



THE ECONOMIC IMPACT OF GOOGLE DATA CENTERS IN THE UNITED STATES

OCTOBER 2022



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EXECUTIVE SUMMARY

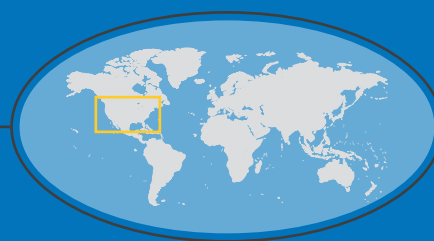
Digital transformation fosters significant opportunities for global economies enabling innovation and improving processes and services. This transformation, greatly accelerated by the COVID-19 pandemic, has required significant new infrastructure to meet the growing demand for digital services. As students and employees shifted to remote work and school, and the public and private sectors required expanded online services, Google has been increasing its capacity to meet these rising digital needs across the globe.

This report analyzes the economic impact that results from Google's hyperscale data center investments throughout North America. These include:

- Data center operations
- Capital investment and construction at the data centers
- Clean energy projects

In 2006, Google opened its first North American data centers in Georgia and Oregon and has since opened new data centers in nine other states, including Iowa, North Carolina, Oklahoma, and South Carolina (2008); Alabama, Tennessee, Texas, Nevada; and two campuses in Virginia (all 2019). Together, these 12 campuses represent a \$17.5 billion investment in North America's technological future. Through network infrastructure currently being developed by Google, these data centers are connected to countries throughout the world. This infrastructure consists of fiber links that span North America and physically connect the entire region to the global internet.

\$17.5 billion
Investment by
Google in 12
North American
data center
campuses.



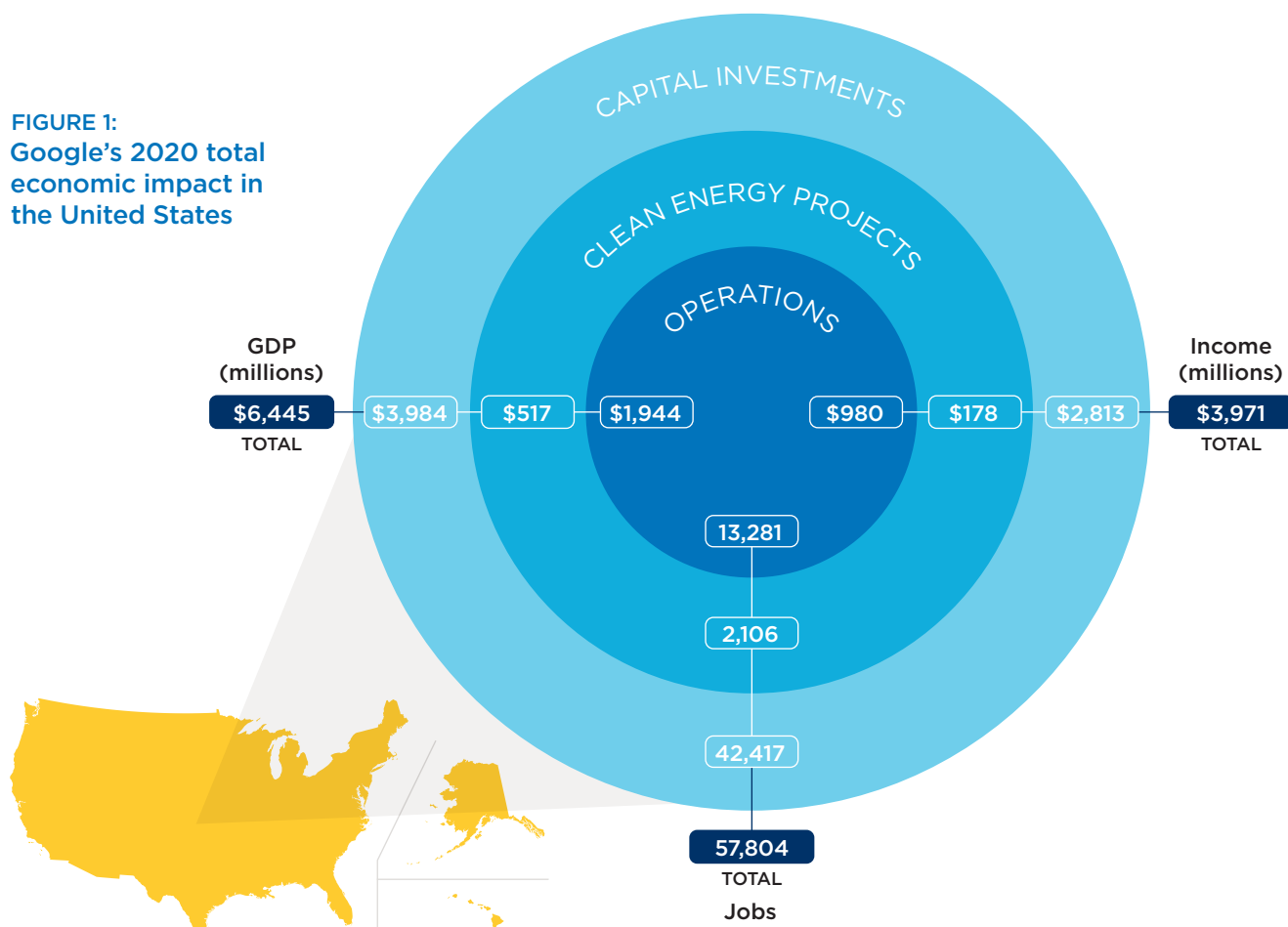
Network infrastructure being
developed by Google **connects** its
data centers in the United States
to points throughout the world.

