Google + Deloitte.

Data Center Impact Report 2023

LOUDOUN COUNTY, VIRGINIA

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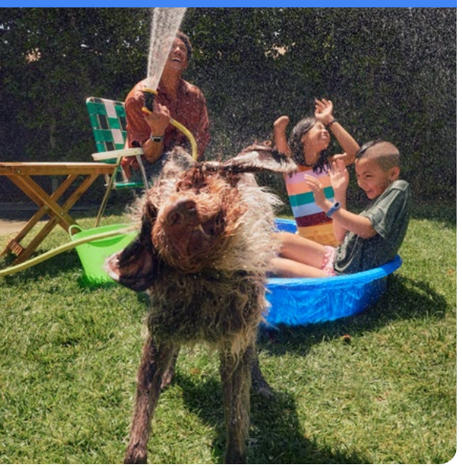
Executive summary

Data centers are at the core of the transformation to a digital economy. They enable a growing number of industries to make quick, information-driven decisions and provide products and services to its stakeholders securely and reliably. Google's data centers are part of this ecosystem, with an owned and operated network of over 25 data center locations around the world. Each location has been strategically chosen based on considerations such as: land availability, infrastructure, talent, and the opportunity for impact to meet the requirements of the world's increasing digital needs.

As Google seeks to drive positive change in the communities where it operates, learning more about the historical impacts its data centers have had in Loudoun County, Virginia became a priority. To do this, Google engaged Deloitte in 2023 to quantify the economic, social and environmental impacts that Google data centers have had in Loudoun County. This report presents the impact across those three dimensions for the period of 2017-2022. The objective of this report is to be as transparent as possible about the data center impacts. In cases where some data was not included, it is due to regulatory, competitive, or data quality considerations. As the ability to do so changes, future impact assessments will reflect Google's capability to share additional information.

Economic impact

From 2017-2022, annually, Google added ~$1.1 billion to the Gross Domestic Product (GDP) of Loudoun County, Virginia through direct, indirect, and induced contributions and ~$330 million in direct, indirect and induced contributions to Labor Income. In the same time period, Google's operations supported ~3,500 direct, indirect and induced jobs in Loudoun County. These contributions to GDP and jobs are in line with Virginia's 'Compete to Win' policy for economic development that aims to drive job growth and elevate industries where Virginia has a competitive advantage.



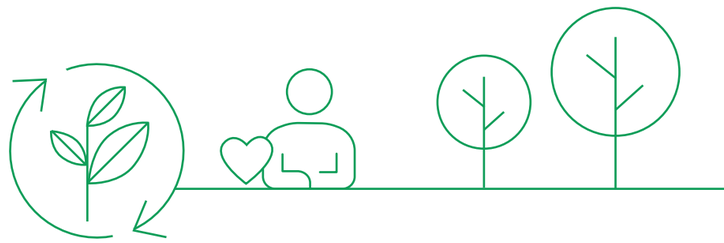
Social advancement

Google aims to improve the lives of as many people as possible – both for people in Google through employee wellbeing measures and for people around Google, through supporting local education and other programs. Between 2019 and 2022, Google.org awarded $2.4 million in grants to communities in Virginia to help strengthen Science, Technology, Engineering, Mathematics (STEM) education programs, secure access to clean drinking water, provide employment training for people with developmental disabilities, and offer COVID-19 fiscal relief to minority-owned businesses.

Environmental sustainability

At its data centers, Google is working to maximize energy efficiency, reduce the use of water, and increase waste diversion from landfills. Google acknowledges the potential impact it has on its surrounding environment—namely through energy usage, greenhouse gas emissions, water, waste, land, and biodiversity — and works to mitigate this impact. To this end, Google has invested in several power purchase agreements (PPAs), including more than $7 million during 2021-22 in Virginia towards carbon-free energy generation capacity. Additionally, Google has set a target that by 2030 all Google data centers will run on 24/7 carbon-free energy. Google also aims to replenish 120% of freshwater used by 2030 and has a goal of achieving Zero Waste to Landfill for its data center operations.

Through this report, Google has a more comprehensive understanding of the economic, social, and environmental impact it has had in Loudoun County, including the issues most important to its stakeholders. Moving forward, Google will take these learnings to continue finding ways to channel its economic impact locally, minimizing its environmental impact through optimizing water and energy, and engaging with local stakeholders - all in support of continuing to make an impact on the communities in which it operates.



Google data centers:
Keeping the internet secure & sustainable

By driving local economic development, fostering thriving communities, and spurring environmental stewardship. In Loudoun County, from 2017-2022, Google data centers impacted the community through:

Economic impacts

Support economic wellbeing through jobs, GDP, labor income and productivity.

+$1.1B Generated per year in direct, indirect, induced impacts as measured **by GDP**

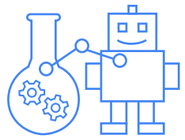
$330M added to labor income**

Google's operations supported **3,500 jobs†**

Social advancement

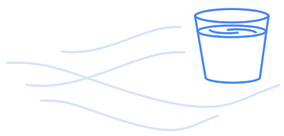
Create strong relationships in communities where it operates and contribute to a higher quality of life for those residents.

Between 2019-22 the following was given **$2.4M** in grants for Virginia communities for:



STEM education

Access to clean **drinking water**



Employment training within the community

COVID-19 fiscal relief for minority-owned businesses

Environmental sustainability

Reduce the demand for finite resources and serve as a catalyst for the transition to sustainable business growth.

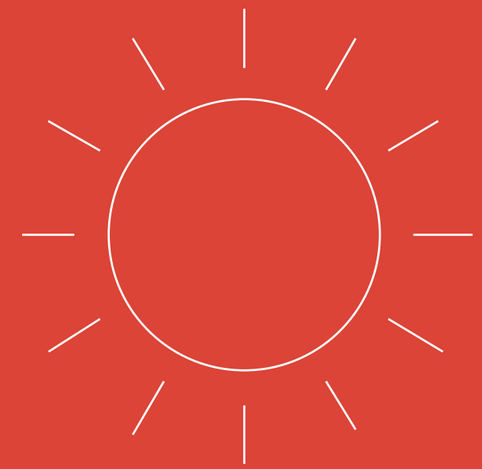
Energy Google data centers are 1.5x more energy efficient and deliver 3x more computing power per unit of electrical power*

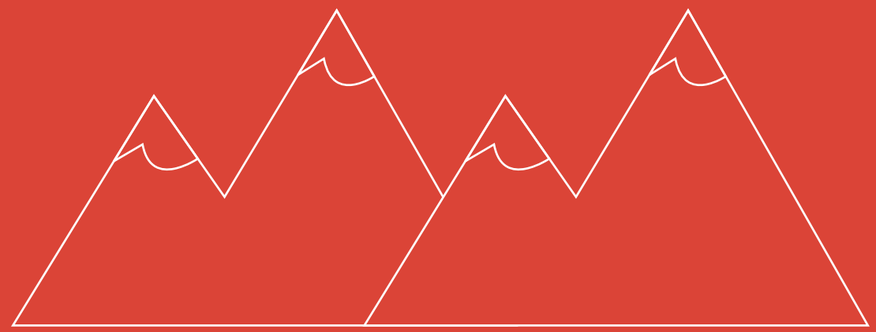
100% **zero-carbon** **By 2030,** data centers will run on 24/7 carbon-free energy

By 2030, Google has pledged to replenish 120% of freshwater used annually, on average, across all offices and data centers globally

FOOTNOTE:
*As of 2022, Google's data centers globally are, on average, 1.5 times as energy efficient as a typical enterprise data center and compared to five years ago, they now deliver approximately three times as much computing power per unit of electrical power. ** Includes direct, indirect and induced labor income. † Includes, direct, indirect and induced jobs.

Introduction





INTRODUCTION

An introduction to data centers

Where does the internet live?

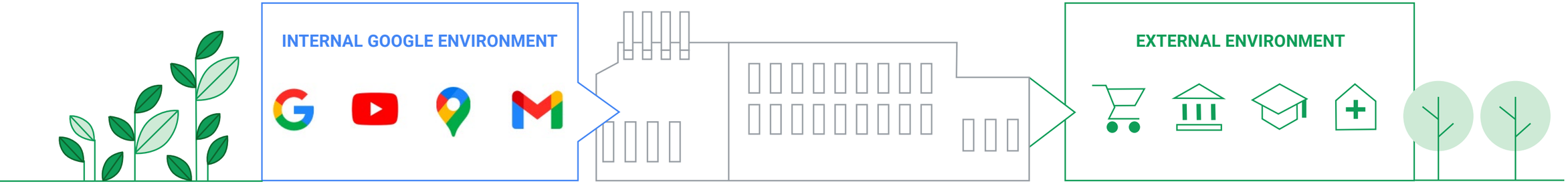
We use data every day when we do things like pull up a map to a new restaurant, attend online classes, stream favorite TV shows, or subscribe for online services. The demand for internet-based services just keeps growing – and as it grows, so does the need to store and safeguard enormous quantities of digital information.

Data centers (DCs) are the global hubs of the internet's connectivity, digital activity, and secure storage. They are where the internet lives. Google's global network of data centers is designed to do this work. Google distributes all the data under its care – including its own – across many computers in different locations. This helps Google keep data safe, and makes it possible to deliver information to users in a fraction of a second, using fiber and internet connections.

Artificial Intelligence (AI) and Machine Learning (ML) contribute to the reliability of Google's data infrastructure and its ongoing innovation.

Google's Virginia data centers securely store data from Cloud customers, ensuring the safety and performance of their web applications. These data centers also play a role in serving everyday user needs, like running Google searching and streaming YouTube videos.

In other words: Google's network of data centers is the heart of Google's services – services that are used every day by people all over the world.



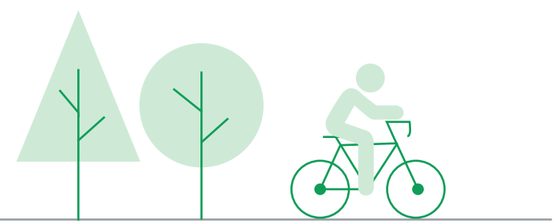
What is a data center?
A data center is a facility with many computers that store and process large amounts of information. Whenever a person accesses Gmail, edits a document, or searches for information on Google, they are using Google's data centers and have the power of a supercomputer at their fingertips. Data centers require different types of supporting infrastructure - including power systems, backup generators, water cooling systems, security facilities, warehouse buildings and office space – that work together to achieve a common goal.

Data center buildings can be as large as dozens of football fields put together. They host servers that are stacked in racks up to the ceiling. These servers are what make the data center run, and Google employs the highest security standards (see footnote) for protecting these machines and the sensitive data they hold.

FOOTNOTE: Google Cloud continues to hold certification against internationally-recognized privacy standards including ISO 27018 and ISO 27701 (read more).

Google's network of enterprise data centers benefit from economies of scale, enabling a favorable ratio of data storage capabilities per kilowatt hour of energy and liters of water that outperforms industry averages. Enterprise data centers also make sure that computations and data processing are evenly distributed across the data center network, which allows them to scale computing power and adapt to client needs more quickly.

