Google

Environmental Report

2018

Google Environmental Report 2018

Our approach

Designing efficient data centers

Advancing renewable energy

Creating sustainable workplaces

Empowering users with technology

Appendix

Environmental sustainability at Google

Since our early days, Google has focused on developing services that significantly improve the lives of billions of people while operating our business in an environmentally sustainable way.

We've come a long way in 20 years: maintaining carbon neutrality since 2007, matching 100% of the 2017 electricity consumption of our global operations with renewable energy purchases, leading the industry in data center energy efficiency, creating over 11 million square feet of LEED-certified office space, and diverting more than 75% of our waste from landfills.

We're encouraged by what we've accomplished and are energized by how much more there is to do. Creating a clean and healthy planet is a shared responsibility, and not something that can be solved in a day. That's why we're excited about the great work being done across Google, as well as through long-term, innovative partnerships.

Matching 100% renewable energy is just the beginning. We're enabling 3 gigawatts of new renewable energy around the world and engaging policymakers to unlock opportunities for corporate renewable-energy procurement. We've also taken a science-based approach in designing our buildings to be as healthy as possible and to add value to the communities around them. Through collaborative partnerships, we're leveraging our technology to provide insights that empower decision-makers to protect both people and the planet.

Our commitment to a zero-carbon future drives us to build sustainability into everything we do, and we'll continue using our technology for good in order to help people around the world make smarter use of the earth's resources and drive positive environmental impact.

Ruth Porat
Senior Vice President and
Chief Financial Officer

Alphabet and Google

Urs Hölzle
Senior Vice President of
Technical Infrastructure

Google

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."[1] We believe in technology's potential to have a positive impact on the world. We also believe we're just scratching the surface. Our goal as a company is to remain a place of incredible creativity and innovation that uses our technical expertise to tackle big problems.

We generate revenue primarily through online advertising. Google's core products—Search, Android, Maps, Chrome, YouTube, Google Play, and Gmail—each have more than 1 billion monthly active users.

We also offer a broad collection of cloud-based products and services, including G Suite business productivity apps like Docs, Drive, and Calendar and satellite mapping and analysis platforms like Google Earth and Google Earth Engine. In recent years we've expanded into consumer electronics with products including Google Pixel, Google Pixelbook, Google Home, and Chromecast.

We're a wholly owned subsidiary of Alphabet Inc., which also includes companies such as Access, Calico, CapitalG, GV, Verily, Waymo, and X. As of December 31, 2017, we had more than $110 billion in total revenues and 80,110 full-time employees.

Google's headquarters are located in California, in the San Francisco Bay Area, United States. In this report the term "Bay Area headquarters" refers to our operations in both Mountain View and Sunnyvale. We own and lease office and building space, research and development labs, and sales and support offices across more than 160 cities, primarily in North America, Europe, South America, and Asia, and we own and operate 14 data centers across four continents.

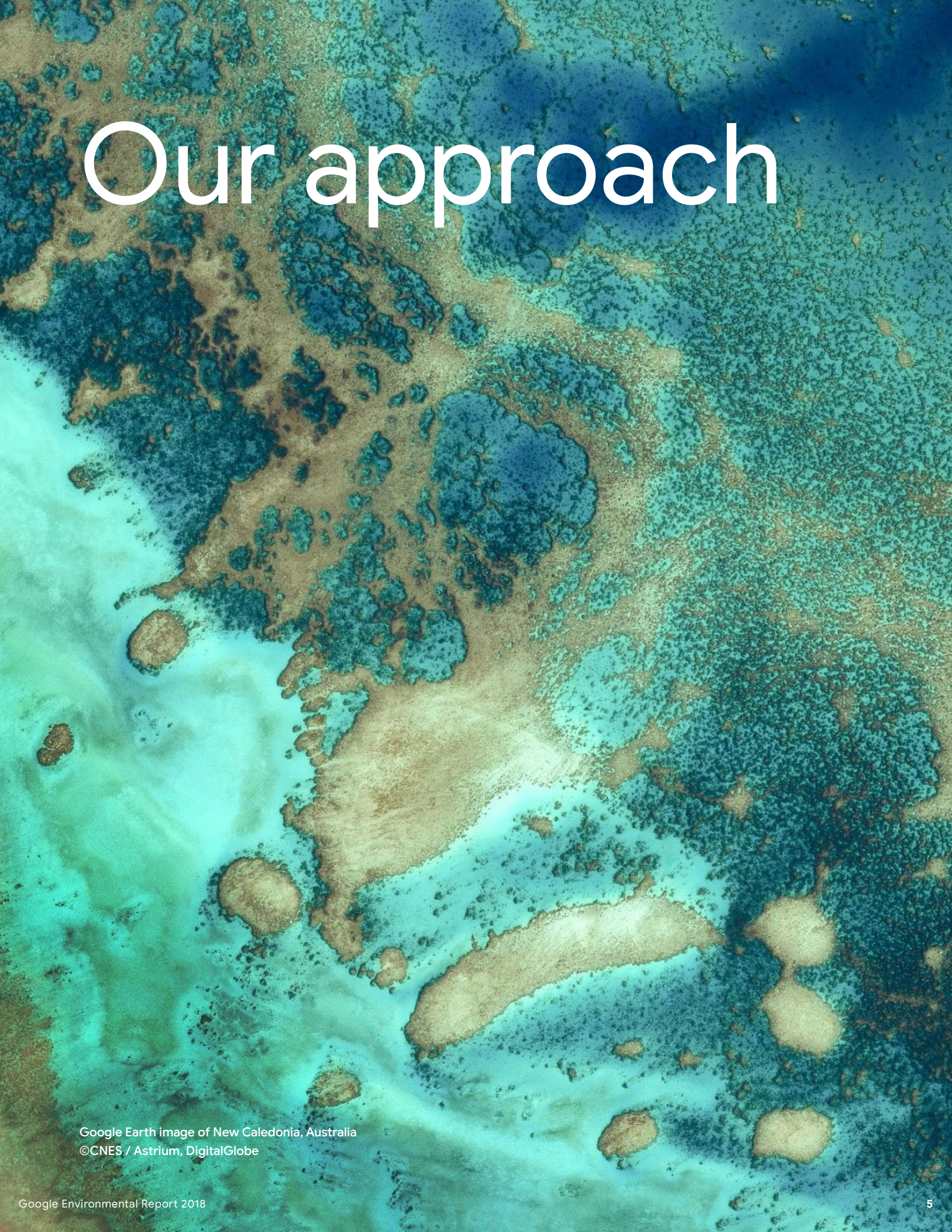
About this report

The annual data in this report covers our 2017 fiscal year (January 1 to December 31, 2017). The spotlights also include data and stories from prior years to provide context, as well as some of our progress in 2018. Unless otherwise specified, all environmental performance data included in this report applies to Google LLC. The primary exception is our greenhouse gas (GHG) emissions and energy use data, which covers the combined operations of Google and our parent company, Alphabet Inc., and has been third-party verified.

For more information about our environmental sustainability initiatives, including case studies, white papers, and blogs, please see our Sustainability website and our *2017 Environmental Report*. Additional information about Google's commitment to corporate responsibility can be found in the resources listed below:

Alphabet's 2018 CDP Climate Change Report
Responsible Supply Chain website
Investor Relations website
Google.org website
Crisis Response website
Diversity & Inclusion website
Accessibility website
Transparency Report
Digital Wellbeing website
Privacy & Security website

Our approach



Google Earth image of New Caledonia, Australia
©CNES / Astrium, DigitalGlobe

The Googleplex in Mountain View, California

Mission and values

Our mission is to organize the world's information and make it universally accessible and useful. Fulfilling this mission and bringing the benefits of information not just to the more than 3 billion people who are already online but to the next 4 billion requires us to use resources ever more efficiently.[2]

The path to a cleaner, healthier future begins with the small decisions we make each day. That's why we're committed to building sustainability into everything we do, making smart use of the earth's resources, and creating products with the planet in mind. We constantly look for ways to have a positive environmental impact and be even more responsible in our use of energy, water, and other natural resources—and we want to empower others to do the same.

Our operations are designed to get the most out of technology, while also being mindful of our use of resources. That's why Google is the world's largest corporate purchaser of renewable energy (see Figure 5 on page 25), and it's what's driven us to be carbon neutral since 2007. Our data centers also lead the industry in energy efficiency, using 50% less energy than the industry average. This same ethos carries over to our workplaces, with over 1 million square meters (11 million square feet) of Leadership in Energy and Environmental Design (LEED) certified offices and the diversion of more than three-quarters of our waste from landfills.

Google Maps provides more than

1 billion

kilometers' worth of alternative transit results per day.

Our tools are built to help us all reduce our environmental impact, understand the planet, and take sustainable action. One hundred percent of the electricity our operations use is matched with renewables, so whether someone is using Google at home or as part of an organization running Google Cloud or G Suite, the net carbon emissions directly associated with those workloads is zero. By mapping the world's forests and fisheries, our technology also makes it easier for researchers and nonprofit groups to monitor the pulse of the planet. For those looking to take sustainable action, the 1 billion kilometers (621 million miles) of alternative transit options we share in Google Maps every day, the tens of millions of rooftops we've mapped for solar potential, and the over 17 billion kilowatt-hours (kWh) we've helped households save through Nest make it easier to do so. And as we continue to grow our Made by Google consumer hardware business, we're on a journey to make consumer electronics that work for people and the planet.

Addressing a global challenge

Humanity is consuming natural resources at an astonishing rate. During the 20th century, global raw material use rose at about twice the rate of population growth.[3] Every year humanity consumes far more than what the planet can naturally replenish. In 2017, global demand for resources was 1.7 times what the earth can support in one year.[4]

These statistics highlight the need to rethink the "take-make-waste" economic model that human societies have followed since the Industrial Revolution, in which we take a natural resource, make a product from it or burn it for fuel, and eventually send what remains to the landfill as waste. A major consequence of this model is climate change, one of the most significant challenges of our time. We believe that Google's scale, resources, and technological expertise can help the world meet its energy and resource needs in a way that drives innovation and growth while reducing GHG emissions and the use of virgin materials and water.

Taking action

Demand for computing power continues to skyrocket, with millions more people coming online every month, and data center capacity continues to expand to meet this need. But despite this growth, the total amount of electricity used by U.S. data centers has remained constant. Annual consumption increased by 90% from 2000 to 2005, but only by 4% from 2010 to 2014, largely due to data centers' ability to improve their efficiency as they scale.[5] As the use of mobile devices increases and more IT users transition to public clouds, we believe our industry can and must do better than just holding the line on energy use. We can actually lower it, serving more users while using fewer resources.

Google Earth image of Santa Cruz Province, Argentina
© CNES / Astrium, DigitalGlobe

Google's energy consumption drives our biggest impact on the environment, and we're focused on tackling it through a threefold strategy for carbon neutrality. First, we pursue aggressive efficiency initiatives. Second, we match 100% of the electricity consumption of our operations with purchases of renewable energy. Third, we buy carbon offsets for any remaining emissions we haven't yet eliminated.

We've long been a vocal advocate for greening electrical grids worldwide. We've supported strong clean-energy and climate-change policies committed to adding clean power to the grid, and we're partnering with governments and nongovernmental organizations to use Google technology and computing power to model the effects of climate change on both a global and a local level. Today, we have contracts to purchase 3 gigawatts (GW) of output from renewable energy projects, and these contracts have led to over $3 billion in new capital investment in projects around the world.[6]

We're also working to incorporate a climate-resilience strategy into our operations that will enable our business and the communities we are part of to thrive despite the effects of climate change. We've developed a set of principles that serve as the foundation for our strategy, which focuses on a people-centric framework that is robust, integrated, diverse, and designed with unique locations, scalability, and longevity in mind.[7] We used this framework to conduct a climate exposure and vulnerability analysis that enabled us to assess the future resilience of our current locations and evaluate the climate resilience of new developments.

In 2017, we diverted

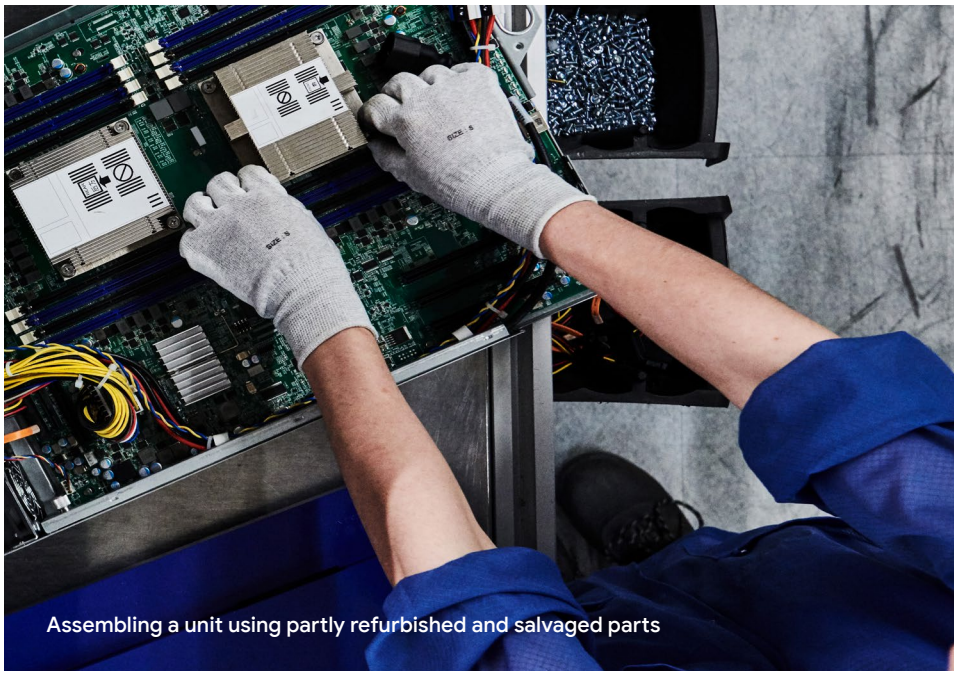
91%

of waste from our global data center operations away from landfills.