In addition to calculating the economic impact attributable to operations at Google's data centers, this report explores how Google's clean energy and capital investments further add to the company's economic impact in the United States. To satisfy its clean energy commitments, for example, Google has long-term procurement agreements with wind and solar power producers. These agreements result in clean energy projects that bring environmental benefit, support the growth of the clean energy industry in the United States, and add to economic impact.

Google's capital investments in its data centers also significantly contribute to the company's economic impact. These include both the large upfront cost associated with the initial construction of a data center and the ongoing capital investments Google makes in each data center campus. When we later explore the economic impact attributable to Google in each of the states and counties where it operates a data center, we will describe in more detail how Google's capital investment supports construction jobs at the local level.

In total during 2020, Google's data center operations, clean energy and capital investments supported 57,804 jobs, generated nearly \$4.0 billion in income for workers, and added \$6.4 billion in economic activity as measured by GDP, throughout the United States.

FIGURE 1:
Google's 2020 total
economic impact in
the United States



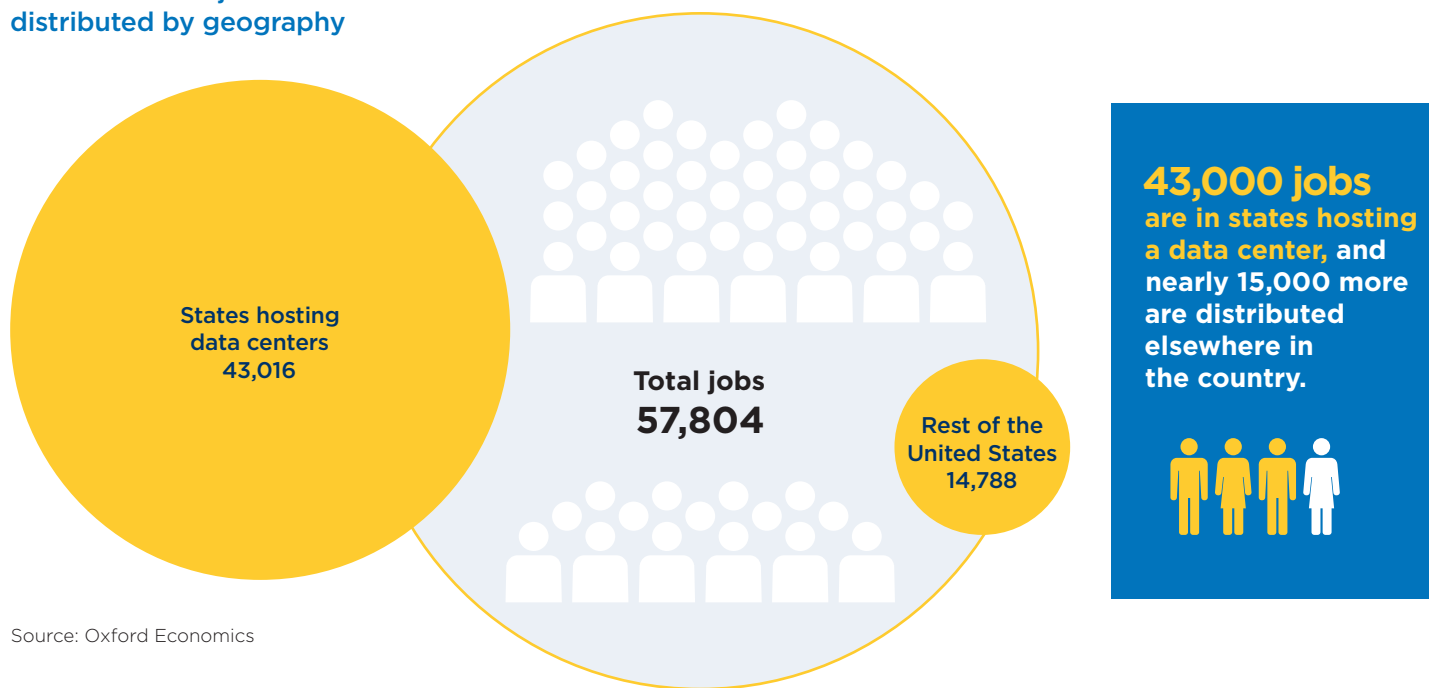
Source: Oxford Economics

Google's data center operations, clean energy and capital investments support **57,804 jobs** throughout the United States.



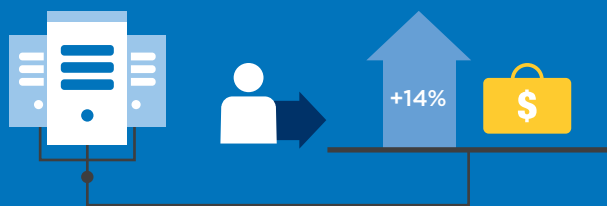
The 57,804 total jobs include both direct jobs and those jobs that result through spillover effects as Google workers and suppliers spend their wages and earnings throughout the region. While most of these jobs are in the states where the data centers are located, nearly 15,000 are located elsewhere in the country. Most of this widespread distribution of jobs can be attributed to the network of people and businesses that provide Google with the goods and services needed to support data center operations and capital and clean energy projects (i.e., Google's supply chain).