Data center buildings are made up of different types of supporting infrastructure – that work together to achieve a common goal.



Google data centers have impacts beyond the efficient delivery of data security, adaptability, and connectivity. The internet lives in the physical infrastructure of data center campuses – and these campuses live within local communities. This report covers the ways Google's data centers in Loudoun County, Virginia impact the environment and the people who live in it, and marks a step towards Google's ongoing practice of accountability and transparency.

Google data centers
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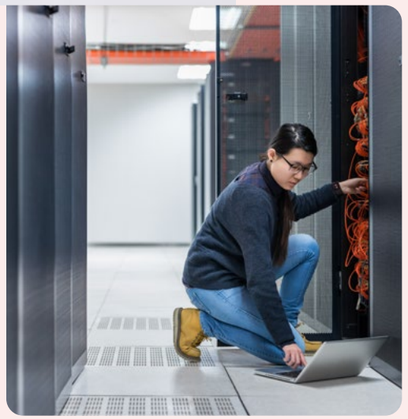


INTRODUCTION

Google in Northern Virginia

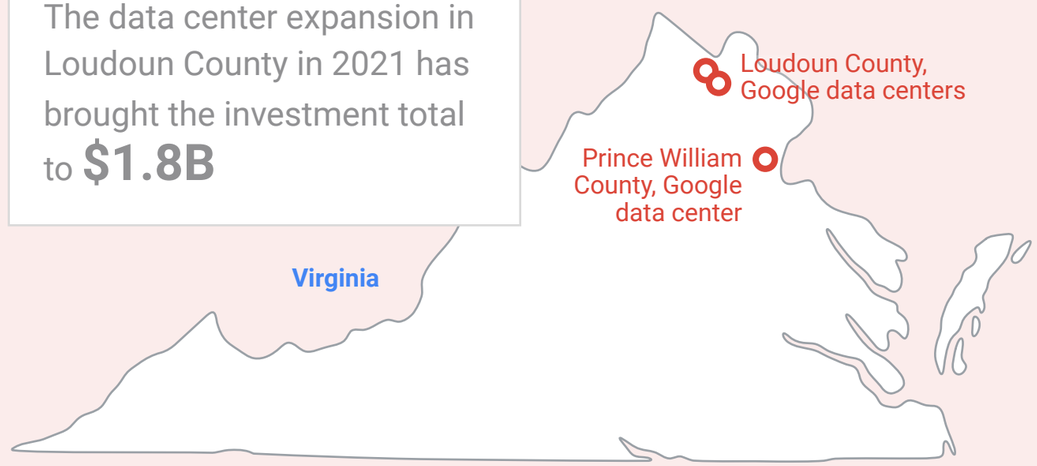
In 2018 Google announced plans to construct a data center campus in Virginia. In 2019, the first phase of construction on two data centers in Loudoun County was completed, reflecting a $1.2 billion investment. An expansion in Loudoun County in 2021 has brought this total to $1.8 billion.

The campuses are located just outside Northern Virginia's "Data Center Alley," an area that contains the largest concentration of data centers in the world. The two campuses are located near Arcola, VA and Leesburg, VA.

Loudoun County is a strategic investment location for Google because of its relatively low-carbon energy infrastructure, developable land, and business friendly climate. The industry's concentration in Northern Virginia has significant advantages, as Google is able to access the combined power of a skilled local workforce, businesses that specialize in addressing data center needs, and a well-developed optical fiber infrastructure.

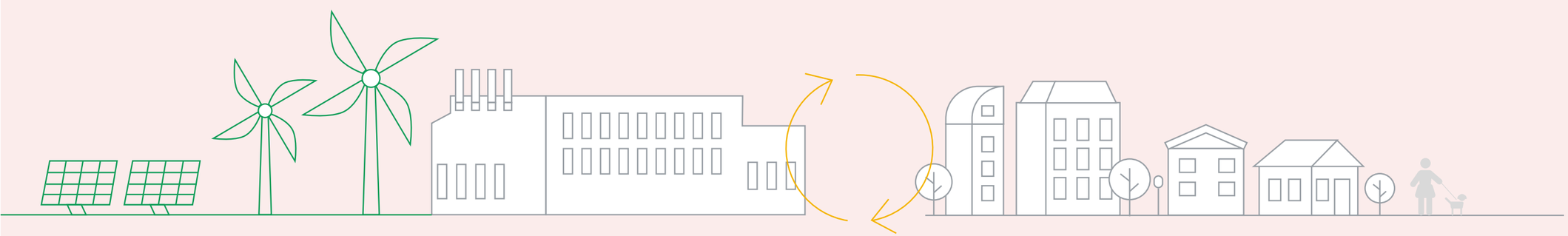
Google's most recent data center campus began operating in 2023 in Prince William County. The campus follows government officials' land zoning recommendations and joins Google's other Virginia data centers in stewarding sustainable development practices in the data center industry.

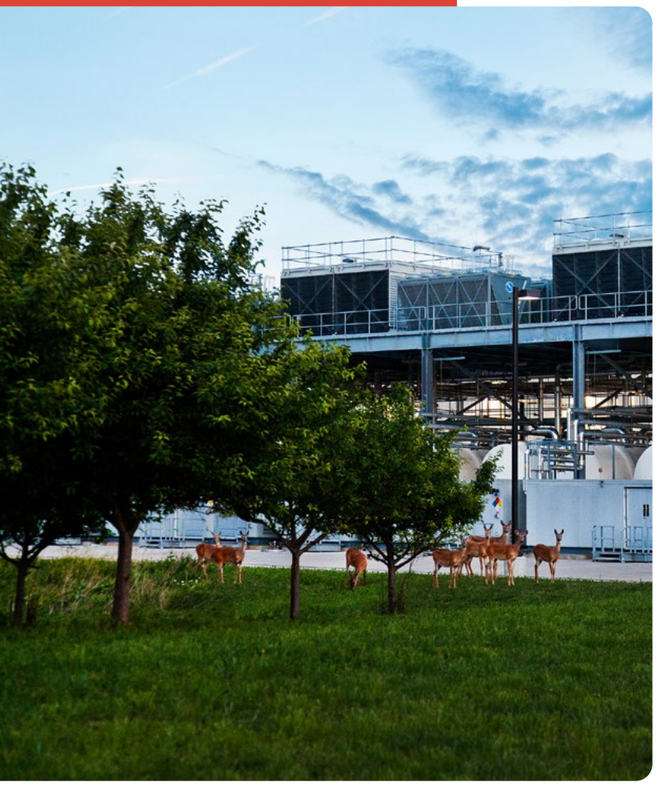
The data center expansion in Loudoun County in 2021 has brought the investment total to **$1.8B**



Compliant with Virginia's 2022 "Compete to Win" policy for economic development, Google has helped facilitate growth in Virginia's workforce by supporting an average of ~3,500 direct, indirect, and induced jobs per year between 2017 and 2022. In addition, Google's tax contributions help to further the government's goal to make Virginia more affordable and accelerate local infrastructure development.

> "Taking an active role in the communities where they have operations is a strong part of Google's culture and it sets them apart. They are making a tremendous economic impact in Loudoun County and Northern Virginia through investments to schools and local nonprofits, quality jobs, and community involvement."
>
> - Buddy Rizer, *Executive Director of the Loudoun County Department of Economic Development*





INTRODUCTION

External business environment

Nearly three fourths of the world's internet traffic passes through Northern Virginia, often referred to as the data center capital of the world. Today, there are more than 275 DCs in Loudoun, Prince William, Fairfax, and other neighboring counties. As of 2023, 35% of the world's known enterprise data centers can be found in the state of Virginia alone.

Loudoun County, and specifically Ashburn, VA hosts the largest number of data centers in Virginia, but Fairfax, Prince William, and the Greater Richmond region are also seeing a growing number of data centers. Due to the data center industry's investments in the area over the past 10 years, these counties have sought to establish legislation that minimizes the potential impact of data centers on local communities by designating specific parcels of land for data center development projects. County officials continue to work towards finding the right balance between data center development, preservation, and other land uses.

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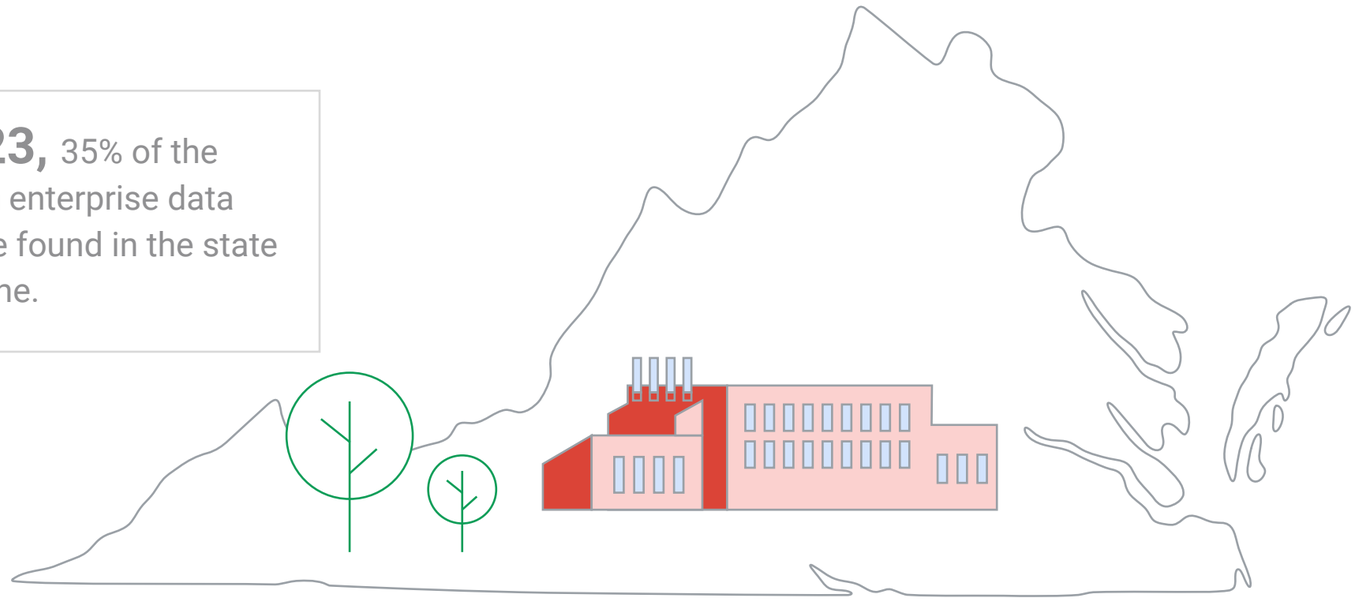


Google's theory of change

GOOGLE DATA CENTER THEORY OF CHANGE

Google's data center guiding principle

Keep digital infrastructure secure and sustainable while driving local economic development, fostering thriving communities, and spurring environmental stewardship

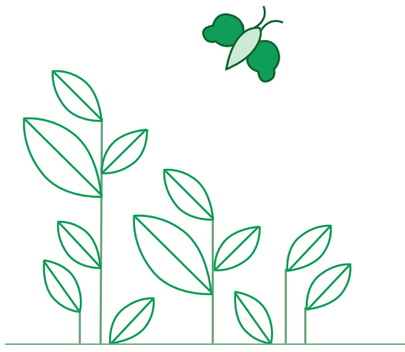
Data centers play an important role in Google's corporate mission to organize the world's information and make it universally accessible and useful. To achieve its mission, Google takes a three-part approach to driving positive change in the communities where its data centers operate.