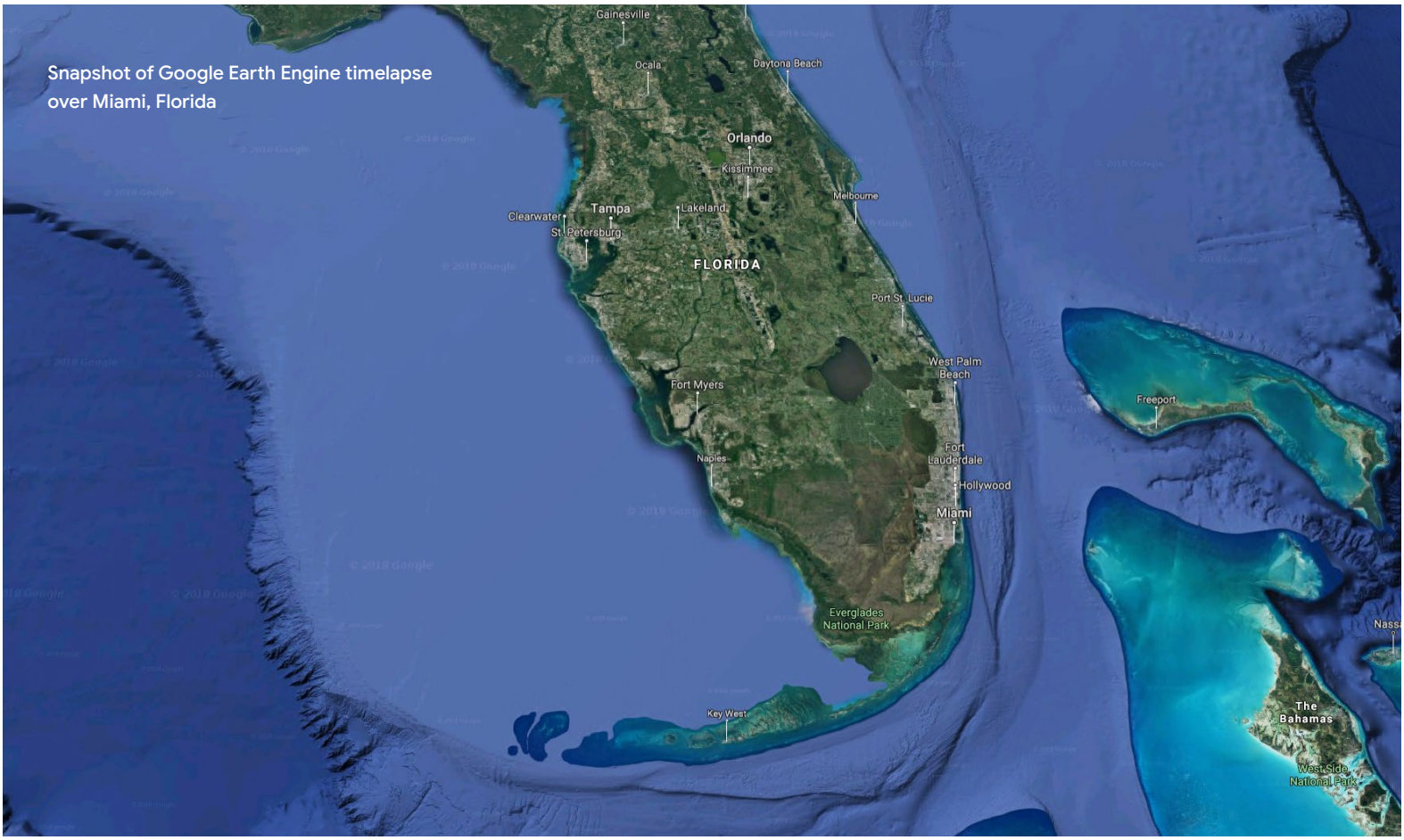
Water is another top priority. The United Nations predicts that by 2025, two-thirds of the world's population could live in water-stressed conditions, and with the existing climate change scenario, almost half the world's population will be living in areas of high water stress by 2030.[8] As a global company headquartered in drought-prone California, we're working to efficiently utilize water, particularly in our data centers, where we regularly redesign and enhance our cooling technologies. We're also using Google technology to help researchers study global water challenges and awarding millions of dollars in grants to promising water-conservation solutions.[9]

Finally, we're changing how we think about waste. In October 2016 we announced that we're committed to achieving Zero Waste to Landfill for our global data center operations by reducing the amount of waste we generate and finding better disposal options. In 2017, we diverted 91% of waste from our global data center operations away from landfills, and we're always looking for new ways to reduce waste in our journey to sustainably manage resources across Google. As a Global Partner of the Ellen MacArthur Foundation, we're also working with other leading companies to help bring initiatives like these to scale, thereby accelerating the transition to a circular economy.

We're applying circular economy principles to design out waste, keep materials in use, and regenerate natural systems. We strive to embed these approaches into everything Google does, from how we manage servers in our data centers to the materials we select to build and furnish our offices. We have also been exploring the role of technology in advancing the circular economy, and we continue to look for opportunities to embed circular principles into the fabric of our infrastructure, operations, and culture.



Assembling a unit using partly refurbished and salvaged parts



Snapshot of Google Earth Engine timelapse over Miami, Florida

Looking toward future opportunities

We believe global businesses like Google should lead the way in improving people's lives, while reducing or even eliminating our dependence on virgin materials and fossil fuels. And we believe this can be done in a way that makes business sense, providing economic returns alongside societal benefits and positive environmental impacts.

Our end goal is to get to a point where renewables and other carbon-free energy sources power our operations every hour of every day. This means empowering all energy users with cheap, clean, zero-carbon energy sources like wind and solar and developing new policies, technologies, and tools that help users, businesses, and activists drive change.

Google tools are helping people measure the planet's health. More and more, machine learning and artificial intelligence applications are enabling scientists and practitioners to create sustainable solutions and to turn the data we have into the insights and knowledge needed to guide better decision-making. Today anyone who is online can view Timelapse on Google Earth Engine and see the world change over recent decades, watching as cities grow, forests disappear, glaciers recede, and lakes dry up. We continue to work with research and nonprofit organizations all over the world to monitor these changes. Our vision is to leverage our mapping, cloud, and machine learning technologies to create a living, breathing dashboard of our planet that can help inform everyday decisions for individuals, organizations, and nations—today and for generations to come—and we are committed to using these technologies in a responsible way.[10]

Figure 1

OUR PRIORITIES

Designing **energy-efficient data centers** and advancing **renewable energy**.

Providing **sustainable workplaces** and engaging our employees in our sustainability programs.

Empowering users with technology that helps address global sustainability challenges.

Managing **water stewardship** and increasing the **climate resilience** of our operations.

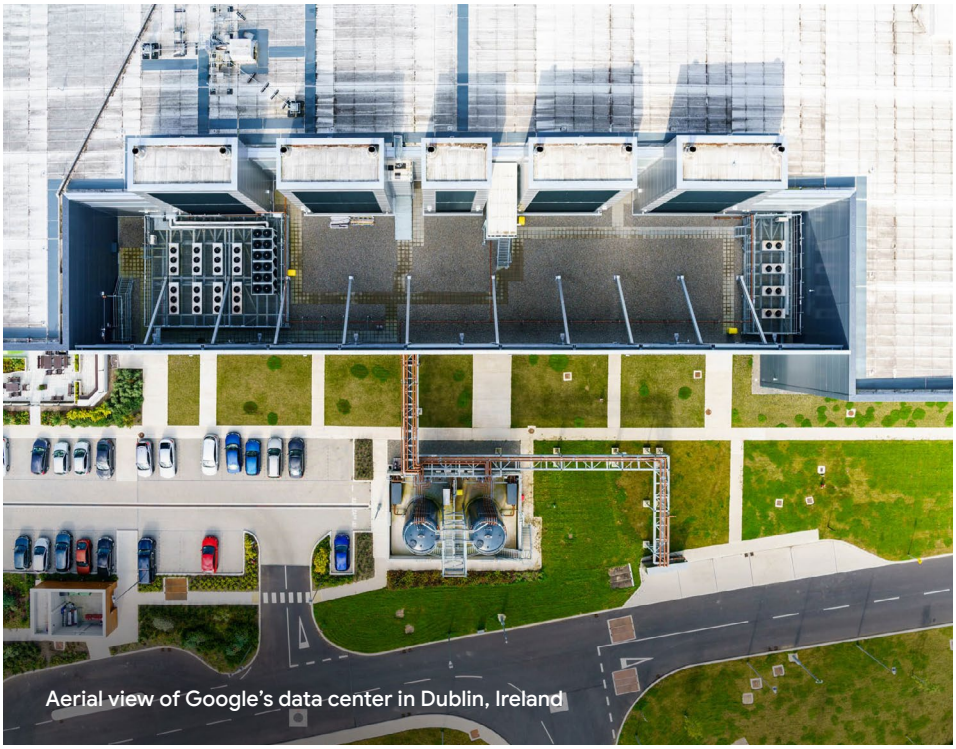
Embedding **circular economy** principles into everything we do.

Engaging our **supply chain** on human rights, safety, and the environment.

Setting our priorities

This year we undertook an assessment to identify and prioritize content for our environmental report. This assessment took into consideration Google's impact on sustainability, the importance of environmental sustainability issues to Google's business strategy, and the perspectives of a diverse range of stakeholders outside of Google.

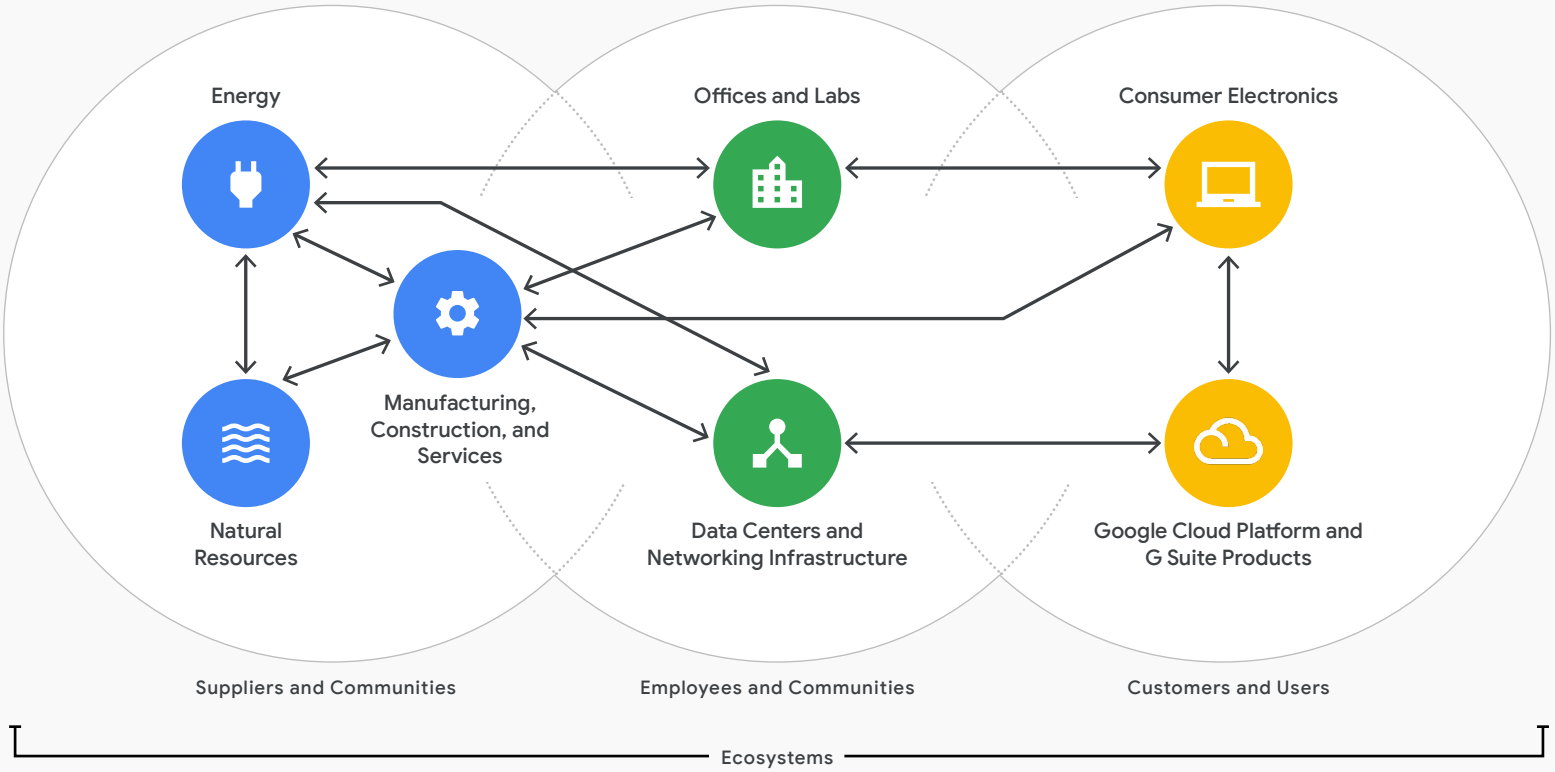
The issue areas that were found to be of greatest relevance include our data centers, workplaces, users, water stewardship, circular economy strategy, and supply chain (see Figure 1). Cutting across these priorities is the importance of engaging on public policy—at local, state, federal, and international levels—to support the success of sustainable business models.



Aerial view of Google's data center in Dublin, Ireland

Figure 2

GOOGLE VALUE CHAIN



Google uses energy, natural resources, and products and services from our suppliers to build our workplaces, data centers, networking infrastructure, and consumer electronics. The software products and services that our customers and users rely on are powered by our data centers and networking infrastructure (see Figure 2). We're driving positive environmental impact throughout our value chain in four key ways: by designing efficient data centers, advancing renewable energy, creating sustainable workplaces, and empowering users with technology.

A view from Google Earth

Performance highlights and targets

The following three pages include highlights of the environmental initiatives discussed in this report. They provide a snapshot of our performance to date and our targets going forward. Together, they demonstrate how we're strengthening our business by reducing the environmental impact of our operations and working to empower people everywhere to live more sustainably.

For a more complete overview of our performance over time, see the environmental data table on page 47.

2017 performance highlights

Designing efficient data centers

Energy

50%
less energy

On average, a Google data center uses 50% less energy than a typical data center.
Page 18

7x
computing power

Compared with five years ago, we now deliver around seven times as much computing power with the same amount of electrical power.
Page 18

1.11
PUE

The average annual power usage effectiveness (PUE) for our global fleet of data centers was 1.11, compared with the industry average of 1.58—meaning that Google data centers use about five times less overhead energy.
Page 19

Certifications

ISO 50001
certification

We maintained ISO 50001 (energy management) certification for 12 of our 14 Google-owned and -operated data centers globally, which together represented more than 96% of our IT energy use.
Page 20

Waste

18%
of servers remanufactured

18% of the servers Google deployed were remanufactured machines.
Page 20

2.1 million
components resold

Over 2.1 million components were wiped clean and resold into secondary markets.
Page 20

100%
landfill diversion

Six of our operating data centers have achieved 100% landfill diversion.[11]
Page 20

91%
waste diverted

We diverted 91% of waste from our global data center operations away from landfills.
Page 20

Advancing renewable energy

Energy

3 GW
of renewable energy

Google is the world's largest corporate purchaser of renewable energy. We've signed 26 agreements totaling nearly 3 GW of renewable energy—generating emissions savings equivalent to taking more than 1.3 million cars off the road per year.
Page 24

100%
renewable energy

We matched 100% of the electricity consumption of our operations with purchases of renewable energy.
Page 24

$2.5 billion
in equity commitments

Since 2010, we've committed to invest nearly $2.5 billion in renewable energy projects with a total combined capacity of 3.7 GW.
Page 27

GHG emissions

87%
decrease in carbon intensity

Over the past six years, our carbon intensity per unit of revenue decreased by 87%.
Page 29

GHG emissions (continued)

11 years
of carbon neutrality

Google has been carbon neutral since 2007. Because of our renewable energy and carbon offset programs, our net operational carbon emissions during this period were zero.
Pages 29 and 30

40
carbon offset projects

Since 2007, we've partnered with more than 40 carbon offset projects to offset more than 17 million metric tons of carbon dioxide equivalent (tCO_2e).
Page 31

2017 performance highlights

Creating sustainable workplaces

Certifications

11.1 million square feet LEED-certified

Over 1 million square meters (11.1 million square feet) of Google office facilities have achieved LEED certification.
Page 34

28% LEED Platinum

28% of our LEED-certified square footage has achieved a Platinum rating and 56% a Gold rating.
Page 34

Water

29 million gallons avoided

We achieved a 15% reduction in potable water intensity at our Bay Area headquarters, which is equivalent to avoiding the use of over 109 million liters (29 million gallons) of potable water.
Page 35

Waste

78% landfill diversion

We reached a 78% landfill diversion rate for our offices globally.
Page 35

Waste (continued)

2.3 million pounds of food waste avoided

Google avoided more than 1 million kilograms (2.3 million pounds) of waste in our cafés globally by tracking pre-consumer food waste and using this data to inform future production levels.
Page 36

Transportation

33,000 tCO_2e savings

By using Google shuttles in the Bay Area, we saved 33,000 tCO_2e emissions—equivalent to taking 6,500 cars off the road every day for a year or avoiding 152 million vehicle kilometers (95 million vehicle miles) per year.
Page 36

Empowering users with technology

Cloud-based products

0 net carbon emissions

Organizations that move IT infrastructure and collaboration applications from a self-managed data center or colocation facility to Google Cloud reduce the net carbon emissions of their computing to zero.
Page 40