FIGURE 2: Total jobs distributed by geography



Source: Oxford Economics

At the heart of Google's economic impact are the data centers themselves. Data center operations support 13,281 total jobs throughout the United States (see Figure 1). The total income associated with these jobs is \$980 million. When we examine the relationship between the jobs and income at the national level, we find that the average income per job supported by Google's data center operations exceeds the national average income per job by 14%.



Jobs supported by Google data center operations generate average income per job that is **14% higher than the national average.**

In addition to supporting well-paying jobs, Google's economic impact touches all sectors of the economy. The jobs supported by Google's data center operations, clean energy, and capital investments are widely distributed among diverse industries, many of which are not normally associated with data center operations. As Figure 3 shows, Google's impact on jobs was spread across a wide range of industries led by Construction and Utilities (19,786), Information and Professional Services (8,554), and Trade and Transportation (6,432). Please note that although Google supported an estimated 3,032 in the Accommodation and Food Services industry, this number was dramatically reduced during the pandemic as a result of travel restrictions.¹

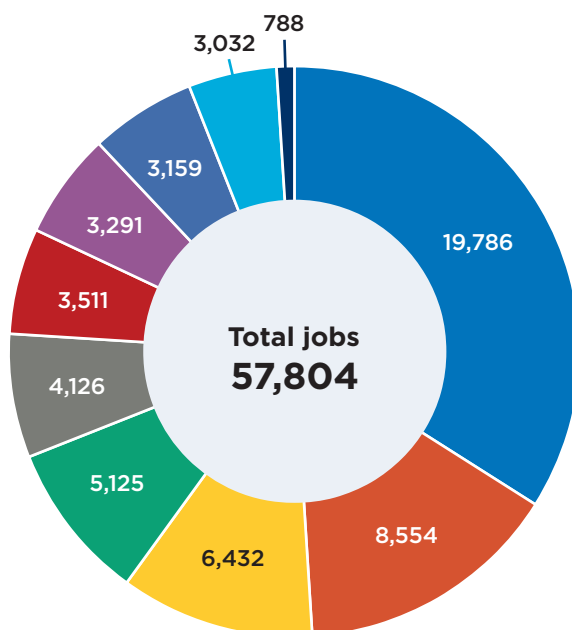


FIGURE 3:
Distribution of Google's data center-supported jobs by industry

Total jobs by industry

- Construction and Utilities
- Information and Professional Services
- Trade and Transportation
- Health, Education, and Government
- Management and Administrative Services
- Finance, Insurance, and Real Estate
- Manufacturing
- Entertainment and Other Services
- Accommodation and Food Services
- Agriculture and Mining

Source: Oxford Economics

Jobs supported by Google are widely distributed, and most are in industries not normally associated with data center operations.