Economic development: Google seeks to make positive contributions to the communities that host its data centers by working to improve the economic conditions of its employees and suppliers, offering grants, and making investments in local businesses and infrastructure.

Social advancement: Google aims to support higher quality of life in the communities near its data centers by providing high-paying jobs, grants, and educational programming to community members.

Environmental sustainability: Google works to maximize its energy efficiency and reduce water use by investing in energy efficient operations, clean power, and site selection.

These three areas of community development work are interconnected, and the impacts made across each towards community wellbeing must be driven by a cascaded approach from action (e.g., digital upskilling programs), to output (e.g., increased technical abilities in the workforce), to outcome (e.g., increased employability in the workforce).



GOOGLE DATA CENTER THEORY OF CHANGE

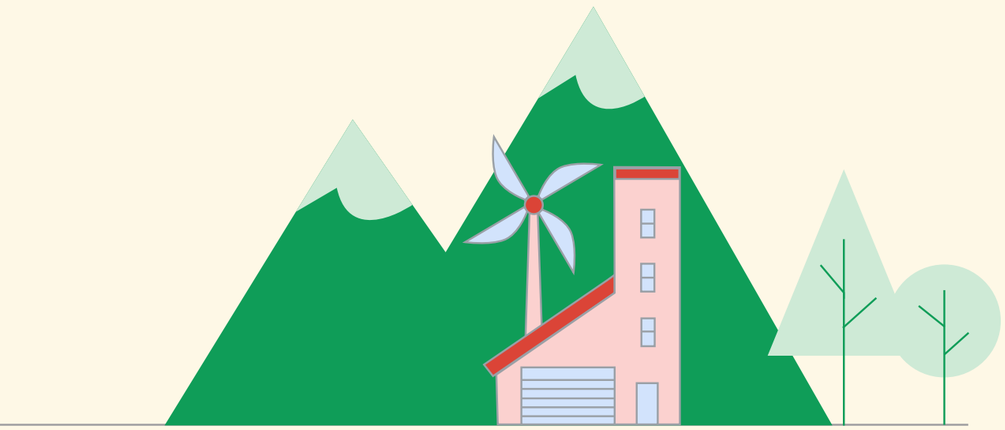
Prioritized topics from stakeholder interviews

This report delves into economic, social, and environmental topics of high importance to stakeholders in Virginia. By identifying areas of focus according to the values expressed by stakeholders, Google will be able to identify which topics are most important to those stakeholders and reflect unique needs and concerns of individual data center communities.

During 12 semi-guided interviews, participants were asked to assess 13 topics that were deemed relevant to Google's business activities and indicate which they considered most important for Google to consider. Interviewees included trade associations, municipality and state development authorities, universities, public policy makers, educators, and NGOs. Internal stakeholders from teams within Google – such as Energy, Operations, Sustainability, Site Selection, and Public Policy – were also interviewed.

In the course of these stakeholder interviews, the following topics emerged as areas of interest for this report:

Economic: The topic stakeholders considered most important to prioritize is the way Google's data center presence in Loudoun County reduces locals' yearly tax burden. This was closely followed by positive impacts on local employment rates and businesses. Stakeholders noted the potential positive impacts data centers can have on their areas when they increase the number of high paying jobs.



Social: Stakeholders indicated that they consider education the most important topic for data centers to prioritize, which aligns with the key priorities of local political leaders. Other action areas stakeholders want to prioritize include digital infrastructure, connectivity, and the impact of data centers on data privacy and security – areas in which data centers are uniquely positioned to create maximum impact.

Environmental: Stakeholders prioritized energy use as the most important environmental topic for data centers, followed closely by the impact of their greenhouse gas emissions and water use. Stakeholders also expressed concerns around noise pollution and the proximity of data centers to schools, homes, and historic sites.

Due to the anonymized nature of these interviews, the directional information about which topics are important to stakeholders reflect broad views on data centers and the data center industry in general, while some are specific to Google as a data center owner and operator.

Keep digital infrastructure secure and sustainable

KEEP DIGITAL INFRASTRUCTURE SECURE AND SUSTAINABLE

Google's economic, social, and environmental data center impacts to Loudon county, Virginia

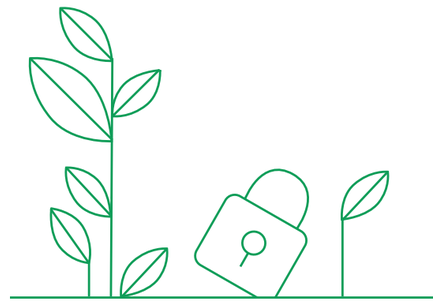
This report provides an overview of how Google's actions are aligned with its work addressing the economic, social, and environmental concerns and priorities for data centers. The first section offers an overview of Google's contributions to the economy in Loudoun County. The second section outlines how Google is prioritizing its people, both internally and externally. The third section examines Google's relationship to the environment, including energy use, emissions, water, and waste.

Google's contributions to the local economy

Google creates economic opportunity throughout Loudoun County both via its direct contributions to GDP and employment and the indirect ripple effects on the local economy. Additionally, the tax revenue generated by Google's business in Virginia helps to support the local education system and has reduced Loudoun County's overall tax burden. Google also supports technology advancements by housing them in its data centers and by patronizing businesses in other sectors such as construction, manufacturing, or IT equipment resale. Overall, Google's data centers in Loudoun County positively impact the economic wellbeing of the area.

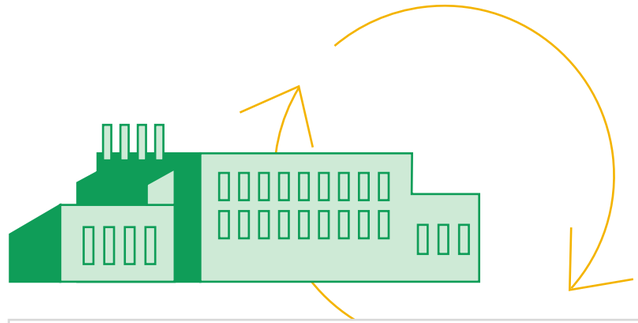
Contribution to Loudoun County's GDP: Direct, indirect, and induced impact

Data centers necessitate the use of land, highly specialized equipment, servers, and buildings; not to mention the ongoing expenditures that must be made on maintenance and repair, equipment upgrades, energy, and retaining highly qualified employees.



Between 2017 and 2022, Google's data center investments in Loudoun County generated an average of ~$800 million per year in direct, ~$180 million in indirect, and ~$100 million in induced economic impacts, as measured by GDP — ~$1.1 billion on average, in total, per year and ~$2.0 billion in total in the most recent year of study, 2022. The direct economic impacts of these investments include the headcount of Google employees and contractors (including their payroll and benefits) and annual spend on Google's suppliers. Indirect effects include the headcount of Google's suppliers' employees and contractors, the suppliers' payroll and benefits due to Google orders, and suppliers' spend. Induced effects are generated by the household spending of Google's employees and their suppliers in their local economies. Overall, Google's data center construction and operations have had a significant impact on the wireless equipment, computer manufacturing and construction sectors.

FOOTNOTE: The GDP contributions above are represented in terms of nominal values, and no adjustments for inflation have been made. All calculations were executed at the most local level possible in order to provide impacts, which in most cases was Loudoun County.



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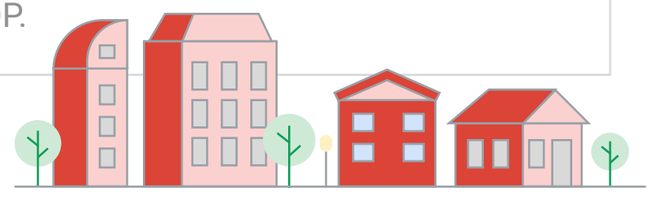
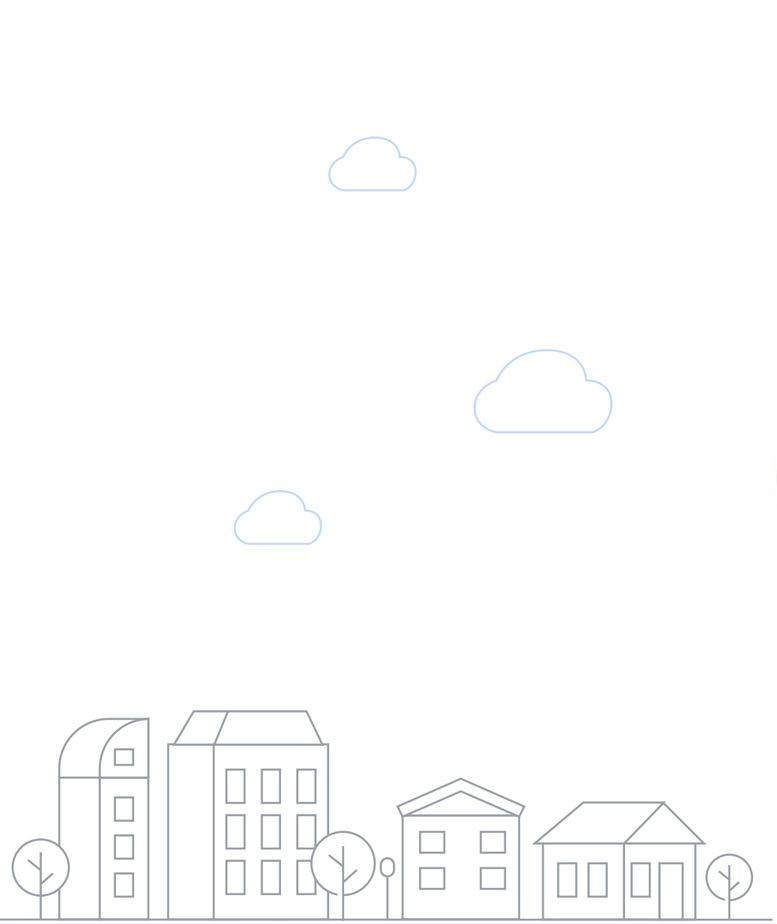
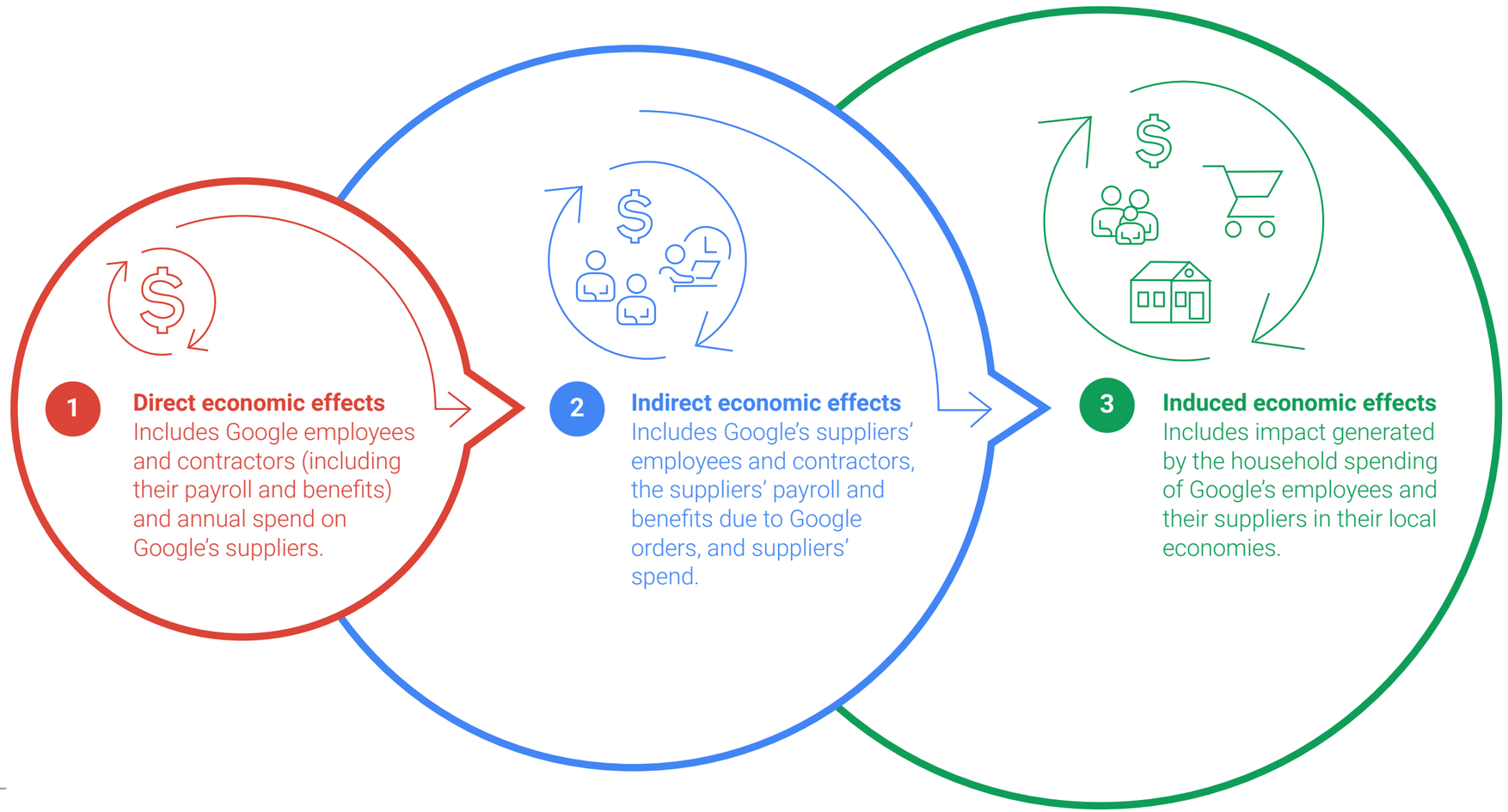