98% emissions reduction

A business using Gmail can reduce the GHG emissions impact of its email service by up to 98% compared with running email on local servers.
Page 40

1 month = 1 mile

Providing an active user one month of Google services creates about the same amount of GHG emissions as driving a car 1 mile.
Page 40

Enabling technologies

17 billion kWh of energy savings

Nest Thermostats have helped customers save more than 17 billion kWh of energy combined, based on average savings studies—enough energy to power all of San Francisco's electricity consumption for three years.
Page 42

Enabling technologies (continued)

1 billion km of transit results

Google Maps provides more than 1 billion kilometers' (621 million miles') worth of transit results per day, helping limit carbon emissions by giving people access to mass transit options, bike routes, and traffic information.
Page 43

67 million mapped rooftops

Since 2015, Project Sunroof has mapped more than 67 million rooftops in the United States and Germany. More than 2 million users have accessed the tool to make informed decisions about solar panel installation.
Page 43

70,000 vessels monitored

Global Fishing Watch, powered by Google Cloud Platforms' machine learning algorithms, monitors the planet's fisheries and provides the first view over space and time, covering more than 70,000 of the largest commercial fishing vessels.
Page 43

20 petabytes of geospatial data

Earth Engine has enabled over 80,000 scientists around the world to easily analyze 20 petabytes of freely available geospatial information, resulting in a deeper understanding of the planet.
Page 44

Progress against targets

Target	Deadline	2017 progress	Status
Designing efficient data centers			
Energy			
Maintain or improve quarterly PUE at each Google data center, year over year.	Annual	The average annual PUE for our global fleet of data centers was 1.11. Our fleet-wide PUE has stayed at or below 1.12 since 2013.	●
Waste			
Achieve Zero Waste to Landfill for our global data center operations.	None	We increased our global landfill diversion rate for data center operations by 5%—from 86% in 2016 to 91% in 2017.	○
Certifications			
Maintain ISO 50001 energy management system certification for all Google-owned data centers that meet certain operational milestones.	Annual	We maintained ISO 50001 certification for 12 of our 14 operating data centers, which together represented more than 96% of our IT energy use. In 2017, our two newest facilities in the Netherlands and Chile successfully passed external audits to the ISO 50001 standard.	○
Advancing renewable energy			
Energy			
Match 100% of the electricity consumption of our operations with renewable energy purchases.	2017	Our wind and solar deals produced enough renewable energy to match 100% of the electricity consumption of our data centers and offices in 2017.	●
GHG emissions			
Maintain carbon neutrality for our operations.	Annual	We purchased enough renewable energy and high-quality carbon offsets to bring our net operational carbon emissions to zero. Google has been carbon neutral since 2007.	●
Creating sustainable workplaces			
Certifications			
Pursue third-party green or healthy-building certifications for office projects, such as LEED, WELL Building Standard, and Living Building Challenge.	Annual	Over 1 million square meters (11.1 million square feet) of Google office facilities have achieved LEED certification, with 28% achieving a Platinum rating and 56% a Gold rating.	○
GHG emissions			
Reduce single-occupancy vehicle commuting at our Bay Area headquarters to 45% of those commuting on any given day.	None	For our Bay Area headquarters, we're on track to meeting this commute goal.	◒
Provide electric vehicle charging stations for 10% of parking spaces at our Bay Area headquarters.	None	We have achieved a design standard of approximately 10% for new construction and tenant improvement projects in the Sunnyvale portion of our Bay Area headquarters.	◒
Waste			
Reduce landfill waste per Googler at our Bay Area headquarters by 10% in 2017, compared with a three-year average baseline (2014–2016).	2017	We achieved a 4% reduction in landfill waste per Googler at our Bay Area headquarters.	◒
Set regional waste-reduction targets for our offices in 2017.	2017	We revised our strategy to focus on the highest-impact waste opportunities within our office portfolio. In 2017, we focused on collecting representative and robust waste audit data from our global offices. This effort is the foundation for understanding waste-performance opportunities based on office purchases, waste generation, and supportive local infrastructure.	○
Water			
Reduce potable water intensity at our Bay Area headquarters by 10% by the end of 2017, against a three-year average baseline (2014–2016).[12]	2017	We exceeded this target, achieving a 15% reduction in our Bay Area potable water intensity. This equates to over 109 million liters (29 million gallons) avoided.	●
Set regional water-reduction targets for our offices in 2017.	2017	We revised our strategy to focus on the most water-stressed regions within our portfolio. In 2017, we collaborated with the World Resources Institute (WRI) to understand our water risk profile using the WRI Aqueduct tool. This effort is the foundation for understanding shared risk and opportunity within and outside of our global operations.	○

● Achieved ◒ On track ○ Ongoing ⊘ Missed

Designing efficient data centers

Overview

Google's data centers are the heart of our company, powering products like Search, Gmail, and YouTube for billions of people around the world, 24/7. We own and operate 14 data centers on four continents and continue to add new sites to better serve our customers. Each data center is a large campus where the vast majority of our facilities, servers, networking equipment, and cooling systems are designed from the ground up for maximum efficiency and minimal environmental impact.

For more than a decade, we've worked to make Google data centers some of the most efficient in the world, improving their environmental performance even as demand for our products has dramatically risen. We've done this by designing, building, and operating each one to maximize efficient use of energy, water, and materials.

To reduce energy use, we strive to build the world's most energy-efficient computing network by squeezing more out of every watt of power we consume. First, we outfit each data center with high-performance servers that we've custom designed to use as little energy as possible. We improve facility energy use by installing smart temperature and lighting controls and redesigning how power is distributed to reduce energy loss. We employ advanced cooling techniques, relying primarily on energy-efficient evaporative cooling, and use nonpotable water at some sites. Finally, we're applying machine learning to drive energy efficiency even further.

Our efforts have paid off: On average, Google data centers use 50% less energy than typical data centers use.[13] Compared with five years ago, we now deliver around seven times as much computing power with the same amount

DATA CENTERS: BY THE NUMBERS

50%
less energy

On average, a Google data center uses 50% less energy than a typical data center.

1.11
PUE

In 2017, the average annual PUE for our global fleet of data centers was 1.11, compared with the industry average of 1.58—meaning that Google data centers use about five times less overhead energy.

ISO 50001
certification

We maintained ISO 50001 (energy management) certification for 12 of our 14 Google-owned and -operated data centers globally, which together represented more than 96% of our IT energy use in 2017.

91%
waste diverted

In 2017, we diverted 91% of waste from our global data center operations away from landfills.

of electrical power. Much of this improvement has come from new innovations with accelerators, such as our Tensor Processing Units (TPUs)—highly efficient computer chips we designed specifically for machine learning applications.

In 2017, the average annual PUE (power usage effectiveness)[14] for our global fleet of data centers was 1.11, compared with the industry average of 1.58[15]—meaning that Google data centers use about five times less overhead energy for every unit of IT equipment energy (see Figure 3). Our fleet-wide PUE has stayed at or below 1.12 since 2013 (see Figure 4).

Generating electricity requires water, so the less energy we use to power our data centers, the less water we use as well. The source of energy matters too: Wind and solar energy require considerably less water to produce than do coal and nuclear energy. In 2017, matching our data center electricity consumption with renewable energy reduced our embedded water use by 86% on average compared with buying grid power.

Figure 3

OVERHEAD ENERGY USE IN GOOGLE DATA CENTERS

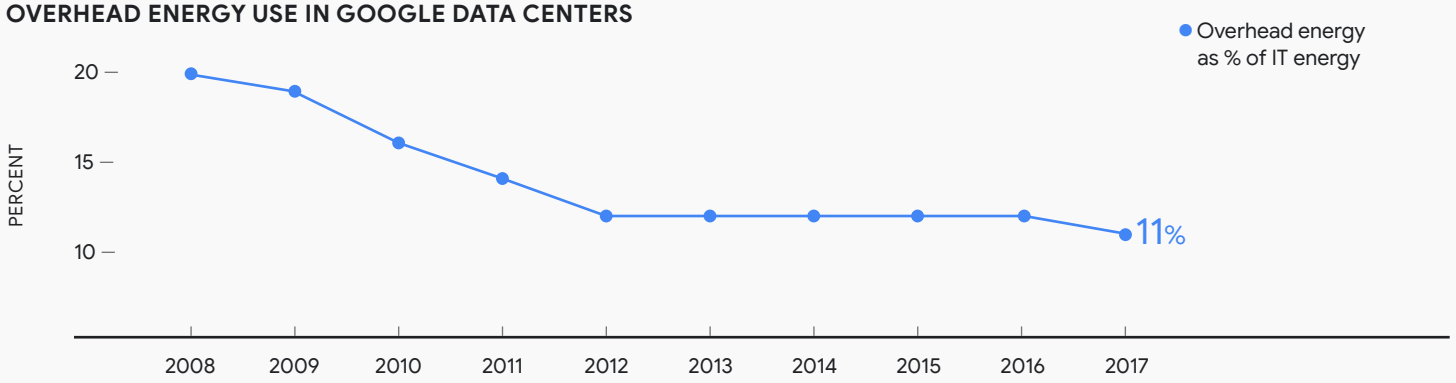
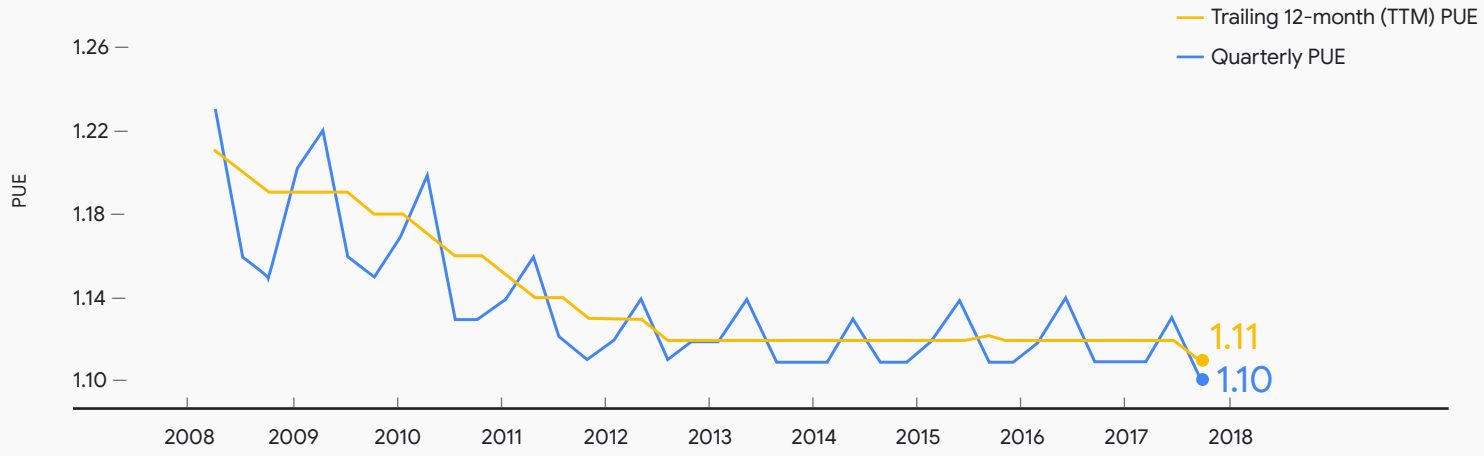
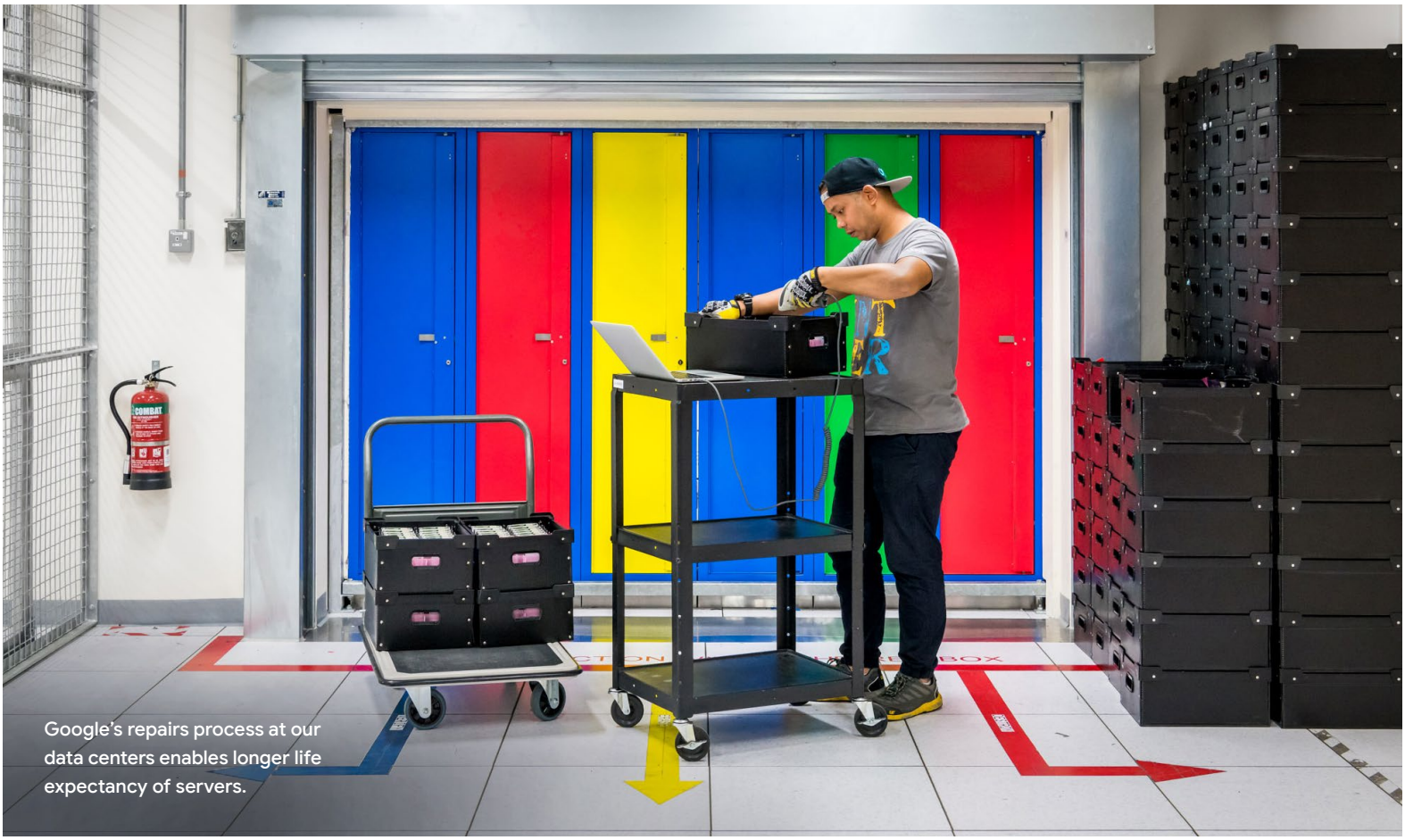


Figure 4

AVERAGE PUE FOR ALL DATA CENTERS





Google's repairs process at our data centers enables longer life expectancy of servers.

In 2013, we became the first company in North America—and the only major internet company—to achieve a multi-site energy management system certification to ISO 50001, a voluntary third-party standard. Our energy management system covers all of our owned data centers globally once they meet certain operational milestones. In 2017, we maintained ISO 50001 certification for 12 of our 14 Google-owned and -operated data centers, which together represented more than 96% of our IT energy use, and our two newest facilities in the Netherlands and Chile successfully passed external audits to the ISO 50001 standard.

