above.

79 Trailing 12-month PUE consists of the average PUE for the previous 12 months.

80 Data from reported ports for ChargePoint stations in the United States and Canada only are used to estimate emissions prevented from employee EV commuting.

81 Based on data collected from shuttle commuting trips in the Bay Area, as compared to a scenario in which these employees had each used a private, fuel-based car for commuting. Assumptions include average Googler commute distance, miles per gallon assumptions from the Bureau of Transportation, and emissions per gallon of fuel assumptions from the Greenhouse Gas Protocol. Equivalency estimate is based on workdays in the year, using data from "Greenhouse Gas Equivalencies Calculator," U.S. Environmental Protection Agency, accessed 2022.

82 See endnote 81 above.

83 Carbon-free energy is any type of electricity generation that doesn't directly emit carbon dioxide, including (but not limited to) solar, wind, geothermal, hydropower, and nuclear. Sustainable biomass and carbon capture and storage (CCS) are special cases considered on a case-by-case basis, but are often also considered carbon-free energy sources.

84 Alphabet's renewable energy methodology is a custom calculation and is based on a global approach. Percentage of renewable energy is calculated on a calendar-year basis, dividing the volume of renewable electricity (in megawatt-hours) procured for our global operations (i.e., renewable energy procured through our PPA contracts, on-site renewable energy generation, and renewable energy in the electric grids where our facilities are located) by the total volume of electricity consumed by our global operations. The numerator includes all renewable energy procured, regardless of the market in which the renewable energy was consumed. Additional details on Alphabet's criteria and methodology can be found in the "Achieving Our 100% Renewable Energy Purchasing Goal and Going Beyond" disclosure.

85 For example, research by Princeton University and TU Berlin has shown that hourly (24/7) carbon-free energy goals have a greater impact on grid-level decarbonization than the prevailing approach of 100% annual renewable energy matching.

86 See endnote 4 above.

87 See endnote 4 above.

88 "Greenhouse Gas Equivalencies Calculator," EPA, accessed 2022.

89 Our CFE percentage measures the degree to which our electricity consumption on a given regional grid is matched with CFE on an hourly basis. This is calculated using both CFE under contract by Google as well as CFE coming from the overall grid mix. CFE coming from the overall grid mix is based on data obtained from a third party, Electricity Maps, and has not been assured. For more information, see our 2021 white paper, "24/7 Carbon-Free Energy: Methodologies and Metrics."

90 A grid region (or regional grid) corresponds to the area over which a single entity manages the operation of the electric power system and ensures that demand and supply are finely balanced. In the United States, this generally means the ISO or RTO in regions that have these regional

market structures. If no such structure exists, then Google defines the grid region as the electricity-balancing authority where our data centers are located. Outside of the United States, the grid region most often refers to the geographic boundary of a country, because most grid system operators operate at the national level. Certain regions that span multiple countries are well interconnected and could be considered as one grid; however, our grid mix calculations already include import and export considerations and therefore take into account power flows from neighboring grids. In the future, we may update our definition as we work with grid operators to better understand how transmission constraints or congestion impact CFE measurement within and across grid regions.

91 Contracted CFE is the hourly electricity production from clean energy projects whose electricity and associated environmental attributes are contracted to Google via power purchase agreements, retail energy supply arrangements, or other contractual structures. See "24/7 Carbon-Free Energy: Methodologies and Metrics" for more details.

92 "Why Did Renewables Become so Cheap so Fast?" *Our World in Data*, December 2020.

93 See endnote 13 above.

94 "How the Tech Sector Can Drive Renewable Energy Opportunities in APAC," ENGIE Impact, accessed 2023.

95 "Climate Change 2022: Mitigation of Climate Change Summary for Policymakers," IPCC, 2022.

96 "Turning the Tide," Global Commission on the Economics of Water, 2023.

97 We define freshwater as naturally occurring water from surface or groundwater sources that isn't salty, and is suitable for consumption if clean or processed. Freshwater excludes seawater and reclaimed wastewater.

98 Based on the average annual irrigation of golf courses in the southwest U.S. of 459 acre-ft or around 150 million gallons. Source: "How Much Water Does Golf Use and Where Does It Come From?" U.S. Golf Association, 2012.