Google Cloud is hosted in these same data centers, and the economic impact of its presence has expanded beyond Loudoun County to the entire state of Virginia. In 2022, Google helped provide $10.21 billion to tens of thousands of businesses, publishers, nonprofits, creators and developers across the state.





1 Direct economic effects
Includes Google employees and contractors (including their payroll and benefits) and annual spend on Google's suppliers.

2 Indirect economic effects
Includes Google's suppliers' employees and contractors, the suppliers' payroll and benefits due to Google orders, and suppliers' spend.

3 Induced economic effects
Includes impact generated by the household spending of Google's employees and their suppliers in their local economies.

Direct and indirect impact on employment

Between 2017 and 2022, Google's initial investment and ongoing operations in Loudoun County have supported the creation of an average of ~150 direct, ~2,730 indirect and ~630 induced jobs per year and $330 million in direct, indirect and induced impact on labor income. The yearly values vary based on specific investments in the construction of data centers and other large capital projects, and the most recent year of study, 2022, saw ~400 direct jobs supported. Direct jobs include full-time, temporary, and vendor positions Google opened and staffed to run its data center. The indirect jobs include Google's suppliers' employees and contractors, suppliers' payroll and benefits, and supplier spend, and induced jobs come from Google employees and suppliers' employees spending within their local communities.

Both in and beyond Loudoun County, Google is working to increase access to high-earning career opportunities like data analytics and UX design by granting Grow with Google career certification program opportunities to local college-level students. Participants in the program engage in a 3- to 6-month career upskilling process. Google has partnered with 16 educational institutions in Virginia, such as the Northern Virginia Community College (NOVA), to implement this program. Nationally, 75% of program graduates report a positive career outcome, such as a promotion or new job, within six months of program completion.

> "Since 2019, this innovative public-private partnership has increased opportunities for students to join the technology workforce. We thank the Commonwealth of Virginia for recognizing this accelerated pathway that helps close the skills gap and greatly expands the region's talent pool."
>
> - Anne M. Kress, *President of NOVA*

Google

Virginia organizations received a portion of **$191M** in loan and grant support to community development and financial institutions.

Much of this support was delivered as low-interest loans given to more than **130,000** underrepresented businesses and nonprofits in the US.

Impact on taxes and public budget

Income from taxes provides the government in Loudoun County with funds to provide essential services – such as education, healthcare, capital improvements, public safety, parks, and recreation and culture – to its citizens.

Small business spotlight

Grow with Google is a global program that offers career certifications and tools to small businesses. In 2022, the program partnered with 252 organizations like public libraries and community colleges to train over 234,000 Virginians in digital business skills. The program includes a state-based digital coach who offers free live training and hands-on coaching to small businesses.

Google's national investments have benefited Virginia's broader business ecosystem, too. In 2022, Virginia organizations received a portion of the $191M loan and grant support Google provided to community development financial institutions. Much of this support was delivered as low-interest loans given to more than 130,000 underrepresented businesses and nonprofits in the US. An example of a Virginia-based organization that benefited from this support is Capital Impact Partners, a nonprofit that aims to "help build inclusive and equitable communities by providing people access to the capital and opportunities they deserve."

70% of generative AI unicorn startups like Cohere, Jasper, and Typeface rely on Google's cloud infrastructure and AI capabilities (read article). Google Cloud is also helping democratize innovative tech for small businesses with access to resources like its Vertex AI platform, advanced TPU chips, and a library of over 80 pre-trained AI models to accelerate development. Google's existing infrastructure and AI capabilities makes it possible for these companies to launch their new capabilities from a platform of preexisting resources, rather than having to start from scratch.

KEEP DIGITAL INFRASTRUCTURE SECURE AND SUSTAINABLE

Google's commitment to people

Google is committed to improving the lives of as many people as possible – both internally, for its employees and contractors, and externally, through initiatives like supporting nonprofits. Its goal is to create strong relationships with stakeholders in the communities in which it operates and contribute positively to a higher quality of life for residents.

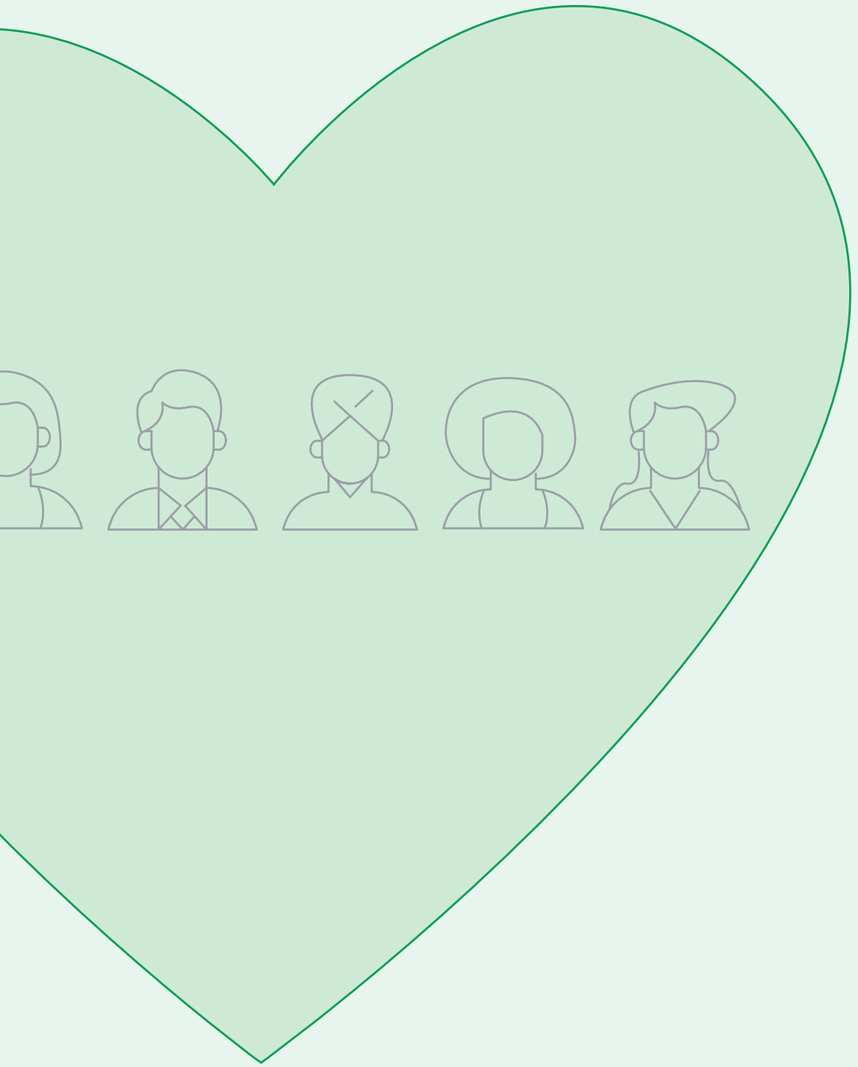
Investing in people around Google: Pursuing equity

In 2022, Google set a goal to spend $2.5 billion in the US with diverse-owned suppliers to create a more equitable supplier ecosystem. Google has since exceeded that goal by $300 million. In Virginia, Google's top subcontractors are represented by woman-owned, veteran-owned, Asian American, and Latinx-American businesses. Beyond spend, Google aims to form relationships with diverse-owned subcontractors.

1. Racial equity
2. Disability inclusion
3. Gender equity
4. LGBTQ+ inclusion
5. Veteran inclusion

5 actions

Google is doing to create a world where everyone belongs, anything is possible.



Early in the Loudoun data center construction, Google formed a construction partnership with a Black-owned business, CD Moody Construction. When the scope of the data center construction project exceeded the capacity of CD Moody's workforce, Google connected CD Moody Construction to its own resources and worked to grow with them.

Google has also worked to strengthen programs for Historically Black Colleges and Universities (HBCUs). Virginia is home to the largest HBCU Festival in the nation, the Alfred Street Baptist Church HBCU Festival. Google was proud to be a title sponsor for this annual celebration in both 2021 and 2022. The 2022 Alfred Street HBCU Festival welcomed 6,000 high school seniors and awarded $4 million in scholarships, expanding access to post-secondary education.

