Google

Environmental Report

2023

Executive Summary

What's inside

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About the 2023 Environmental Report: Executive Summary

This executive summary is an abridged version of our 2023 Environmental 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.

REPORT RESOURCES

- Full 2023 Environmental Report
- 2023 Environmental data tables

ADDITIONAL RESOURCES

- Sustainability.google
- Sustainability reports
- Sustainability blog
- Our commitments
- Alphabet environmental, social, and governance (ESG)
- About Google

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

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

more extreme weather (flood forecasting, for instance), optimizing systems from traffic lights to car routes, and mitigating climate change in new ways, for example.

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

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

Empowering individuals

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.[5]

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.[6] 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.

To that end, 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. For example, Nest Renew is helping people prioritize cleaner energy usage, and 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.

Transportation relies more heavily on fossil fuels than any other sector.[7] 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—like eco-friendly routing in Google Maps and the "Less emissions filter" on Google Flights—to allow people to more easily make sustainable travel and transportation decisions.

HIGHLIGHTS

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[8]

113 billion kWh

of energy cumulatively saved by customers using **Nest thermostats** from 2011 to 2022[9]—more than double Portugal's annual electricity consumption[10] and equivalent to preventing an estimated 36 million tCO_2e emissions[11]

99% of itineraries

on **Google Flights** included carbon emissions estimates
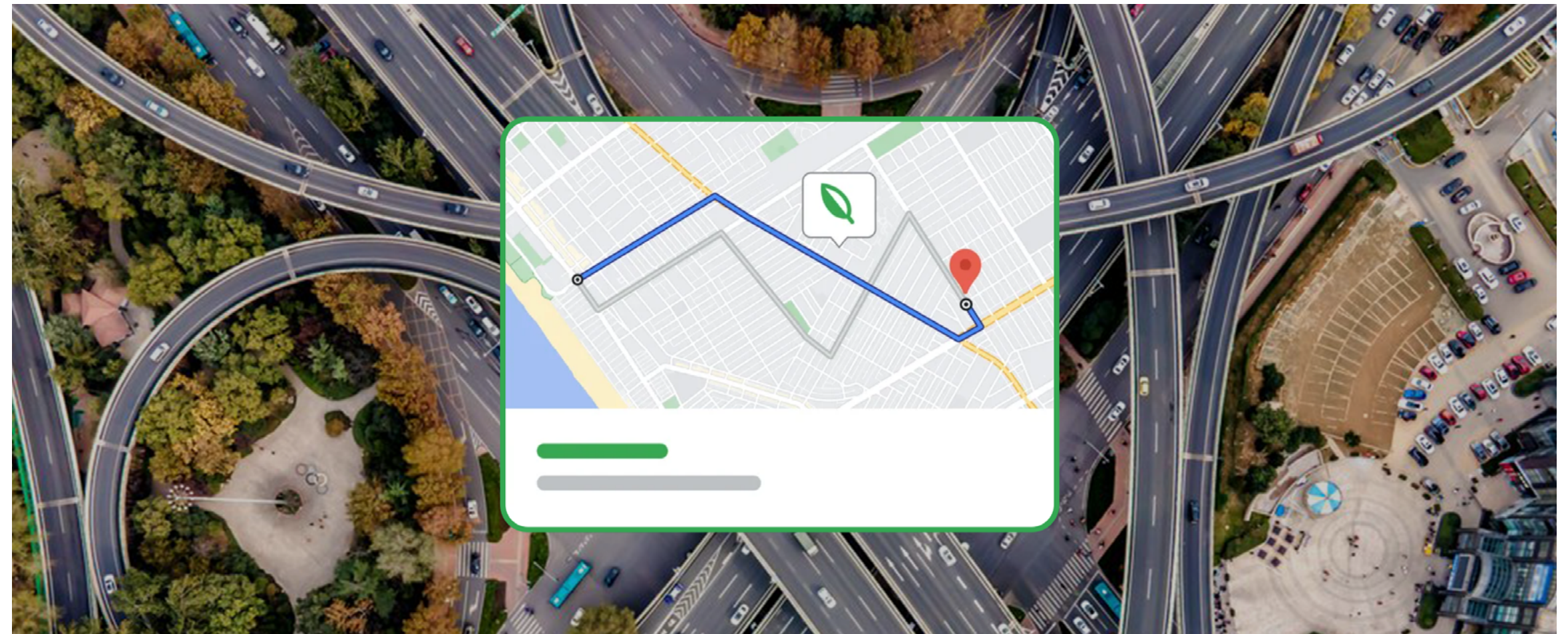
Eco-friendly routing in Google Maps helps users get to their destinations as quickly as possible while minimizing fuel or battery consumption.