We're also working to design out waste, embedding circular economy principles into our server management by reusing materials multiple times. In 2017, 18% of Google's newly deployed servers were remanufactured machines, and 11% of components used for machine upgrades were refurbished inventory. When we can't find a new use for our equipment, we completely erase any components that stored data and then resell them. In 2017, we resold over 2.1 million units into the secondary market for reuse by other organizations.

We're committed to achieving Zero Waste to Landfill[16] for our global data center operations by reducing the amount of waste we generate and finding better disposal options. Six of our operating data centers have achieved 100% landfill diversion.[17] In 2017, we diverted 91% of waste from our global data center operations away from landfills.

Google's data center investments in Europe supported economic activity with

€490

million per year in GDP.

In addition to driving efficiency in our data center operations, we also consider supply chain impacts. Through the efforts of our Responsible Supply Chain program, we collaborate with stakeholders across our supply chain to uphold our high standards for protecting workers and the environment. Our Supplier Code of Conduct builds upon Google's core values and beliefs and incorporates key elements from our internal employee Code of Conduct, international human rights standards, health and safety standards, and environmental standards.

Google has saved more than $1 billion through our energy-efficiency initiatives and hundreds of millions more through resource efficiency. By sharing our best practices and supporting research and collaboration, we hope to help other companies realize their own savings and promote ever-greater data center sustainability worldwide.

Google's investment in digital infrastructure, such as data centers, also supports sustainable growth and creates economic opportunity. In 2016, Google's U.S. data centers generated $1.3 billion in economic activity, $750 million in labor income, and 11,000 jobs.[18] From 2007 to 2017, Google's data center investments in Europe supported economic activity with €490 million per year in gross domestic product (GDP) and 6,600 full-time equivalent (FTE) jobs per year, on average.[19]

LEARN MORE

2016 case study: Circular Economy at Work in Google Data Centers
2016 spotlight: Machine Learning Finds New Ways for Our Data Centers to Save Energy
2018 spotlight: Once Is Never Enough
2018 spotlight: Putting Down Local Roots Where Google's European Data Centers Are Growing
2018 report: European Data Centers: Economic Impact and Community Benefit
2018 report: U.S. Data Centers: Economic Impact and Community Benefit
Google Data Centers website: Efficiency: How We Do It
Website: Responsible Supply Chain

Spotlight

Positive energy: Belgian site becomes first Google data center to add on-site solar

What do you do when your data center is devoted to increasing energy efficiency, but it's already one of the most energy efficient in the world? Start creating your own energy, of course.

This was the conclusion reached by Google data center engineers in Saint-Ghislain, Belgium, who in 2016 proposed constructing an on-site solar facility. While Google is already the world's largest corporate purchaser of renewable energy—in 2017, we matched 100% of electricity use from our operations with renewable energy purchases—the Saint-Ghislain solar plant is the first solar plant we've built on a data center site.

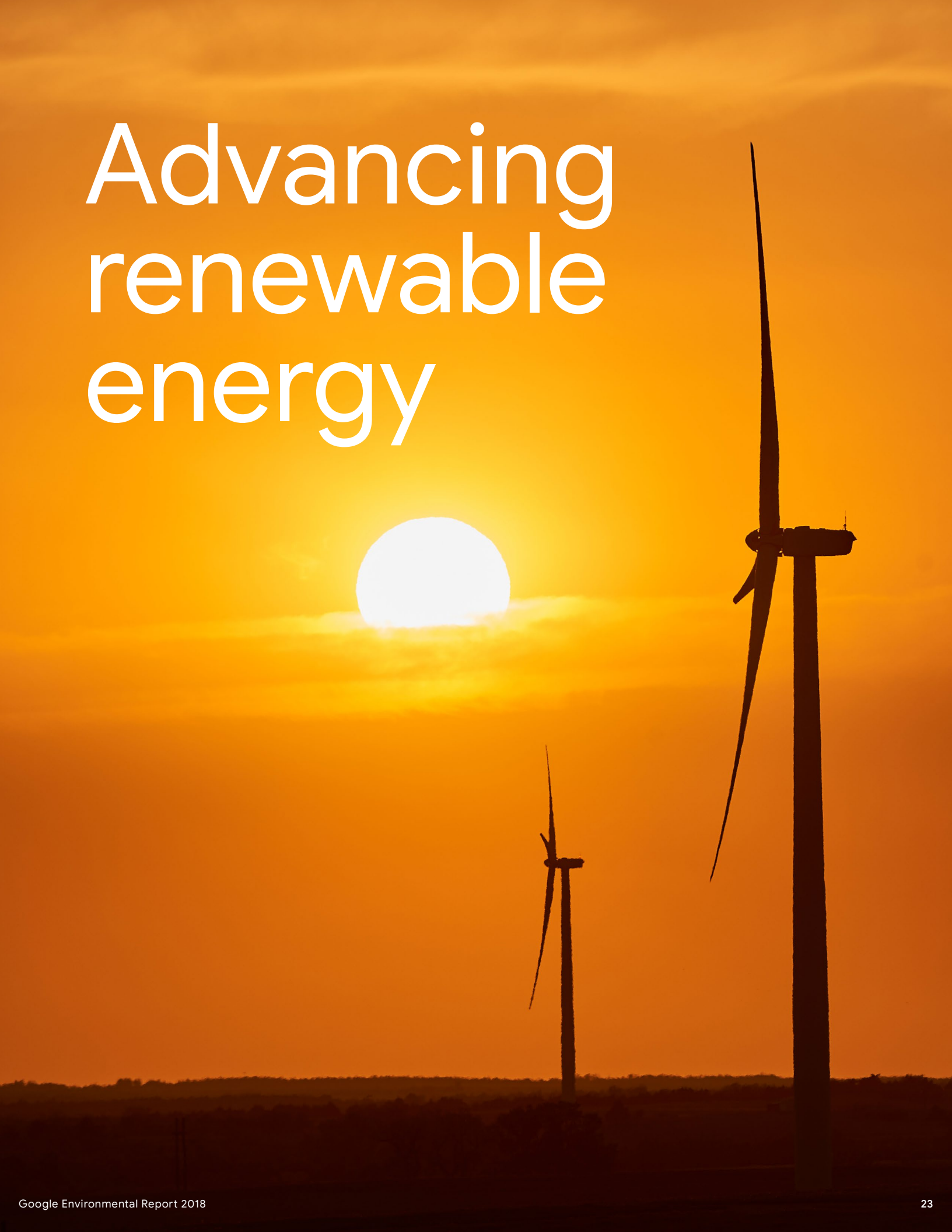
Launched in October 2017, the solar plant's 10,665 photovoltaic panels generate 2.9 gigawatt-hours (GWh) of clean, reliable, renewable energy each year, reducing electricity demand from the Belgian electrical grid and shrinking the site's carbon footprint. Even though the plant meets a relatively small percentage of the site's total power needs, "anything we can do to reduce our consumption of utility energy is significant," says Alain Deprez, facility manager for the Saint-Ghislain site.

In advocating for the solar project, the engineers promoted the role that small-scale renewable projects can play in local communities. The best way to move forward is to continually ask, What's next?

Read about Saint-Ghislain's on-site solar project

On-site solar facility at Google's data center in Saint-Ghislain, Belgium

Advancing renewable energy



Overview

Running our business requires us to use a lot of electricity to power our data centers, offices, and other infrastructure. And combating climate change requires the world to transition to a clean energy economy. So we've made it a top priority to become more energy efficient and to match every unit of energy we consume at our facilities around the world with an equivalent unit of energy from renewable sources, such as wind and solar. Our support for clean energy goes hand in hand with reducing our carbon footprint. By improving the efficiency of our operations and buying both renewable power and high-quality carbon offsets, we've been carbon neutral since 2007.

Google is the world's largest corporate purchaser of renewable energy[20] (see Figure 5). Since 2010, we've signed 26 agreements to purchase a total of nearly 3 GW of renewable energy that is new to the grid (see Figure 6)—generating emissions savings that are equivalent to taking more than 1.3 million cars off the road per year. And in 2012, we set a long-term goal to purchase enough renewable energy to match all the electricity we consume globally on an annual basis.

In 2017, we achieved it: Google's total purchase of energy from sources like wind and solar exceeded the amount of electricity used by our operations around the world, including offices and data centers (see Figure 7). While we're still drawing power from the grid, some of which is from fossil fuel resources, we're purchasing enough wind and solar energy to match every megawatt-hour (MWh) of electricity our data center and office operations consume annually.

RENEWABLE ENERGY: BY THE NUMBERS

3 GW
of renewable energy

Google is the world's largest corporate purchaser of renewable energy. We've signed 26 agreements totaling nearly 3 GW of renewable energy—generating emissions savings equivalent to taking more than 1.3 million cars off the road per year.

100%
renewable energy

In 2017, we matched 100% of the electricity consumption of our operations with purchases of renewable energy.

$2.5 billion
in investment commitments

Since 2010, we've committed to invest nearly $2.5 billion in renewable energy projects with a total combined capacity of 3.7 GW.

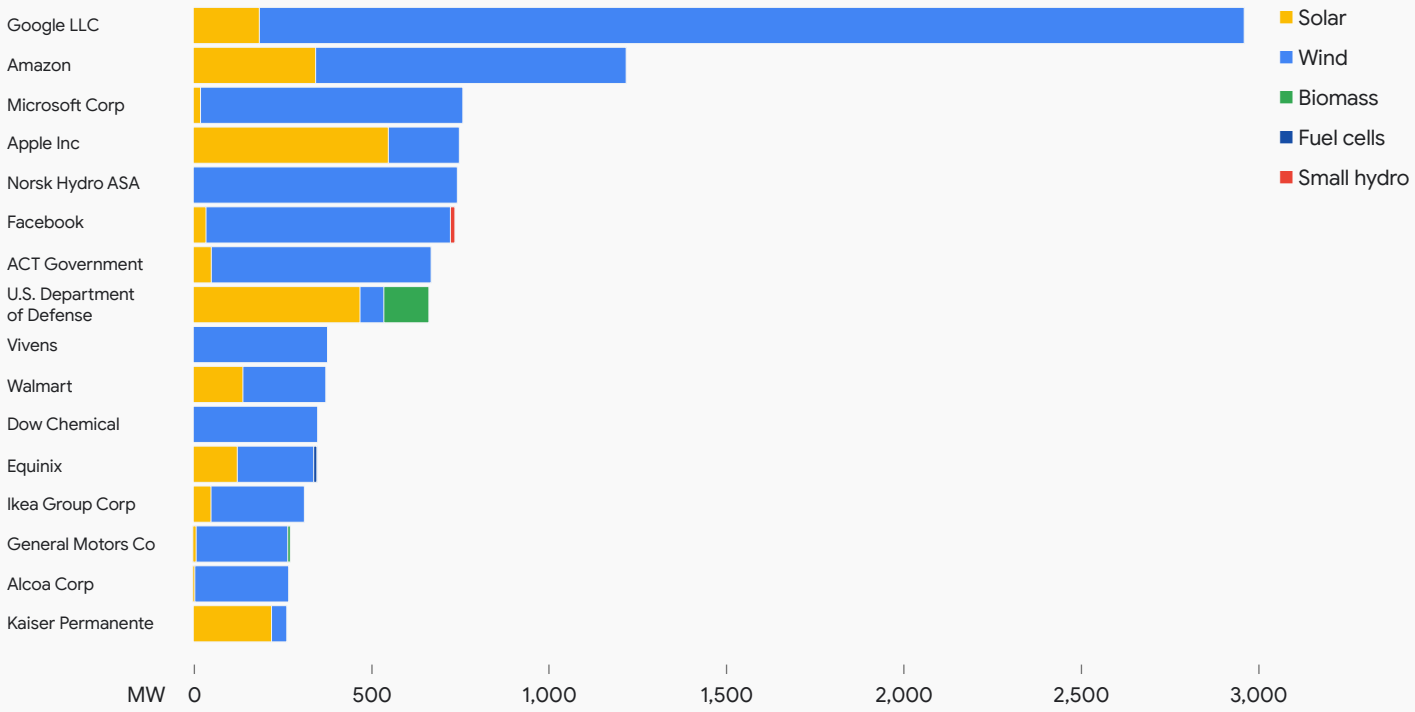
11 years
of carbon neutrality

Google has been carbon neutral since 2007. Because of our renewable energy and carbon offset programs, our net operational carbon emissions during this period were zero.

Minco II wind farm in Oklahoma (101 MW for Google)

Figure 5

CUMULATIVE CORPORATE RENEWABLE ENERGY PURCHASING*



*In Europe, the United States, and Mexico, as of December 31, 2017. Google total also includes one 80 MW project in Chile.

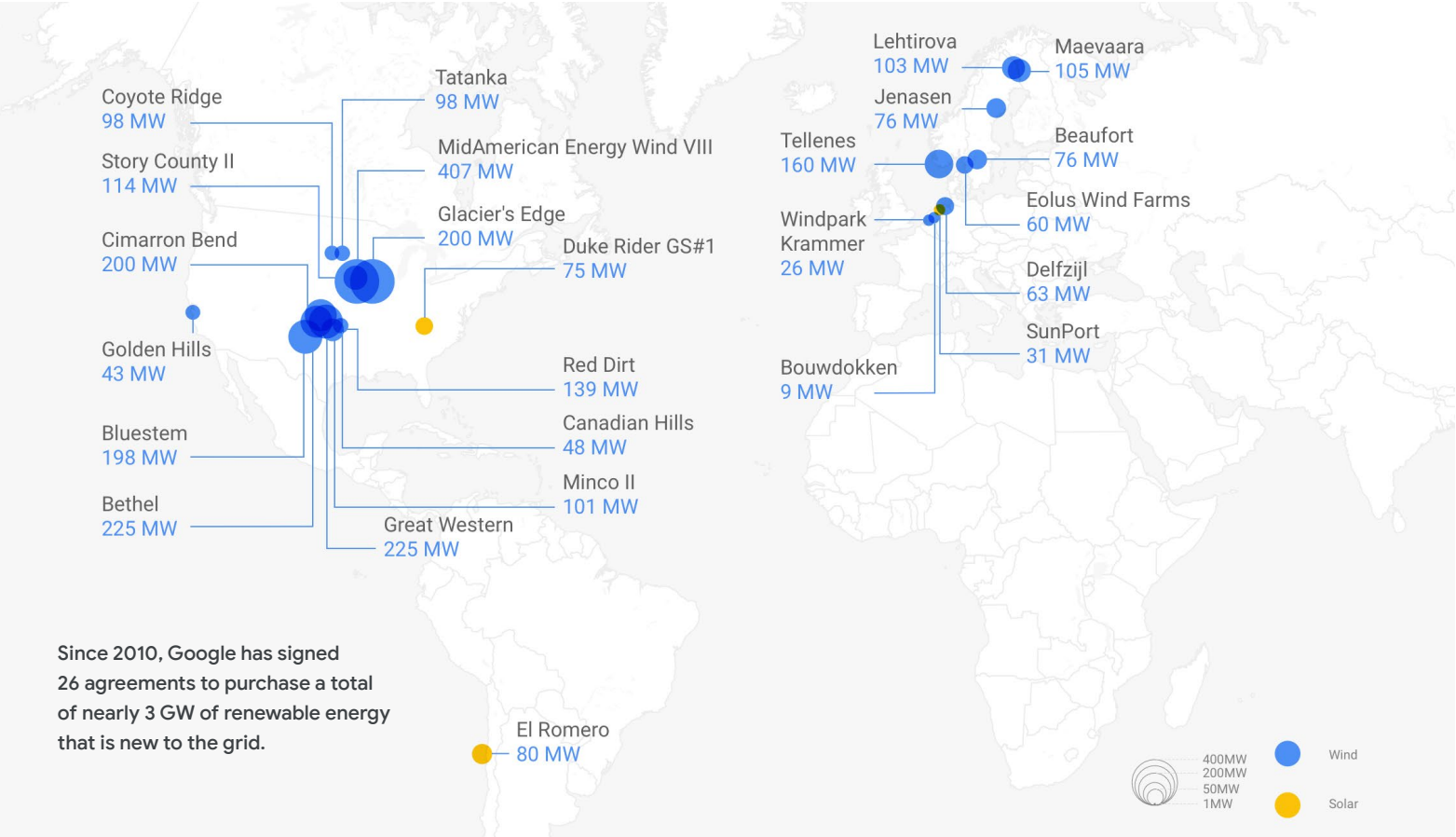
Source: Bloomberg New Energy Finance

We achieved our 100% renewable energy target much faster and at much greater scale than we thought possible when we set this goal six years ago. We met it primarily by buying renewable electricity directly from new wind and solar farms via long-term power purchase agreements (PPAs) on the grids where we have operations, as well as by buying renewable power through utilities via renewable energy purchasing models that we helped create. In addition, a small portion of our utility energy purchases include renewable sources as part of the utility's grid mix.[21] With our PPAs, we're purchasing physical renewable energy, which includes the electrons bundled with renewable energy certificates (RECs).