Supporting local education

Virginia has witnessed the biggest proliferation of data centers in the world in just a few years. As a result, it has become the heart of a technology corridor that is rife with technology learning and career opportunities. However, rapid growth in this sector has made it difficult for Virginia schools to expand their STEM programs and curricula at a pace that will enable students to seize these opportunities.

Since establishing a presence in Loudoun County in 2019, Google has worked with Loudoun County Public Schools, Prince William County Schools, The Loudoun Education Foundation, and other organizations like CodeVA and the Community Foundation of Loudoun and Northern Fauquier Counties to improve digital equity in Virginia. This includes providing the Loudoun Education Foundation $150,000 to support Wi-Fi hotspots for students during the COVID-19 pandemic, supplied to all Loudoun County middle and high schools.

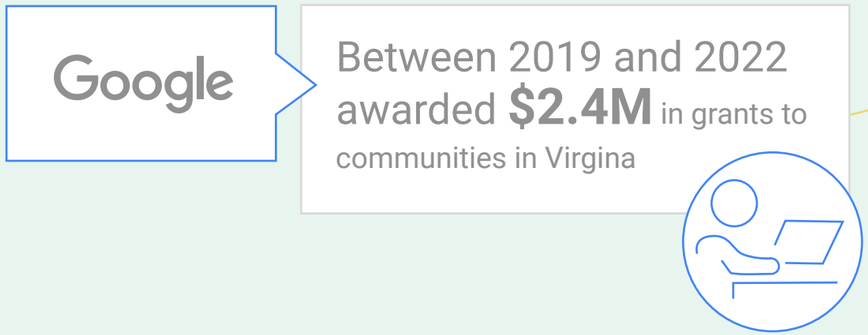
Google plans to invest $20 million to help expand access to computer science (CS) education to over 11 million students across the US, and Google sees Virginia as particularly pertinent to this mission. To help expand computer science education access in Virginia, Google has given over $390,000 to CodeVA, a state-wide nonprofit that works to increase computer science literacy in public schools. The funding will primarily be used to support teacher professional development and to expand Virginia's Computer Science Hub Network, a resource that makes in-person professional and curriculum development available to educators, students, and families.

In 2021, VA was ranked #1 among US states for its robust tech talent pipeline, a result that can be partially attributed to initiatives like the above from Google and other technology companies in the region.

Supporting local community members

Supporting local community members includes both investing in grants and being sensitive to community concerns, including light pollution and noise levels at data centers.

Between 2019 and 2022, Google awarded $2.4 million in grants to communities in Virginia. These grants were designated to help communities strengthen STEM education

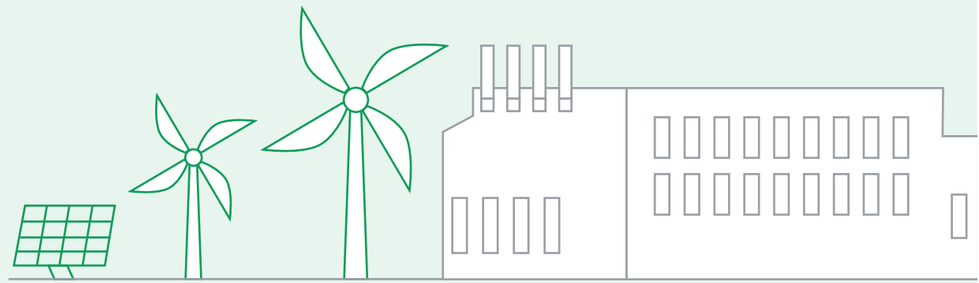


programs, secure access to clean drinking water, provide employment training for people with developmental disabilities, and offer COVID-19 fiscal relief to minority-owned businesses. In some cases, direct grants were given to nonprofits for discretionary use.

On other occasions, Google has offered services with the specific intention to provide business support to nonprofits and help them scale their mission-driven work. For example, in 2022 Google provided $26.64 million in free search advertising to Virginia nonprofits through the Google Ad Grants program.

For several years, Google's Loudoun County data center team has partnered with Mobile Hope on initiatives to support families in need across the region. In 2021, Mobile Hope and Google teamed up to build raised vegetable beds at JK Community Farm which provided over 200,000 community members access to high quality produce. Google also launched a new trade school, Trading Up, on Mobile Hope's campus, and has provided additional annual funding to enhance Mobile Hope's training programs for young adults aged 18–24 who seek careers in trades like plumbing, electrical, HVAC, and automotive.

In 2021, Google invested ~$1.375 million in digital upskilling programs for 4,631 Virginia residents. This led to the subsequent employment of 188 individuals, and to pay raises for another 87 individuals.

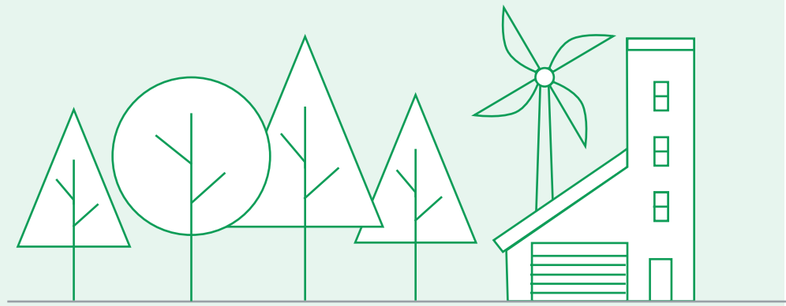


Local stakeholders have expressed concerns about light pollution at data center facilities. The Occupational Safety and Health Act of 1970 (OSHA) requires that data centers maintain 24/7 video capture as a security and safety measure, which typically requires keeping strong lighting on around the clock. Google is required to abide by OSHA requirements. It is working to implement thermal camera technology that will reduce its need for strong lighting while continuing to enable 24/7 video capture in low-light and poor weather conditions.

When preparing to build a data center campus, Google measures existing ambient noise levels for multiple days and nights before construction. Through further modeling and simulation, it then develops baseline understandings of noise levels in sensitive locations, frequencies of concern, and times when noise peaks during the 24-hour day.

These measurements and baselines help Google determine the best methods and times for attenuating self-generated noise.

Google also conducts extensive noise modeling to ensure the noise levels at its data centers meet local noise ordinances for the zoning on and around the Google property. During day-to-day data center operations, Google's main generators of noise are external cooling plants, on-site substations, and miscellaneous HVAC equipment. To mitigate the impact of this noise, Google adjusts the design of cooling towers that are located closest to residential areas.



KEEP DIGITAL INFRASTRUCTURE SECURE AND SUSTAINABLE

Google's data privacy, resiliency, and digital infrastructure

Google specializes in cybersecurity capabilities and services. As such, it takes serious measures to protect the private data its clients trust it to safeguard. Just as Google follows its mission to advance equity by increasing public access to the internet, it must honor its users' and clients' trust by striving to keep their private information safe.

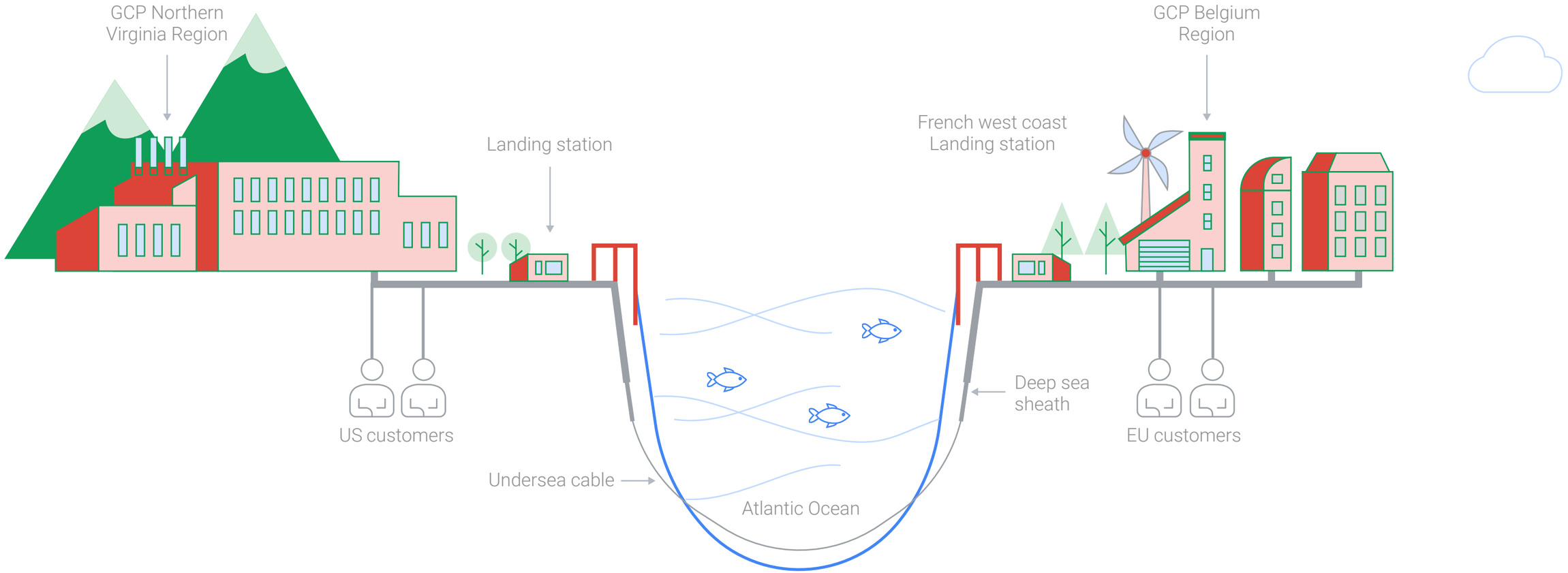
The organizations that trust Google's data centers to protect their private information include small businesses, public organizations, and large corporations. Google works hard to honor this trust with strong security measures, such as requiring Google employees who are not directly employed at a data center to complete a series of security checks before they enter the building. Measures like these might earn data centers a reputation for being secretive, but they are in place for user security and to safeguard the information Google houses for its clients.