Working together

HIGHLIGHTS

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

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.

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, which are available 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.
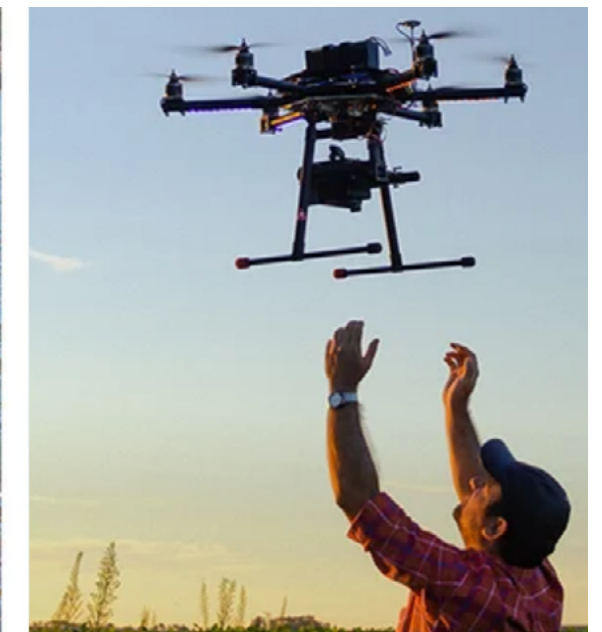
Google has made deep investments over nearly two decades in geospatial technology and platforms such as Google Maps and Google Earth. Google Earth Engine is a leading technology platform for planetary-scale environmental monitoring that was launched in 2010 for scientists and NGOs. In 2022, it was expanded 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.

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.

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.

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

Operating sustainably

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.

We aim 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.

- Replenish more water than we consume and help improve water quality and ecosystem health in the communities where we operate.

- Maximize the reuse of finite resources across our operations, products, and supply chains.

- Protect and enhance nature and biodiversity through our campuses and technology.

There's a shared recognition that unless we act urgently, nobody will be immune from the impacts of climate change, biodiversity loss, or water scarcity in the decades ahead, and that the worst consequences will impact those who are already most vulnerable.

Our role is to combine a sense of optimism and ambition with the power of information and innovation 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 decisively, balancing boldness and responsibility, there's no limit to what we can achieve.

HIGHLIGHTS

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**[12]

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

A view of our Bay View campus with the events center in the foreground and a Google brandmark sculpture. (Photo: Iwan Baan)

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[13]	2022	Achieved
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[14]	before 2030	Ongoing
		Carbon-free energy	Run on 24/7 carbon-free energy on every grid where we operate by 2030	% carbon-free energy	66%	64%[15]	2030	Ongoing
	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
	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
		Offices	Divert all food waste from landfill by 2025	% food waste diverted	N/A	85%	2025	Ongoing
		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
			Make product packaging 100% plastic-free by 2025	% plastic-free packaging	97%	96%	2025	Ongoing
		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

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.[16] 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.[17]

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[18]—more than double Portugal's annual electricity consumption[19] and equivalent to avoiding an estimated 36 million tCO_2e emissions.[20]