To calculate the economic impact attributable to its clean energy projects, Google provided Oxford Economics with data on 26 wind and solar projects throughout the country that are supported by its clean energy commitments. Each year, these projects require people to operate and maintain the infrastructure and keep the

¹ As examples, travel from the Georgia data center was down 75% during 2020 as compared to the prior year, and down 72% in Iowa during the same time period.

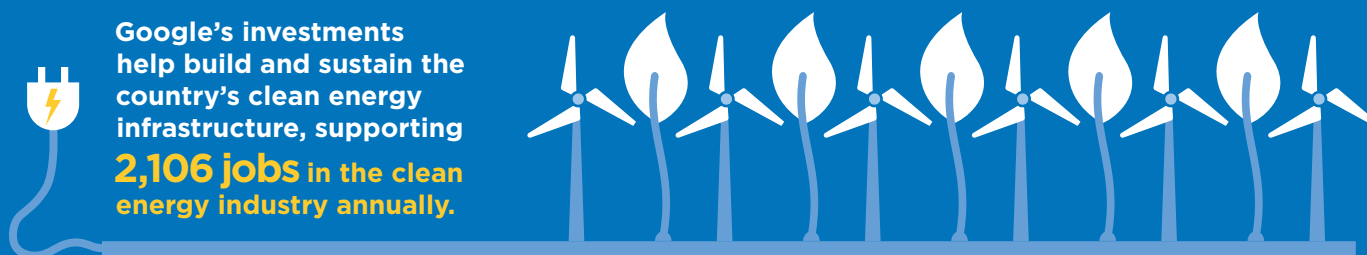
electricity produced by these projects connected to the electrical grid. In the figure below, we examine the nature and distribution of the 2,106 jobs supported each year in the United States as a result of Google's clean energy projects.

FIGURE 4: Geographic distribution of clean energy jobs

Location	Direct	Indirect	Induced	Total
States hosting a data center	167	688	401	1,256
All other states	16	243	591	850
US total	183	931	992	2,106

Source: Oxford Economics

Included in the figure above are 183 jobs held directly by those in the clean energy industry and another 931 jobs in companies that provide equipment and services to the industry (i.e., “supply chain”). An additional 992 induced jobs are supported by the spending out of wages of those employed directly or indirectly. Taken together Google data centers support 2,106 jobs through their clean energy investment—1,114 of which are directly or indirectly tied to clean energy and its supply chain.