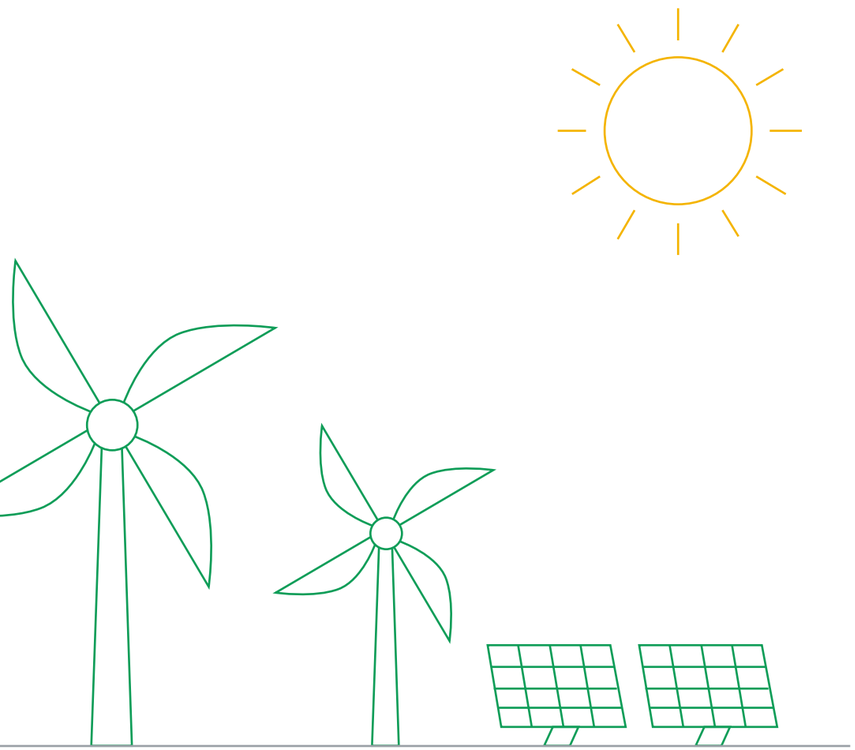
Improving digital infrastructure

The speed at which Google is able to transport data across great distances to enable business operations to run without interruption is made possible by its digital infrastructure. The Google Cloud network consists of fiber optic cables under land and sea, and cloud regions around the world.

Due to its high concentration of data centers, northern Virginia is a hub for internet traffic. Google also contributes to the construction and operation of cabling for the nationwide fiber-optic network, both on land and on the seafloor. In 2020, Google operationalized the Dunant subsea cable, which connects Virginia Beach, VA, with the French Atlantic coast. It has the capacity to deliver information at 250 terabits per second (Tbps). In other words, it is capable of transmitting a quantity of data equal to America's entire digitized Library of Congress across the Atlantic 3 times per second.

The construction of the Dunant cable is part of Google's ongoing effort to strengthen digital infrastructure in Virginia and across the Atlantic. Dunant is part of Google's network, helping provide service to users and customers.





KEEP DIGITAL INFRASTRUCTURE SECURE AND SUSTAINABLE

Google's impact on the environment

The following section includes the impact of Google data centers on energy use, greenhouse gas emissions, water use and waste. In cases where some data was not included, it is due to regulatory, competitive, or data quality considerations. As the ability to do so changes, future impact assessments will reflect Google's capability to share additional information.

Google is undertaking efforts to minimize the necessary impacts its Loudoun County data centers have on the environment, which are in line with government policies like 2020 Virginia Clean Economy Act (100% zero-carbon energy generation by 2050). To minimize its emissions, Google has invested in several power purchase agreements (PPAs), including more than $7 million over 2021-22 towards carbon-free capacity of more than 500 MW in Virginia. Globally, Google is aiming to run 24/7 carbon-free energy at all data centers on every grid where it operates, has pledged to replenish 120% of freshwater consumed, on average by 2030, and is moving towards Zero Waste to Landfill, meaning more than 90% of the waste is diverted from a landfill. In Virginia, Google supports local zoning regulations for land preservation.

As a collective, these actions aim to reduce the demand on finite resources, improve the health and wellbeing of local community members and can serve as a catalyst for the transition to sustainable business growth.

Why do data centers need energy?

The process of storing data, processing data, and networking can be energy intensive. At present, data centers account for about 1–1.5% of global electricity use. A majority of this energy demand comes from a need to source power for data servers. As data servers run they produce heat and need to be cooled, which generates additional energy demand.

The energy market in Northern Virginia

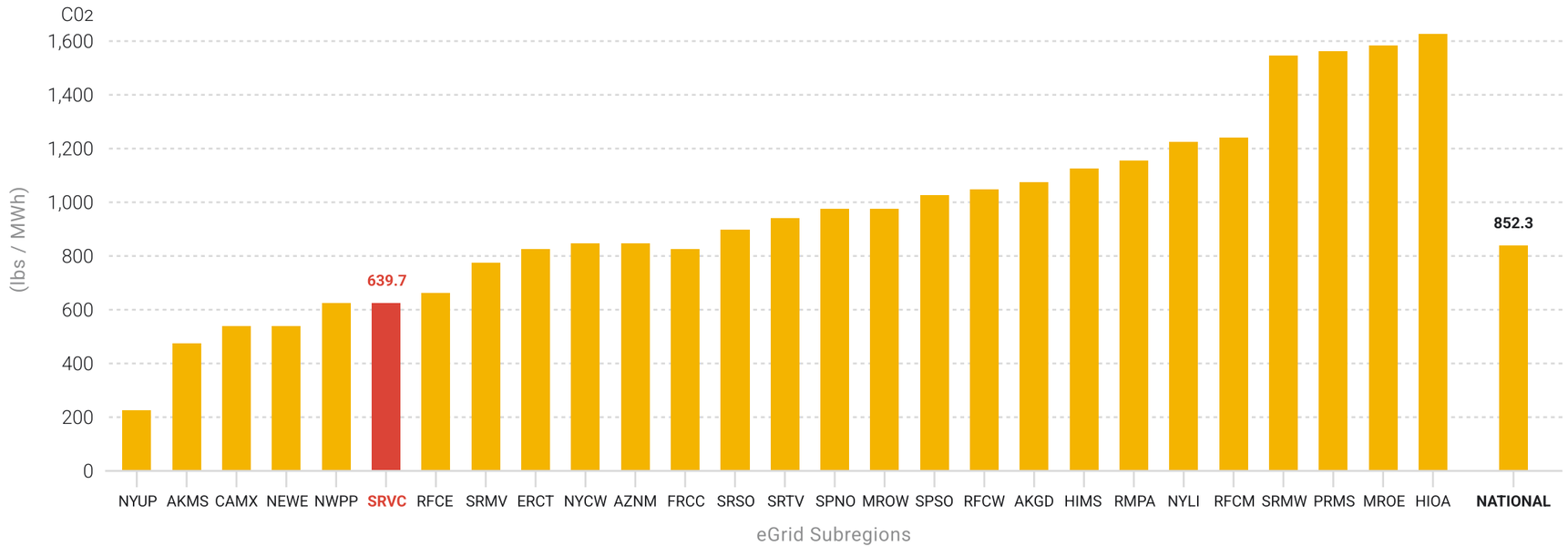


FIGURE 1: Carbon intensity of US sub-grids. SRVC has the 6th lowest carbon intensity, with 639.7 pounds per MWh (graph source).

Google's efforts to reduce its energy impact

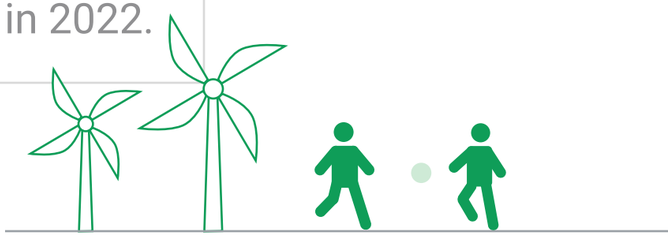
Google's data centers in Loudoun County source most of their power through the PJM Interconnection, a regional transmission organization. PJM's 2021 grid mix was 39.4% carbon-free (32.9% nuclear and 6.5% wind, solar, hydro, and biomass combined).

Google has invested in several power purchase agreements (PPAs), investing more than $7 million between 2021 and 2022 toward cultivating a carbon-free energy capacity of over 500 MW in Virginia. In Virginia, commercial and industrial customers like Google are provided the opportunity to purchase clean energy from third party suppliers to meet sustainability objectives.

Google wants to bring new clean energy to Virginia, as opposed to sourcing carbon-free energy from existing projects. Focusing on energy procurement activities that enable the deployment of carbon-free energy generation new to the grid helps to ensure the addition of new carbon-free electricity to serve the future demand of its data centers.

Due to Google's concerted efforts to source carbon-free energy for its data centers and construct energy-efficient physical structures, it was able to operate at an average of 60% carbon free energy (CFE) in Virginia in 2022, compared to the regional transmission mix of ~39.4% CFE.

Google's data centers operated at an average of **60% carbon free energy (CFE) in Virginia** in 2022.



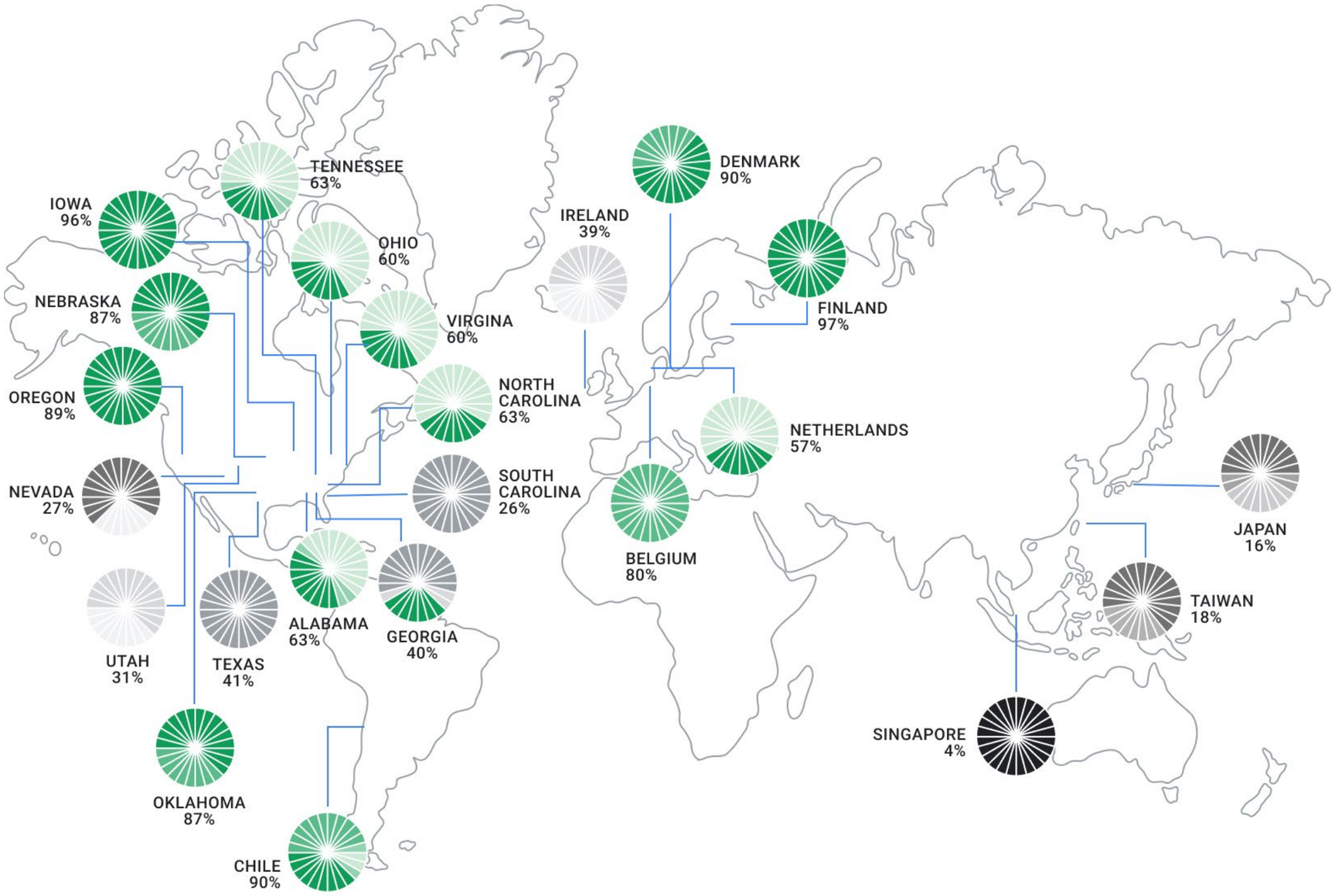
Google's diversified energy sourcing strategy and evolution towards 24/7 CFE

Globally, Google has matched 100% of its annual electricity consumption with renewable energy purchases since 2017 (read article). Additionally, to cut greenhouse gas emissions from its electricity use and purchases, Google set a global goal in 2020 to run on carbon-free energy 24 hours a day, 7 days a week, by 2030. While Power Purchase Agreements (PPAs) and Renewable Energy Certificates (RECs) are tools that contribute towards developing a greener electricity grid, they do not ensure that the total energy consumed by an organization comes from low-carbon sources. New types of energy contracts and advanced clean energy technologies will also be needed.