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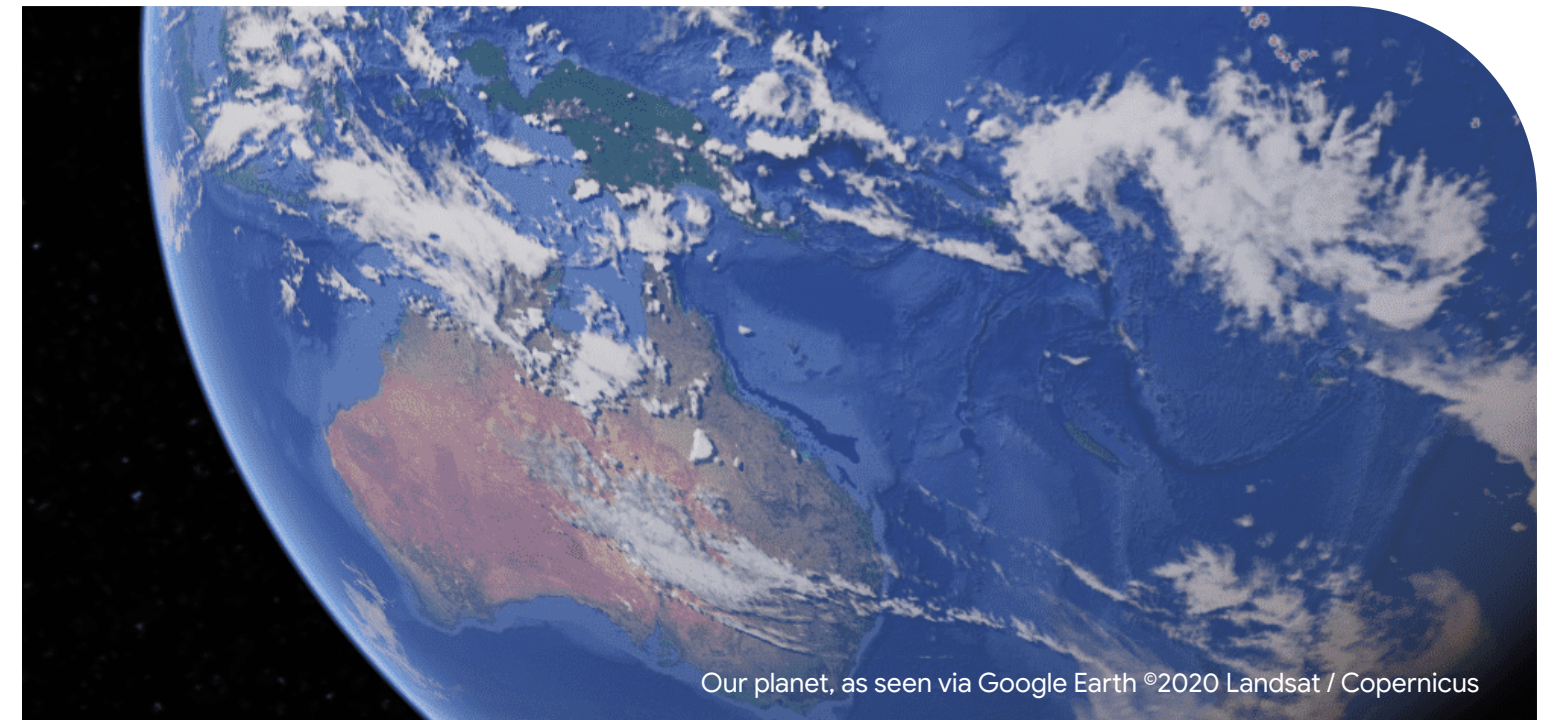
Our planet, as seen via Google Earth ©2020 Landsat / Copernicus

> 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.[21] 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[22] and, compared with five years ago, we now deliver approximately three times as much computing power with the same amount of electrical power.[23] 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.[24]

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.

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

For context, 1 GT is comparable to the entire annual emissions of Japan.[25] 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. This includes concepts like the importance of quantifying real-world actions and the inherent uncertainty of dealing with non-primary data[26].

While carbon accounting principles and these insights 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.

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

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

6 "CO₂ and Greenhouse Gas Emissions," OurWorldInData.org, 2020.

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

8 See endnote 3 above.

9 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.

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

11 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.

12 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.

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

14 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.

15 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 CFE number represents a 2% change from 2021 (66% CFE), as a result of including third-party data centers.

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

17 See endnote 3 above.

18 See endnote 9 above.

19 See endnote 10 above.

20 See endnote 11 above.

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

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

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

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

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

26 Additional approaches and challenges include:

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.

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.

Disclaimers

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. Except as required by law, we undertake no obligation to correct, revise, or update any information included in this report.

Data measurement and uncertainty

All reported values represent the best available data at the time of publication. Where actual data was not 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.

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)

A letter from our Chief Sustainability Officer:
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