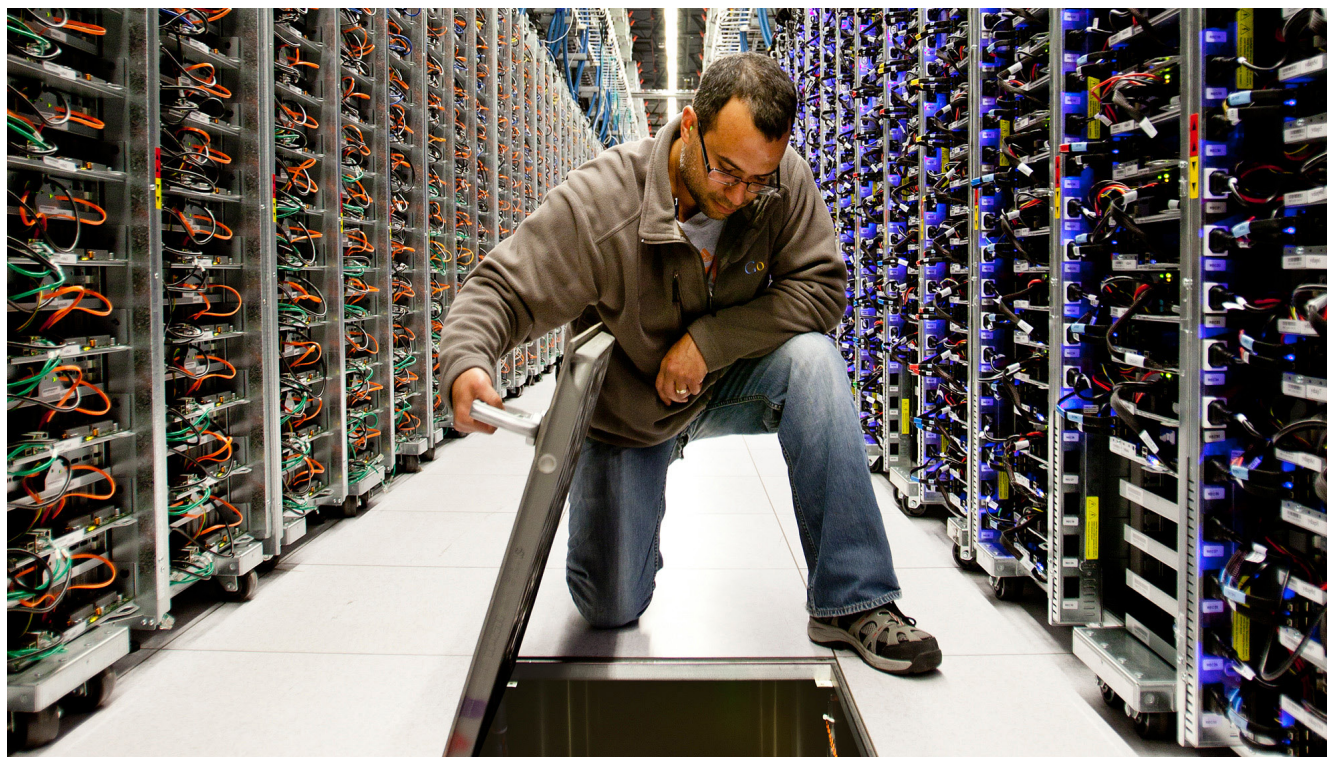


The 2,106 jobs described in Figure 4 are recurring and the result of ongoing operations and maintenance associated with Google's clean energy projects. However, the initial building of this infrastructure generated its own economic impact. In fact, when full spillover effects are included, we estimate that each of these projects supported 468 workers employed for an average of three years building, installing, and making these facilities operational. When all projects are aggregated, 36,529 people-years of employment were supported by investments required to build and install the clean energy infrastructure needed to satisfy Google's clean energy commitments. Thus, Google's clean energy commitments help the United States to build and sustain its clean energy industry.

We also examined the economic impact of data center capital investments made by Google. Capital investments refer to the physical infrastructure put in place to create and improve a given data center. It includes activities such as the construction of new buildings and infrastructure and additional improvements made to existing structures. Capital investments also include the purchases of equipment used on-site. Each year, Google makes significant capital investments to its data centers and when these are made, the economic impact is sizable. At each data center, however, the amount of capital investment fluctuates a great deal year by year. To address this fluctuation, we calculated the average annual amount of capital investment that Google has made at each data center since that campus opened. From there, we calculated the annual average amount of economic impact associated with the capital investment that has occurred at each data center.

Using that methodology, we estimate that each year, capital improvements at Google data centers support (on average) over 42,000 jobs throughout the United States (see Figure 1). These include jobs in construction plus those involved in the manufacturing of equipment used in the capital investment, as well as spillover effects in the broader economy. In our report, we describe the particular contribution made by construction jobs in the communities where data centers are located.

In addition to its economic and fiscal impacts and investments in network infrastructure and clean energy, Google is an active participant in the local communities where its data centers are located. Through partnerships and programs, Google performs educational outreach, provides local grants, and helps prepare local workforces for opportunities in emerging technologies. Specific examples are illustrated in a case study found later in this report.



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1. INTRODUCTION

This study examines the overall economic impact that Google data centers have across the United States and in each state and county where a Google data center is located. Twelve data centers were included in our report.²

FIGURE 5: Google data centers: \$17.5 billion invested to date

Location		Year opened	Total investment (billions)
Jackson	Alabama	2019	\$0.6
Douglas	Georgia	2006	\$2.4
Pottawattamie	Iowa	2008	\$2.5
Caldwell	North Carolina	2008	\$1.2
Clark	Nevada	2019	\$1.2
Mayes	Oklahoma	2008	\$3.0
Wasco	Oregon	2006	\$1.8
Berkeley	South Carolina	2008	\$2.4
Ellis	Tennessee	2019	\$0.6
Madison	Texas	2019	\$0.6
Loudoun (2)	Virginia	2019	\$1.2
Total			\$17.5