By pioneering new energy purchasing models that others can follow, we've helped drive wide-scale adoption of clean energy. For example, we joined forces with three leading Dutch companies—AkzoNobel, DSM, and Philips—to source power from two new wind projects in the Netherlands. Our long-term collaboration offers a successful and replicable model for how companies can save time and money and meet ever-growing sustainability targets in a scalable way by jointly sourcing renewable power. Our efforts earned Google two 2017 Green Power Leadership Awards: one in Green Power Market Development from the Center for

Figure 6

RENEWABLE ENERGY FOR GOOGLE'S OPERATIONS



Since 2010, Google has signed 26 agreements to purchase a total of nearly 3 GW of renewable energy that is new to the grid.

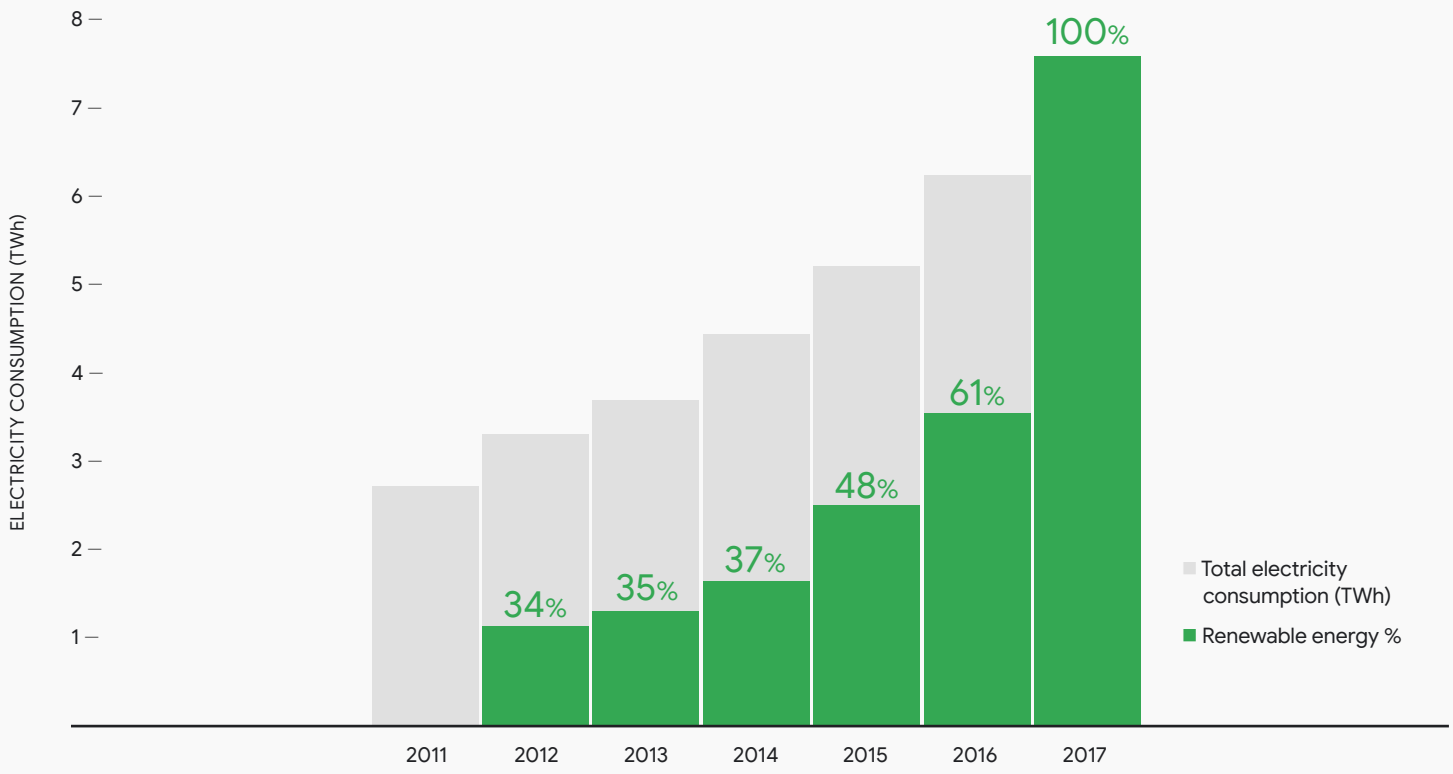
Resource Solutions and one in Excellence in Green Power Use from the U.S. Environmental Protection Agency.

We're also helping to green the power grid through our advocacy of clean energy policies and our support for renewable energy procurement programs. For example, we worked with business and government stakeholders in Taiwan to share our experience with the benefits of corporate renewable energy purchasing and to support the creation of new purchasing channels for companies. We were pleased to see that Taiwan passed a law in January 2017 to allow end-users to directly purchase renewable energy for their operations.

Along with being the world's largest corporate purchaser of renewable energy, Google is also one of the world's largest corporate investors in renewable energy. Since 2010, we've committed to invest nearly $2.5 billion in large-scale renewable energy projects and residential solar rooftop funds with a combined capacity of 3.7 GW. These targeted investments go beyond our own operational footprint, enabling renewable energy deployment at a larger scale while generating attractive risk-adjusted returns.

Figure 7

RENEWABLE ENERGY PURCHASING COMPARED WITH TOTAL ELECTRICITY USE



Minco II wind farm in Oklahoma (101 MW for Google)

The cost of renewable power has dropped precipitously, while its scale has grown dramatically. Over the past eight years, levelized costs for wind and solar energy have decreased by 67% and 86%, respectively.[22] In 2015, wind and solar energy became the world's largest source of newly installed power capacity,[23] and in 2017, 70% of net new power capacity globally came from renewable energy.[24] Renewables have become a mainstream source of affordable electricity for millions of people.

Increasing the share of renewables on the grid will produce many positive impacts. For example, doubling renewables by 2030 is expected to increase global GDP by as much as 1.1%, improve global welfare by 3.7%, and employ more than 24 million people in the renewable energy sector.[25] In fact, Google's renewable energy purchasing contracts have led to over $3 billion in new capital investment around the world.[26] At Google, we'll continue doing our best to help accelerate the transition to clean energy and a more prosperous future.

LEARN MORE

2016 white paper: Achieving Our 100% Renewable Energy Purchasing Goal and Going Beyond
2016 spotlight: Greening the Grid: How Google Buys Renewable Energy
2017 spotlight: Northern Exposure: How Our Nordic Renewable Deals Are Reaping Rewards
2018 blog post: Meeting Our Match: Buying 100 Percent Renewable Energy

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. Our report received an A score from CDP for the past four years, and for the past three years, we earned a spot on CDP's Climate A List, which recognizes top reporting companies.

In 2017, our gross GHG emissions were 6.1 million tCO_2e, but because of our renewable energy purchases, our net GHG emissions were reduced to 3.3 million tCO_2e (see Figures 8 and 9). Our Scope 3 emissions doubled in 2017 due to an increase in our capital expenditures and our hardware business. After accounting for our carbon offset purchases, our net operational carbon emissions were zero.

Because of our emissions-reduction efforts, our carbon intensity has steadily decreased even as our company has grown and our energy use has correspondingly increased. Over the past six years, our carbon intensity per unit of revenue decreased by 87% (see Figure 10), our carbon intensity per full-time

Figure 8

GROSS GHG EMISSIONS (WITHOUT RENEWABLE ENERGY PURCHASES)

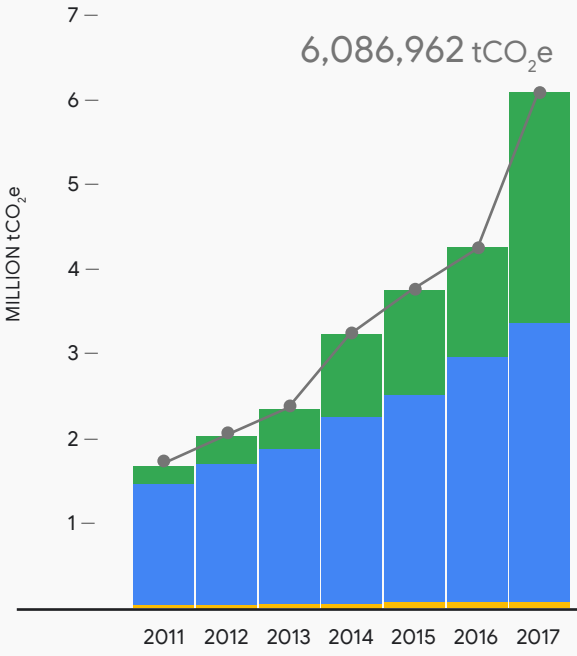
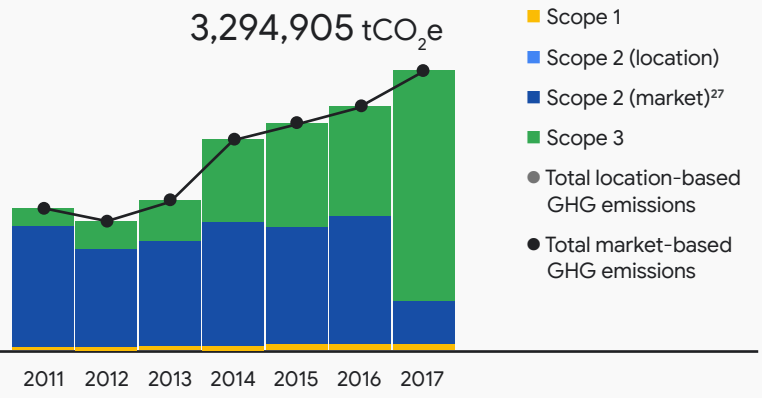


Figure 9

NET GHG EMISSIONS (WITH RENEWABLE ENERGY PURCHASES)



equivalent employee decreased by 85% (see Figure 11), and our carbon intensity for electricity used at our data centers dropped by 91%. This means we're delivering our products and services with decreased carbon impacts, even before using carbon offsets to reach neutrality.

A decade of carbon neutrality

In 2007, Google committed to being carbon neutral, and we've met this goal every year since then. We reach carbon neutrality via three steps. First, we work to reduce our total energy consumption by pursuing aggressive energy-efficiency initiatives. Second, we match 100% of the electricity consumption of our operations with purchases of renewable energy. Third, we buy carbon offsets for any remaining emissions we haven't yet eliminated.[28]

Figure 10

CARBON INTENSITY PER UNIT OF REVENUE

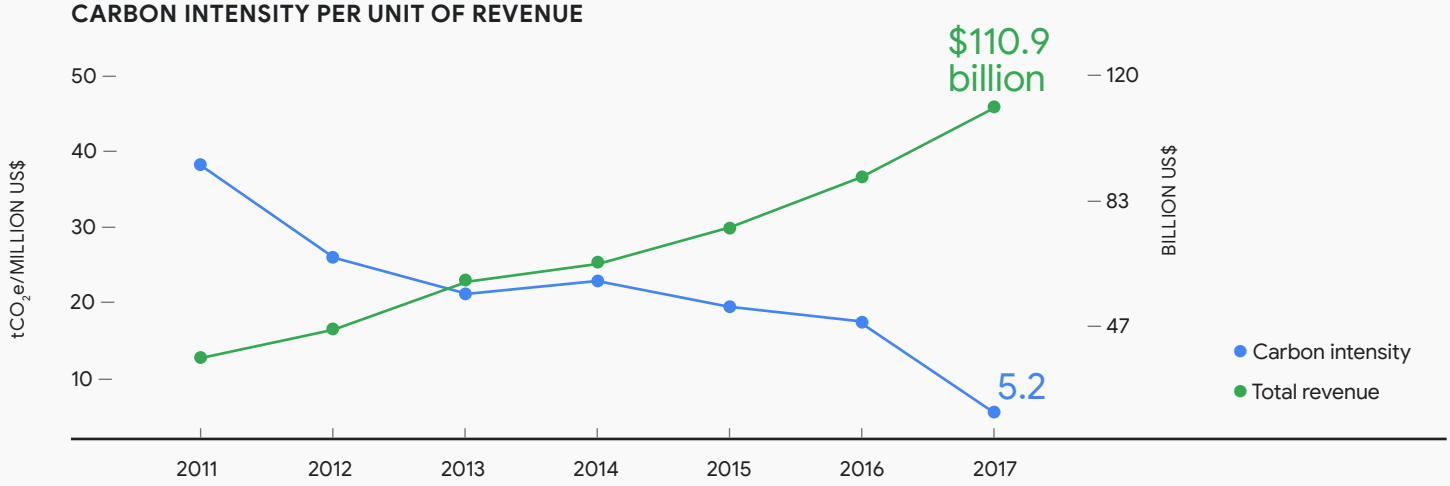
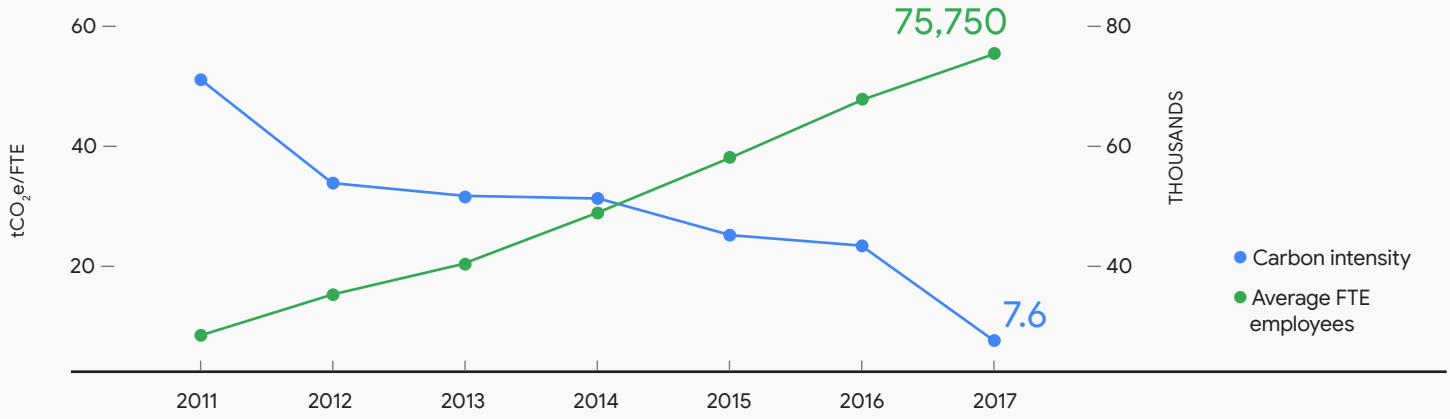


Figure 11

CARBON INTENSITY PER FTE EMPLOYEE



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

When we committed to carbon neutrality, we saw carbon offsets as an interim solution. As we further improve our energy efficiency and procure more renewable energy, our need for carbon offsets will continue to decrease.