In 2021, Google signed an agreement with AES Corporation (an independent power producer) by which AES agreed to become the "CFE Manager" for Google's three data center campuses in Virginia. Using its portfolio of ~500 MW of renewable energy and storage projects, AES has committed to power Google's data centers with 90% carbon-free energy on an hourly basis.

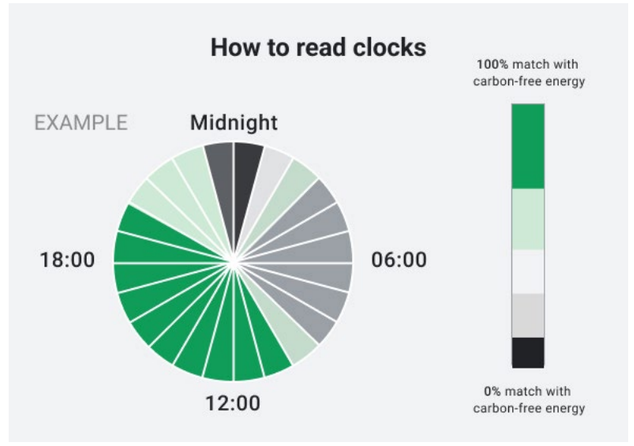
Google's partnership with AES is enabling Google to purchase sufficient annual volumes of clean energy to run its data centers. It does so by sourcing that energy from a regional grid whose time and location better align with the region where Google consumes power than the previous clean energy options Google has utilized. The structure of the deal can be replicated between different locations and/or adopted by other purchasers of clean energy.

FOOTNOTE: Google defines carbon-free energy as any type of electricity generation that doesn't directly emit carbon dioxide, including (but not limited to) solar, wind, geothermal, hydropower, and nuclear. Sustainable biomass and carbon capture and storage (CCS) are special cases considered on a case-by-case basis, but are often also considered carbon-free energy sources.

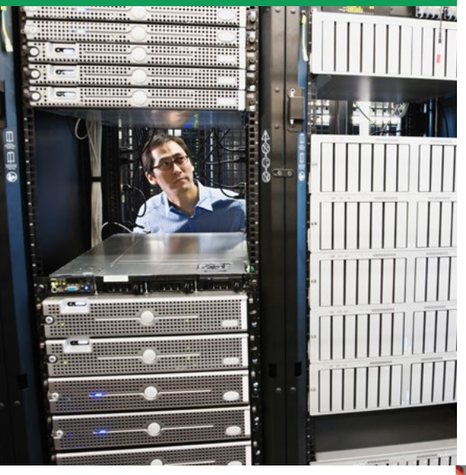


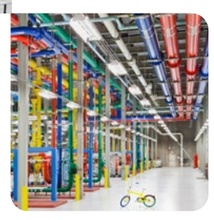
Energy efficient design

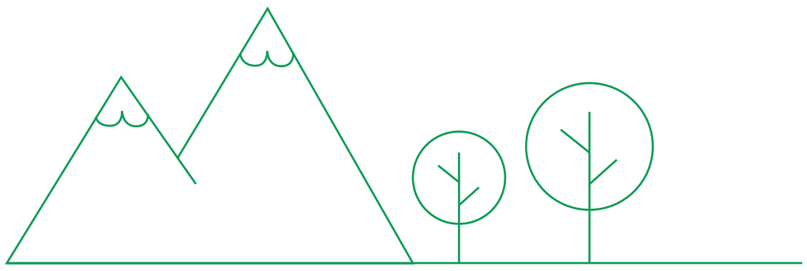
As of 2022, Google's data centers globally are, on average, 1.5 times as energy efficient as a typical enterprise data center and compared to five years ago, they now deliver approximately three times as much computing power per unit of electrical power. In 2022, data center Power Usage Effectiveness (PUE) at Google's Loudoun County data centers was 1.09, a 0.46 improvement over the global industry average of 1.55.



FOOTNOTE: PUE is determined by dividing the total amount of power that enters a data center by the portion of that power used to run the data center's IT equipment. PUE is expressed as a ratio, with overall efficiency improving as the quotient decreases toward 1.0. Google calculates PUE in line with ISO/IEC 30134-2 Standard for Power Usage Effectiveness.







Google uses a carbon-intelligent computing platform, first announced in 2020, to shift certain computing tasks and their associated energy consumption – such as processing a video uploaded to YouTube – to times and places in which carbon-free energy is available on the grid. Google also utilizes a task-shifting capability for demand response to reduce data center electricity consumption during periods of high stress on the local or regional energy grid, temporarily reducing power consumption to provide valuable flexibility when it is needed, so that local grids continue operating reliably and efficiently.

Moreover, Google has designed and implemented highly efficient Tensor Processing Units and has outfitted its facilities with high-performance servers – including smart temperature, lighting, and cooling controls. These measures have promoted even more efficient energy use at Google's data centers.

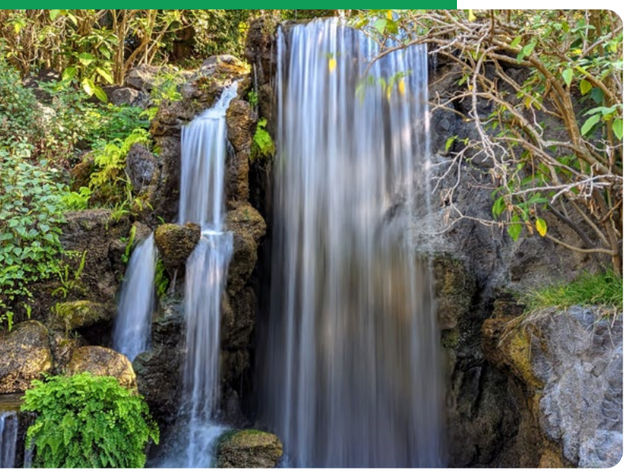
Greenhouse gas emissions reduction

In 2021, Google set a goal to achieve net-zero emissions across the entirety of its operations and value chain globally by 2030.

To accomplish this, Google aims to reduce its combined Scope 1, Scope 2 (market-based), and Scope 3 absolute emissions by 50% against a 2019 baseline before 2030. It also plans to invest in nature- and technology-based carbon removal solutions that will neutralize its remaining emissions. Google has formally committed to seek out the Science Based Targets initiative's (SBTi) validation of its absolute emissions reduction target.

In 2022, Google's total global Scope 1, Scope 2 (market-based), and Scope 3 greenhouse gas emissions were 10.2 million metric tons, and the 24% of that total (2.5 million metric tons) that are Scope 2 emissions are mainly due to the electricity demands of data centers.

FOOTNOTE: Scope 1 emissions are direct emissions from company-owned and controlled resources. Scope 2 emissions are indirect emissions from the generation of purchased energy and cooling, such as from a utility provider. The market-based method of calculating Scope 2 emissions incorporates Google's renewable energy purchases via contractual mechanisms like power purchase agreements (PPAs). Scope 3 emissions are all indirect emissions – not included in Scope 2 – that occur in the value chain of the reporting company.



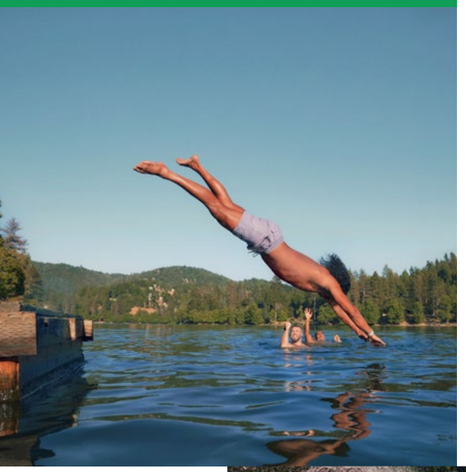
Water stewardship

Data centers are similar to personal devices like laptops in that as they run, they generate heat – though they do so on a much larger scale. In order to keep the servers and chips from overheating, large industrial cooling systems are used to remove heat from the data center. At present, the cooling solutions for data centers include air-cooling, water-cooling, or a combination of these technologies. There is no one-size-fits-all approach to cooling a data center. The best solution for a specific data center depends on local factors like climate as well as availability of carbon-free energy and water.

Before selecting a site for a new data center and identifying the optimal cooling solution, Google assesses the local watershed's depletion and water scarcity risk, incorporating the site's potential impact. Water-cooling is determined to be responsible and resilient at sites that return favorable assessments for both metrics, underscoring the importance of water stewardship and resilience during site selection and facility design. Once operational, Google continues to monitor these metrics to manage future risks and proactively develop strategies to mitigate them.

In Loudoun County, Google uses water to cool its data centers, lowering the impact on the local energy grid. In 2022, Google's data centers in Loudoun County consumed 229.3 million gallons of water.

In 2021 Google set a goal to replenish more water than it consumes globally by 2030 and to take action toward further supporting water security in the communities where it operates. Achieving these goals would mean Google replenishes 120% of the water it consumes annually, on average, across all its offices and data centers globally.

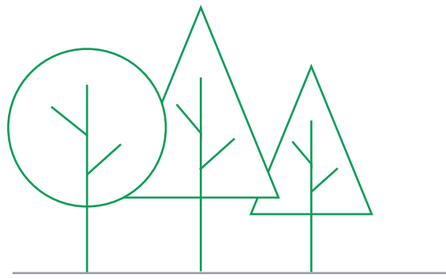


Google supports this effort at the local level by partnering with local groups like Alliance for the Bay, the Potomac Conservancy, and Virginia Association of Soil and Water Conservation on projects that will improve the water quality of the local watersheds. In 2022, Google gave the Alliance for the Bay $235,000 to assist farmers with developing conservation plans that prioritize installing agricultural best management practices on dairy farms in the Potomac Watershed areas.