99 Based on the WRI Aqueduct Water Risk Atlas tool, we define "high water stress" as areas with high or extremely high overall water stress, and "low water stress" as areas with low, low-medium, or medium-high overall water stress.

100 According to Google's own analysis of our data center energy use and carbon emissions in 2021.

101 We contracted a third-party to quantify volumetric benefits by applying industry standard methodologies and defensible data and assumptions.

102 See endnote 101 above.

103 See endnote 35 above.

104 See endnote 63 above.

105 "Earth Overshoot Day," Global Footprint Network, 2023.

106 "The Circular Economy Could Unlock $4.5 Trillion of Economic Growth, Finds New Book by Accenture," Accenture, 2015.

107 "How the Circular Economy Tackles Climate Change," Ellen MacArthur Foundation, 2021.

108 "Building a World Free from Waste and Pollution," Ellen MacArthur Foundation, 2021.

109 "Circular Economy of Construction and Demolition Waste: A Literature Review on Lessons, Challenges, and Benefits," NIH National Library of Medicine, 2021.

110 We've assessed contamination rates for our recycling and composting streams and removed them from our calculation. This contrasts with our historical methodology and the industry standard diversion rate, which assumes that anything placed in recycling or compost bins has zero contamination.

111 Based on Google Trends data as of April 2023, when comparing global Google Search interest from April 2018–April 2023 to that of April 2013–April 2018.

112 See endnote 35 above.

113 "Importance of Methane," EPA, 2021.

114 Percent reduction in food waste per Googler was calculated as food waste generated in kitchens and cafes at Google's global offices per unique badge swipes, against a 2019 baseline.

115 "A Whopping 91 Percent of Plastic Isn't Recycled," *National Geographic*, December 2018.

116 UL110 and IEEE 1680.1 are multi-attribute, consensus-based sustainability standards for mobile phones and for computers and displays, respectively. Google uses a third party to validate conformance and independently certify to these standards. See UL Spot Database.

117 Carbon footprint reduction claim based on third-party verified life cycle assessment. Recycled aluminum in the enclosures is at least 9% of applicable product based on weight.

118 Doesn't include third-party products such as the Nest x Yale Lock.

119 For products launched in 2020 and 2021: Nest, Pixel, and Chromecast devices are made with recycled plastic ranging between 9% and 68% based on weight of plastic used in each respective product launched during this timeframe. The following items are excluded: plastics in printed circuit boards, labels, cables, connectors, electronic components and modules, optical components, electrostatic discharge (ESD) components, electromagnetic interference (EMI) components, films, coatings and adhesives. For products launched in 2022: Pixel, Nest, and Chromecast devices are made with recycled materials ranging between 9% and 60% based on respective product weights.

120 Based on total plastic weight of (A) Google Pixel, Nest, and Chromecast products manufactured in 2022 and (B) Fitbit products launched and manufactured in 2022. Includes U.S. configuration of in-box accessories but does not include standalone accessory products other than Pixel phone cases, and Pixel Watch Active, Stretch, and Woven bands. This does not include plastics in printed circuit boards, labels, cables, connectors, electronic components and modules, optical components, electrostatic discharge (ESD) components, electromagnetic interference (EMI) components, films, coatings, and adhesives.

121 Based on total weight of new Google Pixel, Nest, Chromecast, and Fitbit products launched and manufactured in 2022, including U.S. configuration of in-box accessories. Does not include standalone accessory products other than Pixel phone cases, and Pixel Watch Active, Stretch, and Woven bands.

122 Carbon footprint reduction claim based on third-party-verified life cycle assessment. Recycled aluminum in the enclosures is at least 9% of applicable product based on weight.

123 See endnote 122 above.

124 See endnote 120 above.

125 The following may be excluded from the calculation of percentage: printed circuit boards, labels, cables, connectors, electronic components and modules, optical components, electrostatic discharge components, electromagnetic interference components, films, coatings, and adhesives. Renewable content consists of plastic made from bio-based material. Does not include third-party products such as the Nest x Yale Lock.

126 Based on total weight of new Google Pixel, Nest, Chromecast, and Fitbit retail packaging (excluding adhesive materials) for products launched and manufactured in 2022, as shipped by Google. Due to global variations in packaging, U.S. retail packaging data is used for our reporting. To meet the request of some clients, plastic stickers are applied to some packaging variations. Doesn't include stand-alone accessory products other than Pixel phone cases, and Pixel Watch Active, Stretch, and Woven bands.