When we do purchase carbon offsets, we follow stringent principles. We invest in high-quality, third-party-verified offsets, including landfill gas projects and animal waste management systems. All our offsets are additional, meaning that the projects reduce GHG emissions that wouldn't be reduced through other incentives. We also ensure that the projects we invest in are permanent sources of carbon reduction or sequestration, rather than temporary solutions. Finally, whenever possible, we invest for the long term, which offers owners and developers the financial stability they need to continue operating.

Google has been carbon neutral for more than a decade, and in that time, we've partnered with more than 40 carbon offset projects to offset more than 17 million tCO_2e.[29] We look forward to continuing to work toward net zero carbon in the decade to come.

LEARN MORE

2011 white paper: Google's Carbon Offsets: Collaboration and Due Diligence
2017 white paper: 10 Years of Carbon Neutrality
2017 spotlight: Capturing Value from Waste in Upstate New York

Spotlight

Unlocking access to corporate renewable energy purchasing in Taiwan

In many markets around the world, electricity providers don't offer renewable energy options to their customers. You're stuck with whatever kind of electricity they provide.

In 2015, Google began asking for something dramatically different for our data center in Taiwan—the opportunity to buy renewable energy directly from a specific generating facility. We did this both to mitigate our carbon footprint and because renewable energy makes good business sense. By purchasing electricity from renewable sources like wind and solar, which have no fuel inputs, we can set a long-term fixed price for power and gain access to an increasingly cost-competitive source of electricity.

In January 2017, after two years of careful consideration, the Taiwanese government amended its Electricity Act to allow direct renewable energy purchasing for customers. The first of its kind in Asia, the legislation represents a potentially seismic shift in Taiwan's approach to energy—and opens the door for companies looking to expand infrastructure while advancing a clean energy future.

It's also a prime example of how we champion clean energy policies and market solutions around the world.

Read how we're laying the groundwork for a clean energy future

Google's data center in Singapore, one of our two sites in Asia

Creating sustainable workplaces

Overview

Americans spend roughly 90% of their time indoors, and much of that time is spent at work.[30] At Google, just as we focus on users when it comes to designing our products, we also focus on users when creating healthy and sustainable workplaces—from our Bay Area headquarters to our offices in more than 160 cities spanning nearly 60 countries around the world. To do so, we look for innovative ideas that deliver measurable results and can be implemented at scale.

We start by applying industry-leading green building standards wherever possible. By the end of 2017, over 1 million square meters (11.1 million square feet) of Google office facilities had achieved LEED certification, with 28% of our LEED-certified square footage achieving a Platinum rating and 56% a Gold rating (see Figure 12).

We also have a strong focus on the material selections for our spaces and work to ensure that they are safe for humans and the environment throughout their life cycle. We believe an industry-wide transition to healthier materials is on the horizon. Making safer materials the new norm will require collective action across sectors, increased access to high-quality data that assesses chemical hazards, a demand signal (from buyers like Google) to material and product manufacturers, and advancements in recycling technology and infrastructure.

We take a science- and community-driven approach to managing our campuses, with the aim of restoring the local ecology while improving access to the outdoors for Google employees and the surrounding community. By the end of 2017, we had implemented our science-based Habitat Design Guidelines on 84 acres across our Bay Area headquarters.

SUSTAINABLE WORKPLACES: BY THE NUMBERS

11.1 million
square feet LEED-certified

By the end of 2017, over 1 million square meters (11.1 million square feet) of Google office facilities had achieved LEED certification.

29 million
gallons avoided

In 2017, we achieved a 15% reduction in potable water intensity at our Bay Area headquarters, which is equivalent to avoiding the use of over 109 million liters (29 million gallons) of potable water.

78%
landfill diversion

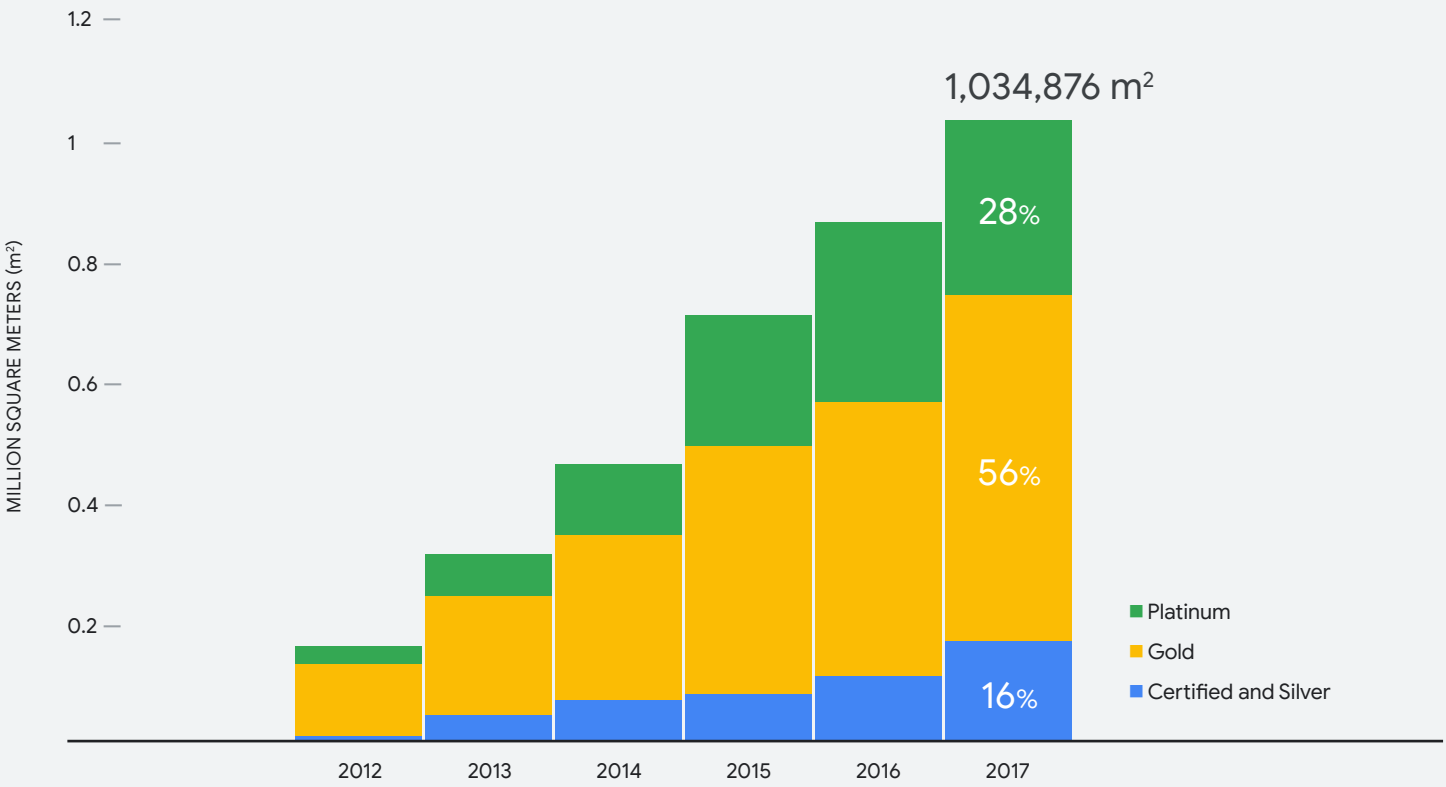
In 2017, we reached a 78% landfill diversion rate for our offices globally.

33,000
tCO_2e savings

By using Google shuttles in the Bay Area in 2017, we saved 33,000 tCO_2e emissions—equivalent to taking 6,500 cars off the road every day for a year or avoiding 152 million vehicle kilometers (95 million vehicle miles) per year.

Figure 12

CUMULATIVE LEED-CERTIFIED OFFICE SPACE



We reduce our water footprint by installing water-saving technologies and using reclaimed water wherever possible. In 2017, we achieved a 15% reduction in potable water intensity at our Bay Area headquarters, which is equivalent to avoiding the use of over 109 million liters (29 million gallons) of potable water. We also collaborated with WRI to analyze our water risk profile using the WRI Aqueduct tool. Over the past year, we've evolved our approach to global goal setting to focus on the highest-impact opportunities. We're now targeting our work at Google offices in highly water-stressed locations and in offices that are supported by recycling and composting infrastructure.

We implement strategies to minimize contamination in our office waste streams and identify diversion pathways that keep the waste we do generate out of landfills. In 2017, we reached 78% landfill diversion for our offices globally and reduced landfill waste per Googler by 4% at our Bay Area headquarters. We tracked waste generation for global offices that represent 42% of Google's total headcount.

In 2017, we avoided more than

1 million

kilograms of food waste in our cafés around the world.

Our cafés and Food Spots offer nutritious, responsibly sourced meals, snacks, and beverages.[31] We make thoughtful choices in the products we buy and the suppliers we buy them from. Our sustainability priorities include food waste prevention, sustainable hydration initiatives to encourage the use of reusable vessels for drinking water, and promoting balanced, plant-forward offerings—all of which help reduce our environmental impact and support the well-being of our users. We compost and donate leftover food wherever we're legally able to do so, but we've learned that the best way to reduce food waste is to prevent it in the first place by tracking data and using it to make adjustments. In 2017, this sort of data-driven optimization helped Google avoid more than 1 million kilograms (2.3 million pounds) of food waste in our cafés around the world.

Our Transportation team works to make commuting and campus mobility a stress-free part of every employee's day. We set ambitious goals for helping Googlers transition to shuttles, carpooling, public transit, biking, and walking. In 2017, our Bay Area headquarters remained on track to meet our long-term goal to reduce single-occupancy vehicle commuting to 45%. We also achieved a design standard of providing approximately 10% of parking with electric vehicle charging stations for new construction and tenant improvement projects in the Sunnyvale portion of our Bay Area headquarters. Our Google shuttle buses in the Bay Area produced savings of more than 33,000 tCO_2e emissions—the equivalent of taking 6,500 cars off the road every day for a year or avoiding 152 million vehicle kilometers (95 million vehicle miles) per year.

Google has installed more than 2,000 electric vehicle charging ports at our offices in the United States.

Googlers learn about sustainable transportation at Google Environment Day.

Because sustainability is part of our culture, we give our employees opportunities to engage on environmental issues and put their passions into practice. Our Bay Area headquarters and many of our global offices host annual events to celebrate Earth Day and World Environment Day, where we share how Googlers can be sustainable at work, at home, and in their communities. We also host an internal awards ceremony to recognize Googlers around the world who are driving sustainability across the company. Throughout the year we invite thought leaders and experts to speak on the latest trends, achievements, and challenges related to sustainability, some of which are posted on the Talks at Google YouTube channel. Our employees constantly reinvigorate our determination to build a better future. As we continue to explore sustainability strategies, we're committed to sharing what we learn with other companies in order to help foster the growth of more productive, environmentally friendly businesses.

LEARN MORE

2018 report: The Role of Safe Chemistry and Healthy Materials in Unlocking the Circular Economy

YouTube channel: Talks at Google

Charleston Retention Basin on the edge of Google's campus in Mountain View, California

Spotlight

Ecologically focused landscapes are coming to life on Google campuses

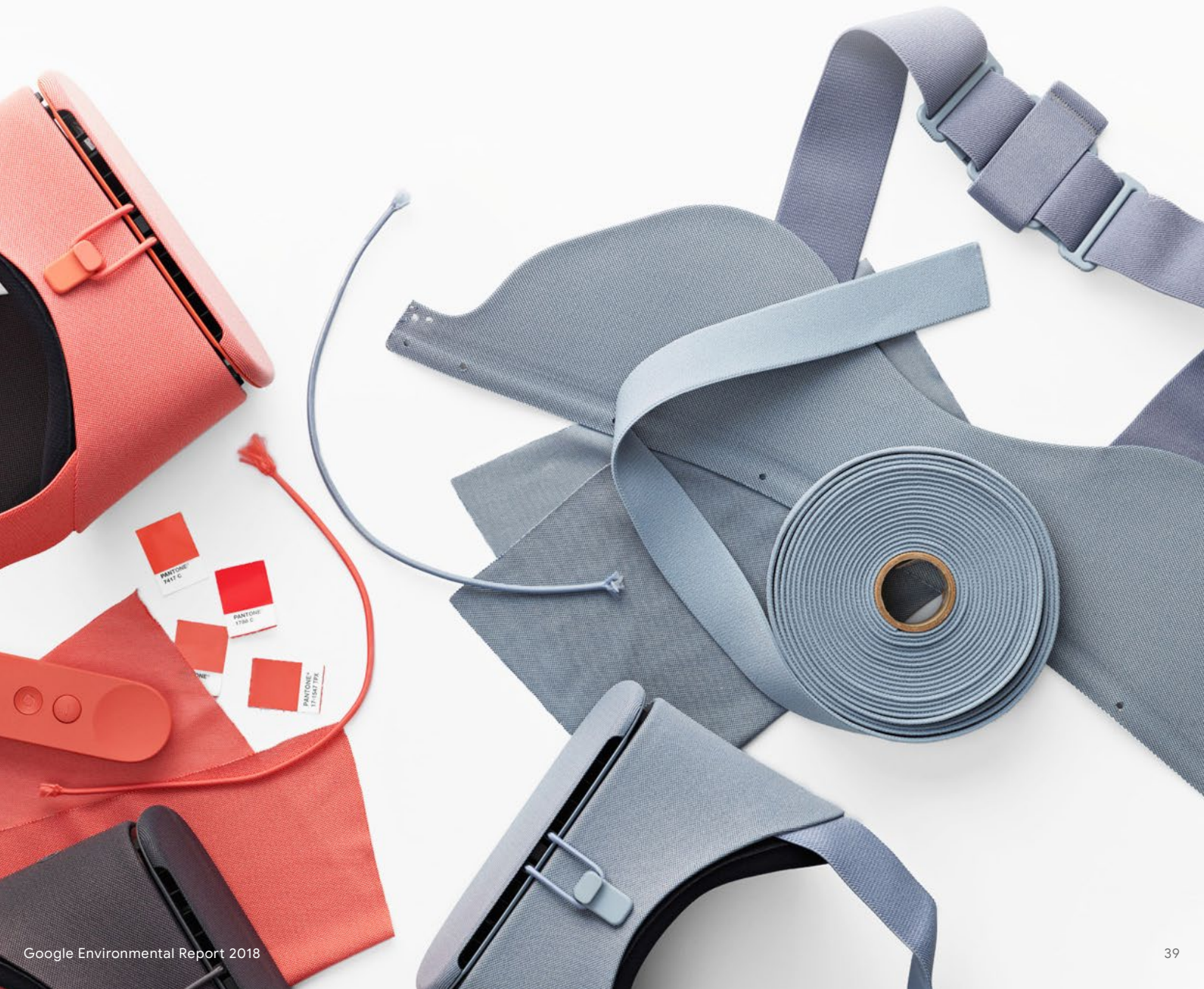
In 2013, we started work on our first major urban ecology project—a planned bike and pedestrian trail system on our Mountain View campus called the Green Loop. We incorporated cutting-edge science and data to create a landscape rich with ecological potential. Our team of internal designers and external partners—including ecologists, landscape architects, planners, and nongovernmental organizations—worked hand in hand to identify and select the right mix of native plant species. In total, we planted 1.4 acres of native vegetation that created or enhanced habitat for birds and other wildlife.

In the years since, we've launched other urban ecology projects across our Mountain View campus. We've designed the projects to work in concert, carefully selecting every flower, tree, shrub, and structure for its additive value to our campus ecology and local ecosystems.

Individually, the projects are improving diversity of species and expanding valuable habitats. Together, they're helping create a more resilient ecosystem that can endure and evolve with the changing climate—part of our efforts to incorporate resilience science across Google's outdoor spaces.