Source: Google, LLC

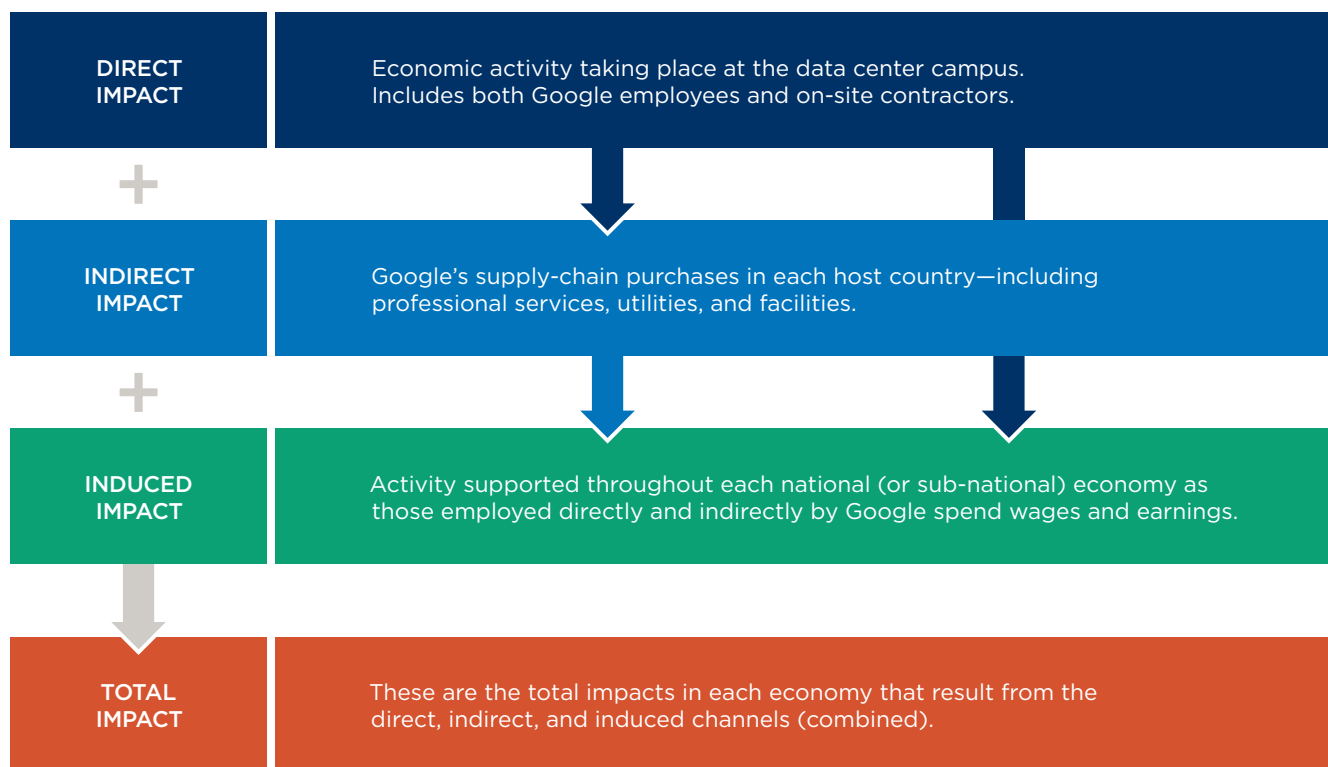
Oxford Economics calculated Google's economic impact at the national, state and county levels. In describing our results, we refer to three "channels" of economic activity:

- **Direct:** On-site workforce at the data center.
- **Indirect:** The economic activity associated with the supply-chain purchases made by Google to vendors who provide services that support the data center. This is the business-to-business network that supplies Google with the goods and services associated with data center operations.
- **Induced:** This channel measures the spillover effects that result as workers at the data center and those of the businesses in Google's supply chain spend their wages and earnings throughout the broader economy.

² Google operates other facilities in the United States including other data center operations that were not included in this report.

The following schematic depicts the relationship among these three channels:

FIGURE 6: An economic impact overview

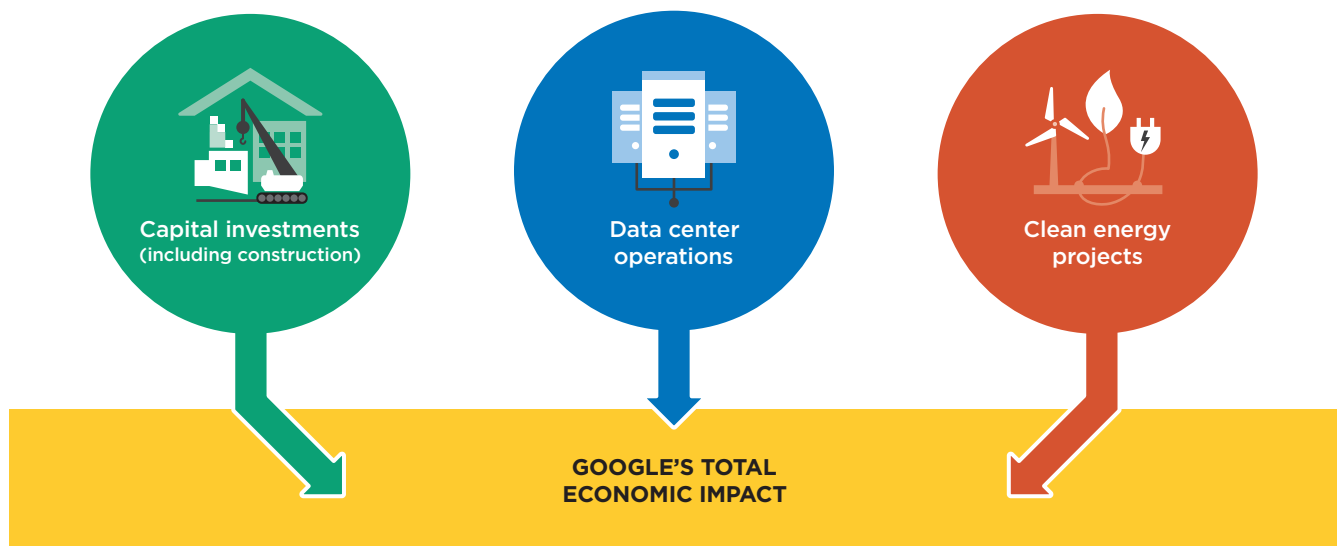


In this report, we examine how Google data centers generate economic impact from three different business activities:

- operations of the data centers;
- on-site capital investment including construction; and
- wind and solar projects supported by Google clean energy commitments.

Each of these activities generates economic impact through the three channels described above. These impacts are independently calculated because each requires unique modeling and assumptions. The total economic impact of Google data centers is the sum of the economic impacts calculated for each of these activities—as depicted in the figure below:

FIGURE 7: Total economic impact: Operations, clean energy projects, and capital investment



Most of our analysis is focused on the recurring economic impact that results each year from Google's data center operations, clean energy, and capital investments. By recurring, we mean the economic impact that is expected to repeat in subsequent years.

In addition to the large upfront capital investment that is associated with the initial construction of a data center, Google makes ongoing capital investments in each data center campus that generate significant economic impact. Given that these capital investments fluctuate in size from year to year, we calculated an annual average amount of capital investment for each data center that is based on the actual capital investment that has occurred at that particular data center. Our estimate of recurring economic impact includes the economic impact associated with these annual averages.

Also included in our report are the one-time economic impact benefit attributable to the initial investment in wind or solar power generation projects that result from Google's clean energy commitments. These and other impacts associated with clean energy projects are discussed in the next chapter on Google's economic impact at the national level.

Interpreting economic impact results

In general, the size of country or regional economic impact varies based on the data center size and the amount of Google's supply chain that is located in that specific geography:

- **Size:** The bigger the data center, the bigger the economic impact, other things being equal. For example, the bigger the data center, the bigger the economic impact at the data center itself plus that of the network of businesses in its supply chain.
- **Concentration:** The greater the concentration of the data center's supply chain that is located in the country or region being examined, the greater the economic impact in that location. More specifically, the bigger the supply chain located in a country or region, the bigger the economic impact found in that location's indirect channel.

Differences in either of size or concentration get amplified as we consider the induced effects occurring in the broader economy. That is because the more workers that are located in the country or region (whether direct employees or those in the supply chain), the more likely it is that economic benefit will spill over to the broader (local) economy as these workers spend their wages near to where they live.

For readers interested in our technical modeling assumptions we have included a separate chapter on methodology found at the end of this report. To complete our calculations, Google provided us with data regarding its operations, clean energy, and capital investments. However, all analytic findings and conclusions presented herein are the result of independent research conducted by Oxford Economics.

Capital investments (data centers): The expenditures Google made in property, plant, and equipment at its data center campuses. Most significant is the construction or renovation of infrastructure put in place at each data center campus, including the construction of the data center building itself.

Capital investments (clean energy projects): The wind and solar projects that result from Google's clean energy commitments (see discussion below). Each wind or solar project constructed is a one-time occurrence and hence the economic impact associated with the manufacture and installation of each wind or solar project is also treated as a one-time occurrence.