127 Based on U.S. retail packaging weight with adhesive materials excluded. To meet the request of some clients, plastic stickers are applied to some packaging variations.

128 See endnote 127 above.

129 See endnote 126 above.

130 See Learn when you'll get software updates on Google Pixel phones for more details.

131 We offer free recycling for eligible products from any brand. Learn more about Google's recycling program on our site.

132 Learn more about UL 2799 Zero Waste to Landfill certification.

133 See endnote 108 above.

134 "A Warning Sign: Where Biodiversity Loss Is Happening Around the World," World Wildlife Fund, 2021.

135 See endnote 134 above.

136 "From Savanna to Suburb: Effects of 160 Years of Landscape Change on Carbon Storage in Silicon Valley, California," *Landscape and Urban Planning*, vol. 195, March 2020.

137 "Charleston Retention Basin Improvement Project," California Environmental Quality Act, accessed 2023.

138 "Western Monarch Thanksgiving Count Tallies Over 330,000 Butterflies Before Storms Batter Overwintering Sites," Xerces Society, 2023.

139 See endnote 13 above.

140 "Reduce Urban Heat Island Effect," EPA, May 2019.

141 The percentage of FSC-certified wood used at Bay View and Charleston East is calculated based on material costs for new wood purchased for these projects during construction.

142 See endnote 141 above.

143 "Paris Agreement," UNFCCC, 2015.

144 "Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C Approved by Governments," IPCC, 2018.

145 "Sixth Assessment Report," IPCC, 2019.

146 All reported Scope 1 GHG emissions, Scope 2 GHG emissions, and biogenic emissions values are rounded to the nearest hundred. All reported Scope 3 emissions values are rounded to the nearest thousand.

147 In 2022, we included estimates for hydrofluorocarbon (HFC) emissions resulting from the leakage of refrigerants from cooling equipment at our offices and data centers in our Scope 1 emissions. We have not updated prior years to include estimated refrigerant emissions.

148 Our Scope 2 market-based emissions increased 37%, primarily due to increased data center electricity consumption and a lack of full regional coverage of renewable energy procurement in the United States and Asia Pacific regions.

149 Certain Category 1: "Purchased goods and services" emissions are presented in Category 2: "Capital goods." See the Methodology section for more details.

150 In 2022, we updated our Scope 3 Category 7: "Employee commuting" methodology to estimate additional modes of transportation due to the availability of new data sources. See the Methodology section for more details.

151 We present certain Scope 3 emissions from Category 1, Category 2, Category 11, and Category 12 as an aggregated subtotal "Other categories" for business reasons, as described further in the Methodology section.

152 Other GHGs, including perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3), are not included in our inventory, as they're not emitted as a result of our operations.

153 "Total renewable energy allocated" includes the total amount of renewable electricity generation conveyed via contractual instruments, which have been used in the calculation of Scope 2 market-based emissions per the Greenhouse Gas Protocol Scope 2 Quality Criteria.

154 Reported energy values (in MW or MWh) are rounded to the nearest 100.

155 "Purchased electricity" is electricity sourced from an electrical grid and purchased from a local electric utility company. This metric differs slightly from "Total electricity consumption," which includes both purchased and self-generated electricity.

156 See endnote 155 above.

157 See the Methodology section for an overview of our "percentage of electricity procured from renewable sources" calculation.

158 We report individual campus PUE only for campuses with at least twelve months of data. All reported PUE values are rounded to the hundredths place.

159 See endnote 76 above.

160 See endnote 89 above.

161 See endnote 12 above.

162 See endnote 90 above.

163 See endnote 90 above.

164 Reported waste generated values are rounded to the nearest hundred.

165 Landfill diversion is calculated as waste diverted to a more sustainable pathway than landfill, as a percentage of total waste. Starting in 2022, we've updated our landfill diversion rate methodology for our office operations by removing contamination from our recycling and compost streams, providing a more accurate representation of landfill avoidance, and supporting our efforts to maintain high-quality diverted materials.

166 We expanded this data center hardware refurbishment key performance indicator from including only decommissioned parts that were reused for server maintenance to also including other refurbished part types reused for server maintenance as well as server deployment and upgrades. This change more accurately reflects Google's approach to data center material reuse.