Learn how Google is using resilience science to transform our campus landscapes

Empowering users with technology



Overview

A global challenge requires a global response. We strive to meet the vast challenge posed by climate change by working to empower everyone—businesses, governments, nonprofit organizations, communities, and individuals—to use Google technology to help create a more sustainable and resource-efficient world.

Google Cloud Platform and G Suite products like Gmail, Docs, and Drive are enabling millions of businesses to shift computing needs to Google Cloud's highly efficient, renewable energy–based computing infrastructure. By moving IT infrastructure and collaboration applications from a self-managed data center or colocation facility to Google Cloud, the net carbon emissions directly associated with those workloads is zero. Businesses that switch to cloud-based products like G Suite have reported reductions in IT energy use and carbon emissions up to 85%,[32] and a business using Gmail can reduce the GHG emissions impact of its email service by up to 98%, compared with running email via on-premises servers.[33] Individual users also benefit, since providing an active user one month of Google services creates about the same amount of GHG emissions as driving a car 1 mile.[34]

Google has made it a company-level goal to increase the sustainability and circularity of our consumer electronic products, operations, and communities. In October 2017, we launched a suite of new Google-branded products, including the Google Pixel 2 and Google Pixel 2 XL, Google Home, Google Home Max and Google Home Mini, Google Pixelbook, and Google Daydream View. For many of these products, we released a report that provides an overview of the product's environmental impact in areas such as material composition, life cycle GHG emissions, and energy efficiency.

TECHNOLOGY: BY THE NUMBERS

0
net carbon emissions

Organizations that move IT infrastructure and collaboration applications from a self-managed data center or colocation facility to Google Cloud reduce the net carbon emissions of their computing to zero.

17 billion kWh
of energy savings

Nest Thermostats have helped customers save more than 17 billion kWh of energy combined, based on studies of average savings—enough energy to power all of San Francisco's electricity consumption for three years.

1 billion km
of transit results

Google Maps provides more than 1 billion kilometers' (621 million miles') worth of transit results per day, helping limit carbon emissions by giving people access to mass transit options, bike routes, and traffic information.

20 petabytes
of geospatial data

Earth Engine has enabled over 80,000 scientists around the world to easily analyze 20 petabytes of freely available geospatial information, resulting in a deeper understanding of the planet.

Google Home Max uses machine learning to match the acoustics of the room.

We also support greener electronics standards and certifications, including UL110, IEEE 1680.1, and the Electronic Product Environmental Assessment Tool (EPEAT).[35]

We want to ensure that the materials and substances used for our Google-branded products are safe for people and the environment, can be reused to create future products, and retain economic value. One of the keys to unlocking the circular economy will be safer chemistry from the start, so for the first time we published our Restricted Substances Specification to ensure the use of safer materials across our products. To date, we've shipped millions of devices made with post-consumer recycled plastic. Products like the Nest Thermostat E, Google Home, and Chromecast all contain parts with 20%–75% post-consumer recycled plastic content. We think it's critical to create demand for recycled materials to accelerate the transition to a circular economy. Going forward, we are committed to expanding the use of sustainable materials across our portfolio of products. We're also making it easier for customers to responsibly recycle devices for free via our U.S. take-back program for all products and via our U.S. Pixel trade-in program.

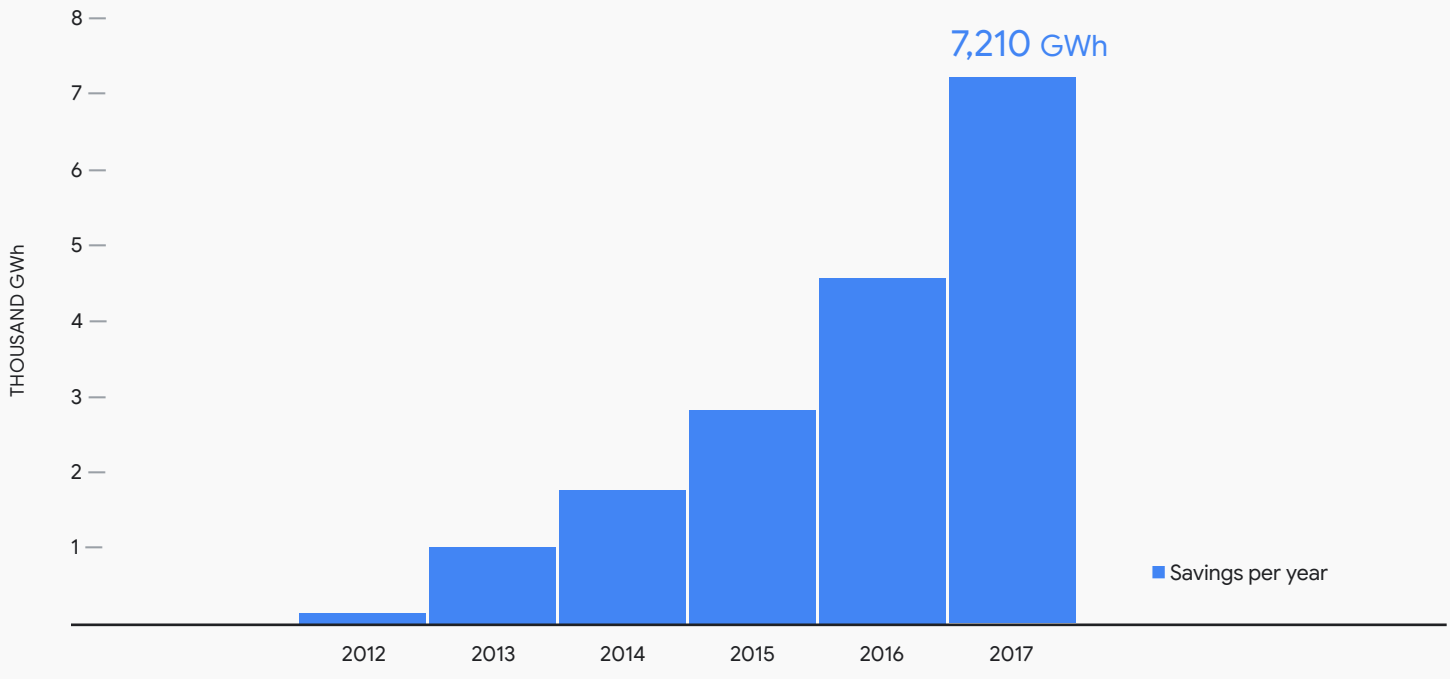
Our products also enable customers to be more thoughtful about their impact. The Nest Learning Thermostat controls residential heating and cooling systems, reduces home energy consumption, and helps achieve collective savings. By the end of 2017, Nest Thermostats had helped customers save more than 17 billion kWh of energy combined (see Figure 13), based on average savings studies—enough energy to power all of San Francisco's electricity consumption for three years. That's equivalent to avoiding 5.7 million tCO_2e of emissions.

Nest's Rush Hour Rewards program works in partnership with utilities to reduce energy use during times of peak demand. During the 2017 solar eclipse, Nest launched a special Rush Hour program with an opt-in feature that allowed Nest Thermostats to automatically pre-cool customers' homes, reducing demand on the grid at a time when solar energy production dropped by thousands of megawatts. More than 750,000 Nest Thermostats worked together across the United States to reduce energy demand by 700 MW.[36]

Our commitments go beyond the consumer electronic products we make. Our Responsible Supply Chain program works with suppliers across our supply chain to protect workers and the environment. Our Supplier Code of Conduct articulates our expectations for suppliers and is based on Google's employee Code of Conduct and on international human rights standards, safety standards, and environmental standards.

Figure 13

HOUSEHOLD ENERGY SAVED BY NEST THERMOSTAT USERS



In 2017, Project Sunroof mapped

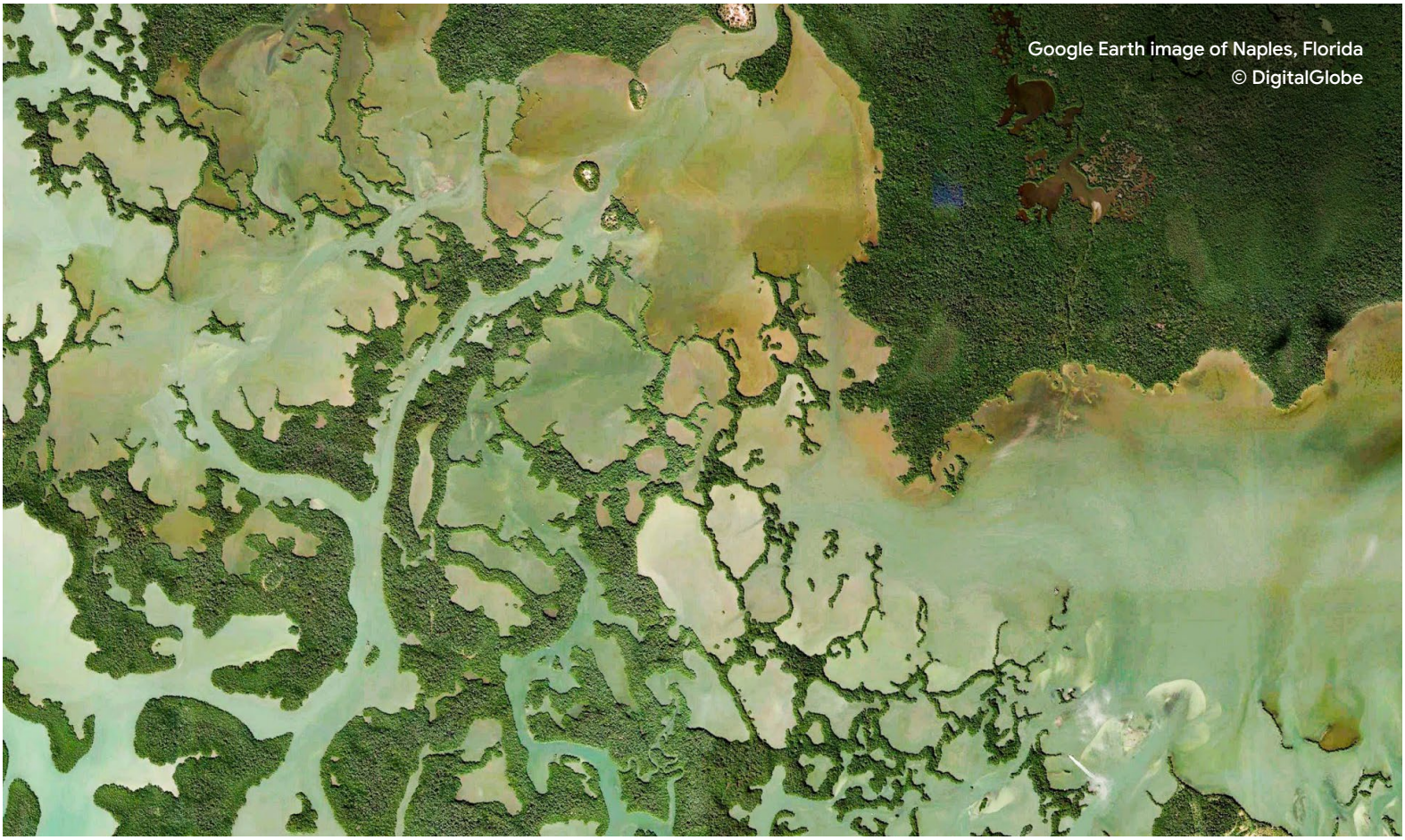
67 million

rooftops across 8,900 cities in the United States and Germany.

Google Maps provides more than 1 billion kilometers' (621 million miles') worth of transit results per day, helping limit carbon emissions by giving people access to mass transit options, bike routes, and traffic information. We also put Google technology to work helping others study and respond to environmental challenges. Our Geo team is working with numerous research and nonprofit organizations to map the world's forests, oceans, watersheds, and air quality—and even to create a global database of power plants. We then work on getting that information into the hands of decision-makers.

In 2017, Project Sunroof expanded coverage beyond the United States into Germany, mapping 67 million rooftops across 8,900 cities, which enabled over 2 million users to make informed decisions about solar panel installation. For three regions in California, Project Air View released heat maps with hyper-local air quality information that contained hundreds of millions of ambient air quality data points measured by the Google Street View cars equipped with air quality sensors. Global Fishing Watch (GFW) scaled to process over 60 million automatic identification system messages per day, enabling the number of fishing vessels displayed on the platform to reach 70,000. Insights gleaned from the GFW platform were leveraged to help create five marine protected areas. These tools—along with Global Surface Water Explorer, Global Forest Watch, the DiSARM platform for malaria risk mapping, and PowerExplorer—were built with close partners and experts in the field to provide critical information and solutions to global challenges.

Rooftop solar provides renewable energy to a community in Manchester, England. Project Sunroof expanded coverage to the United Kingdom in 2018.



Google Earth image of Naples, Florida
© DigitalGlobe

Google Earth was launched in 2017 as a web and mobile application, after nearly 10 years as a desktop application, and it's used globally by millions to explore the planet. With a specific focus on education, the new Google Earth is helping tell stories and raise awareness of our planet and environment with a much broader audience. While Google Earth is for exploration, Google Earth Engine is focused on analysis and creating new knowledge. Earth Engine provides researchers with simple access to Google's massive cloud and computational capabilities for large-scale geospatial analysis; it includes 20 petabytes' worth of freely available geospatial data that provide valuable information to scientists, environmental organizations, and communities working to devise more informed solutions.

LEARN MORE

2017 report: Cities in the Circular Economy: The Role of Digital Technology
2018 report: Circular Consumer Electronics: An Initial Exploration
2018 reports: Product Environmental reports
Guidelines: Restricted Substances Specification
Websites: Google Cloud Environment and Google Cloud Renewable Energy

Spotlight

Transparency unleashed: How Global Fishing Watch is transforming fishery management

Home to one of the world's richest arrays of sharks, giant manta rays, and humpback whales, Mexico's Revillagigedo Archipelago is also a hub of Mexico's commercial tuna fishing industry—or so the industry has long claimed in arguments against protecting the surrounding waters.

In 2017, Global Fishing Watch (GFW) put that claim to the test. The cutting-edge transparency platform uses Google technology to track the locations and behaviors of commercial fishing fleets, helping to create an accurate picture of global fishing activity. Using the GFW platform and vessel tracks for the region, the National Geographic Pristine Seas program and other researchers found that Revillagigedo accounted for only 4% of Mexico's tuna catch, far less than the 20% cited by the industry.

"Using GFW was a game changer for us because, for the first time, we were able to bring transparent data to the negotiating table," says Enric Sala, who fights to protect the ocean's last wild places as executive director of National Geographic's Pristine Seas.

From helping establish "no-take" marine reserves like Revillagigedo—now the largest marine protected area in North America—to cracking down on illegal fishing in Indonesian waters, researchers, governments, and fishery organizations have started using the GFW platform and data in historic new ways. The goal is nothing short of revolutionary: harness the power of data transparency to protect our oceans.

Read how GFW is bringing data transparency to the high seas

The Revillagigedo Archipelago in Mexico was officially designated a 57,000-square-mile no-take National Park in 2017.
Photo: Enric Sala / National Geographic

Appendix

Environmental data

The following table provides an overview of our performance over time and includes environmental data for our global operations, including our data centers, offices, and other facilities.

Data for GHG emissions and energy use covers Alphabet Inc. and all of its subsidiaries, including Google LLC. The exceptions are the figures for data center energy efficiency and renewable energy, which cover Google only. All other data applies only to Google and is global unless otherwise specified.

For more information on our energy use and GHG emissions data and initiatives, see Alphabet's 2018 CDP Climate Change Report.