Waste and circularity

Data centers are filled with servers, drives, routers and other components. Due to frequent use and the rapid pace of technological change, these components once had fairly short life spans. Google works to maintain and refurbish hardware components to ensure device longevity. When components are decommissioned from use, some are reused, remarketed or recycled. These efforts can reduce the need for new data center equipment to be created from finite resources.

Google has implemented strategies to prevent waste from entering landfills. These strategies include re-using equipment, recycling equipment materials, and re-selling used equipment in the secondhand market. On a global scale, 10 of Google's data centers have achieved Zero Waste to Landfill, which means a greater than 90% diversion rate.



Conclusion

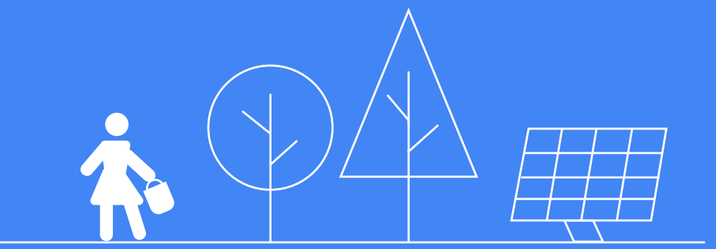
This report provided an overview of the economic, environmental and social impact of Google's data centers in Loudoun County from 2017-2022, and some of the actions it is taking to scale positive impacts and minimize negative impacts.

Data centers are essential for the transition to a more digitized economy. From 2017-2022, Google's data centers have had an economic impact of ~$1.1 billion in contributions to Loudoun County's GDP annually. Between 2019 and 2022, Google.org awarded $2.4 million in grants in Virginia to further STEM education, bolster access to clean drinking water, provide employment training for people with developmental disabilities, and offer COVID-19 fiscal relief to minority-owned businesses. Google has made investments in environmental sustainability, which can be seen in its Power Usage Effectiveness (PUE).

In alignment with the Theory of Change, Google aims to keep digital infrastructure secure and sustainable while driving local economic development, fostering thriving communities, and spurring environmental stewardship. These three areas (economic, social, and environmental) are interconnected, and collectively impact community wellbeing.

One generally accepted way to measure community-wellbeing is through the Organization for Economic Co-operation and Development (OECD) Better Life Index. This index assesses wellbeing across a range of topics and indicators that the OECD has identified as essential in the areas of material living conditions and overall quality of life. The OECD Better Life Index is a way to frame the overall impact that Google data centers may have on the communities in which they operate.

Of the eleven topics measured and weighted equally by the OECD Better Life Index, Google data centers might influence four. It is important for Google to recognize that over one-third of the wellbeing measure in a community could be driven by its actions. With deliberate action going forward, Google data centers can positively influence the following topics: Income (measured by



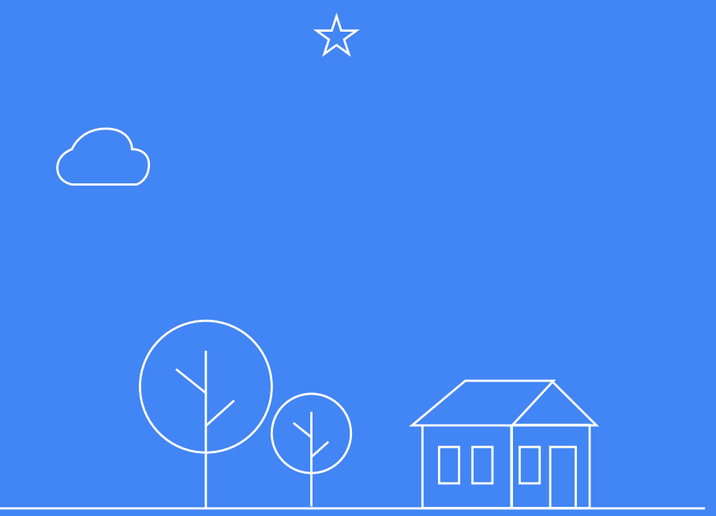
Household net adjusted disposable income and Household net wealth), Jobs (measured by Labor market insecurity, Employment rate, Long-term unemployment rate and Personal earnings), Education (measured by Educational attainment, Student skills, Years in education) and Environment (measured by Air pollution and Water quality).

Although Google has made investments in environmental sustainability, there are still emissions from its data center operations. Google aims to achieve net-zero emissions across its operations and value chain by 2030 (read article). Google is working towards this in Virginia by investing in local renewable energy capacity, optimizing the balance between water usage and energy usage, and by finding innovative ways to reuse or recycle waste.

As the capacity required to meet the needs of a more digital future grows, so will digital infrastructure needed to enable it. While any expansion will increase GDP and add jobs, Google can channel its impact by using local contractors where possible, formalizing relationships with employment agencies to shape programs that address digital skill talent gaps and continuing to use Grow with Google for career certification and for small businesses.

Google is passionate about being a good neighbor. As such, it is critical for Google to continue addressing local opportunities and challenges, which is dependent on engagement from local stakeholders, investment in collecting and sharing reliable data when possible, and a continued, proactive strategy. Continuing to participate in open dialogue will build more trust moving forward. Google will also continue to monitor its economic, social, and environmental impacts at the local level through robust data and consistent adherence to its Theory of Change. Filtering decisions related to data center investments and operations through this lens will create a secure and sustainable internet.

Appendices



APPENDICES

Glossary

The topics as defined below were used to assess regional priorities in the interviews conducted to inform this study.

Economic topic	Definitions
Employment creation	Number of jobs - direct, indirect or induced - that are created as a result of a data center operator's employment opportunities and workforce upskilling programs, as well as induced workforce outcomes.
Contribution to local businesses & industry sectors	Contracts with local businesses, adjacent sectors supported, and other positive or negative externalities related to data center operators' engagements around a point of presence.
Contribution to tax income	National & local taxes on data center land use, equipment, and other taxed activities paid to governments.

Social topic	Definitions
Education	Local educational programs supported and financed through a data center operator's investments and partnerships.
Employee health & wellbeing	Physical safety protection and mental support provided to data center employees and contractors.
Diversity, equity & inclusion	Support, development, and/or empowerment of talent from vulnerable and historically under-represented groups in a way that supports equal access.
Contribution to digital infrastructure & connectivity	Investments in local digital infrastructure, cabling and connectivity.
Contribution to data privacy & cybersecurity	Reinforced data security and reliability as a result of a data center's adherence to high privacy and cybersecurity standards.

Environmental topic	Definitions
Emissions reduction	Efforts to change energy consumption and other drivers of emissions (i.e., greenhouse gases) resulting from data center operations.
Energy use & impact on grid	Use of non-renewable or renewable energy impacting energy prices, capacity, and regional grid, and efforts to reduce the amount of energy used through operations.
Waste recycling & sustainable materials	Waste produced from data center equipment and operations as generated, recycled, or reduced through the employment of sustainable materials.
Water usage & treatment	The withdrawal, consumption, and discharge of water in operations, including impacts to local water quality.
Biodiversity & land preservation	The impacts of a data center's physical presence and operations on natural resources, including deforestation, species impacted, and restoration programs.

Acronyms

AI	artificial intelligence
CDN	content delivery network
CFE	carbon-free energy
CO_2e	carbon dioxide equivalent
CS	computer science
dBA	A-weighted decibel
DC	data center
DEI	diversity, equity, inclusion
ESG	environmental, social and governance
GCP	Google Cloud Platform
GDP	gross domestic product
GHG	greenhouse gas
HVAC	heating, ventilation, and air conditioning
IT	information technology
ML	machine learning
MW	megawatt
MWh	megawatt-hour
NGO	non-governmental organization
OSHA	Occupational Safety and Health Act
POP	point of presence
PPA	power purchase agreement
PUE	power usage effectiveness
RCM	reliability-centered maintenance
REC	renewable energy certificate / credit
SDM	space division multiplexing
SROI	social return on investment
STEM	science, technology, engineering and mathematics
tCO_2e	metric tons of carbon dioxide equivalent
UX	user experience
WUE	water usage effectiveness

APPENDICES

Methodology

Direct, indirect, induced economic impact calculations – input-output models and assumptions

To calculate economic impacts, this report uses an input-output model developed by IMPLAN. IMPLAN defines input-output analysis as "A means of examining inter-industry relationships within an economy. It captures all monetary market transactions between industries in a given time period. The resulting mathematical formulae allow for examinations of the effects of a change in one or several economic activities on an entire economy (impact analysis)." For more information on IMPLAN, and their assumptions made as part of their input-output analyses, refer to the articles on Input-Output Analysis and Assumptions and Detailed Key Assumptions of IMPLAN & Input-Output Analysis.

Based on IMPLAN's input-output tables, a set of multipliers that reflects the capital investments and operating expenditures from Google's data centers were created to derive GDP, employment and labor income multipliers. For GDP contributions, all Opex categories were included in GDP, Labor Income and Employment calculations. The following Capex categories were included in GDP, Labor Income and Employment calculations: Building + Site Infrastructure, General + Office Equipment, Land, R&D and Vehicles while the Capex categories of Networking, Computer & IT Equipment, Software were excluded.

As part of this analysis, the following industries were considered: Advertising, public relations and related services, Air transportation, Air travel, Automobile manufacturing, Broadcast and wireless communications equipment manufacturing, Business support services, Commercial and industrial machinery and equipment rental and leasing, Computer terminals and other computer peripheral equipment manufacturing, Construction of new power and communication structures,

Electric power transmission and distribution, Electronic and precision equipment repair and maintenance, Electronic computer manufacturing, Employment services, Facilities support services, Ground travel, Hotels and motels, including casino hotels, Legal services, Maintenance and repair construction of nonresidential structures, Management consulting services, Monetary authorities and depository credit intermediation, Office administrative services, Office supplies manufacturing (excluding paper), Other amusement and recreation industries, Other computer related services, including facilities management, Other electronic component manufacturing, Other snack food manufacturing, Postal service, Rail travel, Real estate & rental/leasing, Retail, Transit and ground passenger transportation, Utilities, Wired telecommunications carriers, Wireless telecommunications carriers, Wood office furniture manufacturing.

OECD better life index

This report investigates how the presence of Google's data centers have affected the economic, social and environmental conditions in the country. In addition to the set of indicators outlined throughout the report, it also considers the OECD Better Life Index as a method of measuring the overall well-being of a community. The OECD Better Life Index includes the following eleven topics (and indicators): Housing (Housing expenditure, Dwellings with basic facilities, Rooms per person), Income (Household net wealth, Household net adjusted disposable income), Jobs (Job security, Personal earnings, Long-term unemployment rate, Employment rate), Community (Quality of support network), Education (Years in education, Student skills, Educational attainment), Environment (Water quality, Air pollution), Civic Engagement (Stakeholder engagement for developing regulations, Voter turnout), Health (Self-reported health, Life expectancy), Life Satisfaction (Life satisfaction), Safety (Homicide rate, Feeling safe walking alone at night), Work-Life Balance (Time devoted to leisure and personal care, Employees working very long hours).

Google + Deloitte.

Thank you

To the many individuals across Google and Deloitte who made this report possible.
For additional information or any questions please reach out to:

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