167 All reported water values are rounded to the nearest hundred thousand gallons and reported in million gallons.

168 In 2019, we aligned our water reporting with industry standards to disclose three water indicators: total water withdrawal, consumption, and discharge. Data for total water consumption and total water discharge is not available for prior years. Our reported water metrics don't include seawater.

169 We contracted a third party to quantify volumetric benefits by applying industry standard methodologies and defensible data and assumptions. See the Benefiting watersheds and communities section for more details.

170 Our reported water metrics don't include seawater. All reported water values are rounded to the nearest hundred thousand gallons and reported in million gallons.

171 Treated wastewater from the Sweetwater Creek Sidestream Reuse Facility.

172 Air-cooled facility; no water used for cooling.

173 Industrial water supplied by North Water.

174 See endnote 98 above.

175 See endnote 170 above.

176 Water drawn from the Nimy-Blaton-Peronnes shipping canal and treated on-site.

177 See endnote 172 above.

178 See endnote 98 above.

Glossary

AI: artificial intelligence

Bay View: our Bay View campus in Mountain View, California

CDP: formerly known as the Carbon Disclosure Project

CDR: carbon dioxide removal

CFE: carbon-free energy

CO_2e: carbon dioxide equivalent

EIE: Environmental Insights Explorer

EPA: U.S. Environmental Protection Agency

ESG: environmental, social and governance

EV: electric vehicle

ft: foot

FSC: Forest Stewardship Council

GHG: greenhouse gas

GHGP: Greenhouse Gas Protocol

GT: gigaton

GW: gigawatt

GWP: global warming potential

IEA: International Energy Agency

ILFI: International Living Future Institute

IPCC: Intergovernmental Panel on Climate Change

ISO: International Organization for Standardization

kg: kilogram

km: kilometer

kWh: kilowatt-hour

lb: pound

LBC: Living Building Challenge

LCA: life cycle assessment

LEED: Leadership in Energy and Environmental Design

m: meter

ML: machine learning

MW: megawatt

MWh: megawatt-hour

NGO: non-governmental organization

PPA: power purchase agreement

PUE: power usage effectiveness

SDGs: Sustainable Development Goals

tCO_2e: metric tons of carbon dioxide equivalent

TCFD: Task Force on Climate-Related Financial Disclosures

TWh: terawatt-hour

WBCSD: World Business Council for Sustainable Development

WRI: World Resources Institute

UNEP: United Nations Environment Programme

UNFCC: United Nations Framework Convention on Climate Change

X: Alphabet's "moonshot factory"

Photo details

On the cover:
Google Earth image of Soalala, Madagascar ©2015 DigitalGlobe

Table of contents:
Norther Offshore wind farm in Belgium (92 MW for Google)

Introduction:
Googlers in a courtyard at our new campus in Mountain View, California.

A letter from our Chief Sustainability Officer:
Photo by Vaughn Ridley/Sportsfile for Web Summit via Getty Images

Empowering individuals:
A parking lot full of electric vehicles lined up outside a Google office, plugged into charging stations.

Working together:
Satellite-derived Earth Engine image showing seasonal agricultural peaks near the Columbia and Snake Rivers in Washington state. The perfectly round fields are center pivot irrigated corn and wheat maturing in different months. Data source: Landsat 8, U.S. Geological Survey.

Operating sustainably:
A view of our Bay View campus with the events center in the foreground and a Google brandmark sculpture. (Photo: Iwan Baan)

Net-zero carbon:
Golden Hills wind farm in California (43 MW for Google)

Water stewardship:
Our Bay View campus, as seen from across its stormwater retention pond. (Photo: Iwan Baan)

Circular economy:
A closeup of many small, broken circuit boards in a pile. Our approach to circularity for data center equipment is to maintain components for as long as possible, refurbish components for future reuse, reuse or resell components following a rigorous security process, and recycle any components that can't be reused.

Nature and biodiversity:
The design of the Charleston Retention Basin on our Mountain View Campus allows visitors to experience, learn about, and enjoy the expanded riparian habitat.

Governance and engagement:
Googlers collaborate in a common space in one of our offices.

Appendix:
A bright, colorful wall in a Google office.

Google

Environmental Report

2023

Want to learn more about our latest efforts?

To stay up to date on our news and progress, see our Sustainability blog.

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