		Fiscal year[37]					
Key performance indicator	**Unit**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Greenhouse gas (GHG) emissions[38]							
Scope 1*,†	tCO_2e	37,187	41,373	51,802	66,991	66,218	66,549
Scope 2 (market-based)*,†,[39]	tCO_2e	1,149,988	1,245,253	1,460,762	1,384,427	1,518,643	509,334
Scope 2 (location-based)*,†	tCO_2e	1,654,645	1,831,142	2,198,821	2,450,438	2,902,554	3,301,392
Scope 3*,†	tCO_2e	332,612	479,388	980,783	1,234,683	1,292,267	2,719,022
Total (Scope 1, 2 [market-based], and 3)	tCO_2e	1,519,787	1,766,014	2,493,347	2,686,101	2,877,128	3,294,905
Emissions neutralized by carbon offset projects	tCO_2e	–1,519,787	–1,766,014	–2,493,347	–2,686,101	–1,898,889	-931,942
Net operational carbon emissions[40]	tCO_2e	0	0	0	0	0	0
Carbon intensity[41]							
Carbon intensity per unit of revenue	tCO_2e/million US$	25.8	23.2	22.9	19.4	17.6	5.19
Carbon intensity per full-time equivalent (FTE) employee	tCO_2e/FTE	33.8	31.9	31.0	25.0	23.4	7.6
Carbon intensity per megawatt-hour (MWh) of electricity consumed at data centers	tCO_2e/MWh	0.337	0.325	0.316	0.242	0.227	0.049

Environmental data

		Fiscal year					
Key performance indicator	**Unit**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Energy use							
Total energy consumption[42]	MWh	3,547,045	3,970,438	4,702,387	5,533,433	6,513,719	8,029,409
Electricity consumption*	MWh	3,324,818	3,712,865	4,434,390	5,221,476	6,209,191	7,609,088
U.S.	MWh	2,326,210	2,562,688	2,985,108	3,779,280	4,522,314	5,533,782
International	MWh	998,608	1,150,177	1,449,282	1,442,196	1,686,877	2,075,306
Data center energy efficiency							
Trailing 12-month (TTM) power usage effectiveness (PUE)[43]	TTM PUE	1.12	1.12	1.12	1.12	1.12	1.11
Data center sites included in ISO 50001 certificate	#	0	9	9	12	12	12
% of IT energy use represented by data centers included in ISO 50001 certificate	%	–	–	–	–	98	96
Renewable energy							
Total cumulative renewable energy contracts, in megawatts (MW)	MW	263	634	1,147	2,121	2,611	2,960
% of total electricity obtained from renewable sources[44]	%	34	35	37	48	61[45,46]	100
Waste generation							
Total waste generated annually	Tons	–	–	–	50,050	45,705	56,575
Waste diversion							
Annual landfill diversion rate for data centers[47]	%	–	–	–	84	86	91
Annual landfill diversion rate for offices	%	–	–	–	78	78	78
Annual food waste prevented in cafés	Kilograms	–	–	–	229,971	702,865	1,060,456
Hardware refurbishment and reuse							
Servers deployed that were remanufactured machines	%	–	–	–	19	36	18
Components used for machine upgrades that were refurbished inventory[48]	%	–	–	–	52	22	11
Components resold into the secondary market	#	–	–	–	2,000,000	2,100,000	2,114,567
Unsellable hard drives crushed and sent to recycler	%	–	–	–	100	100	100
Water consumption							
Total annual water consumption[49]	Million gallons	–	–	–	–	2,500	3,071

Environmental data

Key performance indicator	Unit	Fiscal year 2012	2013	2014	2015	2016	2017
Sustainable workplaces							
Offices							
Cumulative LEED-certified office space, in square meters (m^2)	m^2	156,894	313,209	462,395	711,626	865,494	1,034,876
Gold	%	75	63	59	58	54	56
Platinum	%	19	23	26	31	34	28
Commuting							
Cumulative electric vehicle (EV) charging ports installed at Google offices in the United States[50]	Ports	415	601	988	1,382	1,646	2,077
Estimated annual emissions avoided due to employee EV commuting in the United States	tCO_2e	148	483	929	1,489	2,142	2,891
Total annual employee shuttle commuting trips in the Bay Area	Total trips	2,000,000	2,500,000	3,000,000	3,500,000	3,750,000	3,800,000
Peak daily employee shuttle riders in the Bay Area	Unique riders	5,000	6,000	7,500	8,500	9,000	10,000
Annual emissions avoided due to employee shuttle trips in the Bay Area	tCO_2e	7,858	10,065	18,856	28,901	33,656	33,241
Equity investments in renewable energy projects[51]							
Cumulative commitments, in gigawatts (GW)	GW	1.9	2.4	2.7	3.7	3.7	3.7
Empowering users with technology							
Household energy saved by Nest Thermostat users, in gigawatt-hours (GWh)	GWh	142	1,004	1,749	2,822	4,553	7,210
Rooftops mapped for solar potential by Project Sunroof	Millions	–	–	–	43	60	67
Cities covered globally by Project Sunroof	#	–	–	–	–	7,300	8,900
Cumulative air quality measurements captured by Project Air View	#	–	–	13,771,873	37,867,975	121,663,079	281,744,820
Cumulative cities covered globally by Project Air View[52]	#	–	–	–	10	27	41
Number of fishing vessels displayed on Global Fishing Watch	#	–	–	–	–	35,000	70,000

* Indicates verified data. Scope 1, 2, and part of Scope 3 emissions are verified by an independent, accredited verifier. Our electricity use is also part of our Scope 2 verification.

† Scope 1 emissions are direct emissions from sources we own or control, such as company vehicles or generators at Google's offices and data centers.

Scope 2 emissions are indirect emissions from the production of electricity we purchase to run our operations. The location-based category reflects the average carbon intensity of the grids where our operations are located and thus where our energy consumption occurs. The market-based category incorporates our procurement choices, i.e., our renewable energy purchases via contractual mechanisms like PPAs.

Scope 3 emissions are indirect emissions from other sources in our value chain, such as business travel or our suppliers.

Endnotes

1. Read our 2004 Founders' Initial Public Offering Letter at https://abc.xyz/investor/founders-letters/2004/ipo-letter.html.

Our approach

2. "Internet Users by Region and Country, 2010–2016," International Telecommunication Union, accessed 2018, http://www.itu.int/en/ITU-D/Statistics/Pages/stat/treemap.aspx.
3. Mathy Stanislaus, "A Virtuous Circle," *The Environmental Forum*, September/October 2016, https://www.epa.gov/sites/production/files/2016-08/documents/stainislaus_a_virtuous_circle_2016_final.pdf.
4. "Earth Overshoot Day," Global Footprint Network, accessed 2018, https://www.overshootday.org/newsroom/past-earth-overshoot-days/.
5. Arman Shehabi et al., *United States Data Center Energy Usage Report*, Lawrence Berkeley National Laboratory, June 2016, https://eta.lbl.gov/publications/united-states-data-center-energy.
6. Bruno Basalisco et al., *European Data Centres: How Google's Digital Infrastructure Investment Is Supporting Sustainable Growth in Europe*, Copenhagen Economics, February 2018, https://static.googleusercontent.com/media/www.google.com/en//about/datacenters/eustory/report/Google_EU-DCs_Report.pdf.
7. Alicia Seiger, Kate Brandt, and Kate Randolph, "Connecting Climate Resilience to the Bottom Line," *Stanford Social Innovation Review*, May 1, 2017, https://ssir.org/articles/entry/connecting_climate_resilience_to_the_bottom_line.
8. "International Decade for Action 'Water for Life' 2005–2015," United Nations Department of Economic and Social Affairs, accessed 2016, http://www.un.org/waterforlifedecade/scarcity.shtml.
9. Jacquelline Fuller, "Water Organizations Using Tech to Make an Impact," *The Keyword* (blog), March 22, 2016, https://www.blog.google/outreach-initiatives/google-org/world-water-day.
10. Read about Google's AI principles at https://www.blog.google/technology/ai/ai-principles.
11. Our data centers that have achieved 100% landfill diversion have a current waste-to-energy contribution greater than 10%, meaning they haven't yet achieved Zero Waste to Landfill.
12. In previous years, we have reported our potable water-reduction target in terms of per-Googler consumption, but we will be using water intensity as the equivalent metric moving forward.

Designing efficient data centers

13. According to Google's own analysis of our more efficient servers, power infrastructure, and cooling systems, compared with data center industry averages.
14. PUE is a standard industry ratio that compares the amount of noncomputing 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.
15. According to the Uptime Institute's 2018 Data Center Industry Survey, the global average PUE of respondents' largest data centers was around 1.58.
16. At Google, Zero Waste to Landfill means that when waste leaves our operating data centers, none of it goes to a landfill—100% is diverted to more sustainable pathways, with no more than 10% going to a waste-to-energy facility, unless waste to energy can be proved more valuable than alternative diversion paths. Our approach is based on UL's Environmental Claim Validation Procedure for Zero Waste to Landfill.
17. See note 11 above.
18. *Google Data Centers: Economic Impact and Community Benefit*, April 2018, Oxford Economics, https://static.googleusercontent.com/media/www.google.com/en//about/datacenters/usstory/full-report/full-report.pdf.
19. See note 6 above.

Advancing renewable energy

20. Bloomberg New Energy Finance database for wind and solar energy PPAs, as of December 31, 2017.
21. WRI's market-based Scope 2 methodology requires the use of residual grid mixes, which represent the mix of resources generating electricity in a region after accounting for those designated for specific customers via contractual instruments like PPAs.
22. *Lazard's Levelized Cost of Energy Analysis—Version 11.0*, Lazard, November 2017, https://www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf.
23. *Medium-Term Renewable Energy Market Report 2016*, International Energy Agency, October 25, 2016, https://www.iea.org/Textbase/npsum/MTrenew2016sum.pdf.
24. *Renewables 2018 Global Status Report*, REN21, June 2018, http://www.ren21.net/gsr-2018.
25. *Renewable Energy Benefits: Measuring the Economics*, International Renewable Energy Agency, 2016, http://www.irena.org/DocumentDownloads/Publications/IRENA_Measuring-the-Economics_2016.pdf.
26. See note 6 above.
27. Since 2010, we've procured renewable energy for our operations, and in 2012, we began publishing how this reduces our overall carbon footprint. Up until 2015, there was no guidance from WRI on how to account for these emissions reductions, so we developed our own methodology, whereby on an annual basis we assigned renewable electricity procured against electricity consumed (in MWh) in the closest data center to the renewable energy project. In 2015, WRI released new guidance for market-based Scope 2 accounting, which we adopted, starting with 2015 data. Our pre-2015 methodology differs from WRI's in the use of residual mixes, which avoid double-counting of claimed renewable energy attributes.
28. A carbon offset is an investment in an activity that reduces carbon emissions. The reduction in carbon emissions is represented by a carbon credit. The credit, usually verified by a third party, signifies that GHG emissions are lower than they would have been had no one invested in the offset. One credit equals 1 metric ton (1,000 kilograms or 2,204 pounds) of carbon dioxide equivalent (CO_2e) prevented from being released into the atmosphere.
29. Carbon dioxide equivalent (CO_2e) is a quantity that describes, for a given mixture and amount of GHG, the amount of carbon dioxide (CO_2) that would have the same global warming potential (GWP), i.e., the ability of a gas to trap heat in the atmosphere when measured over a specified timescale (generally, 100 years). Some GHGs are more potent than others, as measured by their GWP. Carbon dioxide is the baseline and thus has a GWP of 1.

Endnotes

Creating sustainable workplaces

30. Neil E. Klepeis et al, "The National Human Activity Pattern Survey: A Resource for Assessing Exposure to Environmental Pollutants," *Journal of Exposure Analysis and Environmental Epidemiology*, 2001, http://www.readcube.com/articles/10.1038/sj.jea.7500165.
31. "Food Spots" is an umbrella term covering Google's MicroKitchens, Hubs, and Hydration Stations.

Empowering users with technology

32. Eric Masanet et al., *The Energy Efficiency Potential of Cloud-Based Software: A U.S. Case Study*, Lawrence Berkeley National Laboratory, June 2013, https://www.osti.gov/scitech/servlets/purl/1171159.
33. The annual carbon footprint of a Gmail user is about 1/80th that of a small business with locally hosted email servers. Larger organizations show smaller, though still impressive, efficiency gains. "Google's Green Computing: Efficiency at Scale," Google, 2011, https://static.googleusercontent.com/media/www.google.com//en/green/pdfs/google-green-computing.pdf.
34. Google emits less than 8 grams of carbon dioxide equivalent per day to serve an active Google user—defined as someone who performs 25 searches and watches 60 minutes of YouTube a day, has a Gmail account, and uses our other key services.
35. UL110 and IEEE 1680.1 are multi-attribute, consensus-based sustainability standards for mobile phones, computers, and displays. Google uses a third party to validate conformance and independently certify to these standards.
36. Ben Bixby, "Solar Eclipse, Meet the Nest Thermostat," *Inside Nest* (blog), August 10, 2017, https://nest.com/blog/2017/08/10/solar-eclipse-meet-the-nest-thermostat.

Appendix

37. Alphabet's fiscal year runs from January 1 to December 31. Unless otherwise specified, reported data is global.
38. GHG emissions are calculated according to WRI's Greenhouse Gas Protocol. For more information on our methodology, see Alphabet's 2018 CDP Climate Change Report.
39. See note 27 above.
40. In 2016, we adopted the industry practice of including only operational emissions in our carbon neutrality commitment. Our 2016 operational emissions include Scope 1, Scope 2 (market-based), and Scope 3 (business travel and employee commuting). For more information, see our 2017 white paper *10 Years of Carbon Neutrality*.
41. Carbon intensity figures are based on our combined Scope 1 and market-based Scope 2 emissions, with the exception of electricity consumption intensity, which is calculated using only market-based Scope 2 at the data centers.
42. Total energy consumption represents total Scope 2 electricity consumption plus total Scope 1 fuel use.
43. Power usage effectiveness (PUE) is an industry-recognized ratio to measure data center efficiency. For more information on our PUE and how we calculate it, see "Efficiency: How We Do It" on our website.
44. Percentage of renewable energy is calculated on a calendar-year basis, comparing the volume of renewable electricity (in MWh) purchased for our operations (i.e., renewable energy procured through our PPA contracts, on-site renewable energy generation, and residual renewable electricity delivered directly through the grid) with the total volume of electricity consumed by our operations.
45. To align with the method outlined in note 44 above, starting in 2016, we adapted our methodology for calculating total electricity obtained from renewable sources. Prior to 2016, we were not accounting for the residual renewable electricity purchased through grid electricity.
46. We have restated our 2016 data for the percentage of total electricity obtained from renewable sources due to quality assurance improvements in our data collection and calculations.
47. Waste diverted to a more sustainable pathway than landfill or incineration without energy recovery.
48. Decommissioning (decom) activity decreased in 2017 and 2018 because most of the decom returns in this period were from an older generation of technology, which did not qualify for redeployment. We might expect to see a higher percentage of refurbished parts in upgrades for 2019.
49. Includes all water (both recycled and potable) consumed at offices and data centers.
50. Number of ports for ChargePoint stations in the United States only, which represent the majority of our electric vehicle charging ports in the United States. Emissions avoided are estimated using data from these ports only.
51. In addition to our renewable energy contracts, Google also invests in renewable energy projects around the world that have an attractive risk-adjusted financial return. These projects are not used to offset our carbon footprint.
52. Of the cities mapped by Project Air View in 2017, one city was measured for methane, while 13 were measured for other air pollutants. This brings the total cities mapped to date to 16 cities measured for methane and 25 cities measured for other air pollutants (e.g., particulate matter, ozone, nitrogen dioxide).

Google

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On the cover:
Researchers used data provided by Global Fishing Watch to help create North America's largest fully protected marine reserve around Mexico's Revillagigedo Archipelago.
Photo: Enric Sala / National Geographic

Designing efficient data centers:
Servers in a Google data center

Advancing renewable energy:
Minco II wind farm in Oklahoma (101 MW for Google)

Creating sustainable workplaces:
Through Google's Ecology program, we select flowers and other plants for their additive value to local ecosystems.

Empowering users with technology:
Materials used to make Google Daydream View