Clean energy commitments: Google enters into agreements to purchase clean energy. As noted above, these commitments result in the construction of wind and solar projects.

Gross Domestic Product (GDP): GDP is defined as the total market value of all final goods and services produced within a region during a given time period (usually annually). As a broad measure of overall domestic production, it functions as a comprehensive scorecard of a region's economic health.

Income: Includes all forms of employment income, including employee compensation (wages, salaries, and benefits) and proprietor (or self-employment) income.

People-years: Throughout our report, a job supported by Google is generally understood to be a job that will be supported year after year given Google's current operations. We treat jobs attributable to the capital investment of clean energy projects differently because once the project is completed the job is no longer supported by the investment. To account for this finite duration, we count each job supported during the construction period as one person-year for each year that each project is being constructed. For example, one person employed for two years of construction employment would be counted as two people-years.

2. UNITED STATES

Google opened its first data centers in the United States in 2006 and has since opened data center campuses in a total of 11 states. State-of-the-art internet service requires a sophisticated interconnected network that links data centers and brings their computational and communication power closer to users and customers. To improve this service in the United States, Google continually strengthens and expands network infrastructure that spans the country and connects the data centers to countries throughout the world.

The data centers generate significant economic impact in the states and counties where they are located. In this chapter, we will explore how the economic impact spreads more broadly throughout the United States, including to states without a Google data center. Much of the distribution of the economic impact is the result of the national supply chain that supports Google's data center operations. These are the businesses throughout the country that supply the data centers with equipment or provide services that support data center operations. In Figure 8, for example, we see that one in every four jobs supported by Google is in a state not hosting one of the 12 data centers examined in this report.

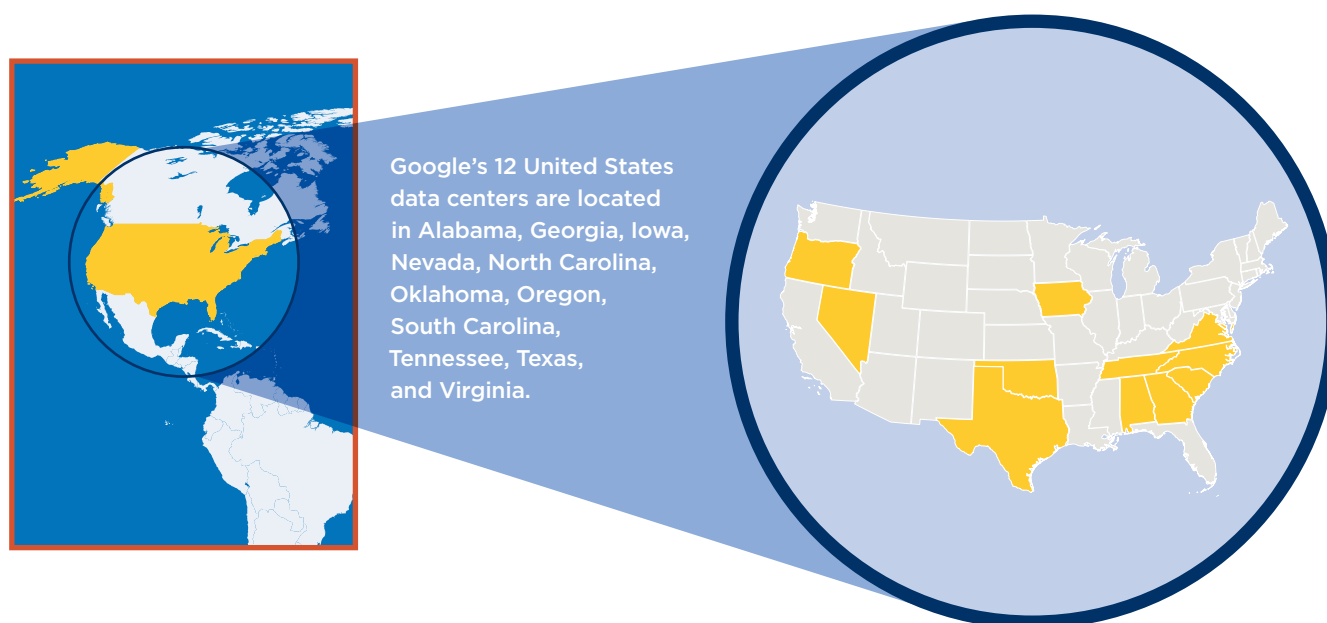
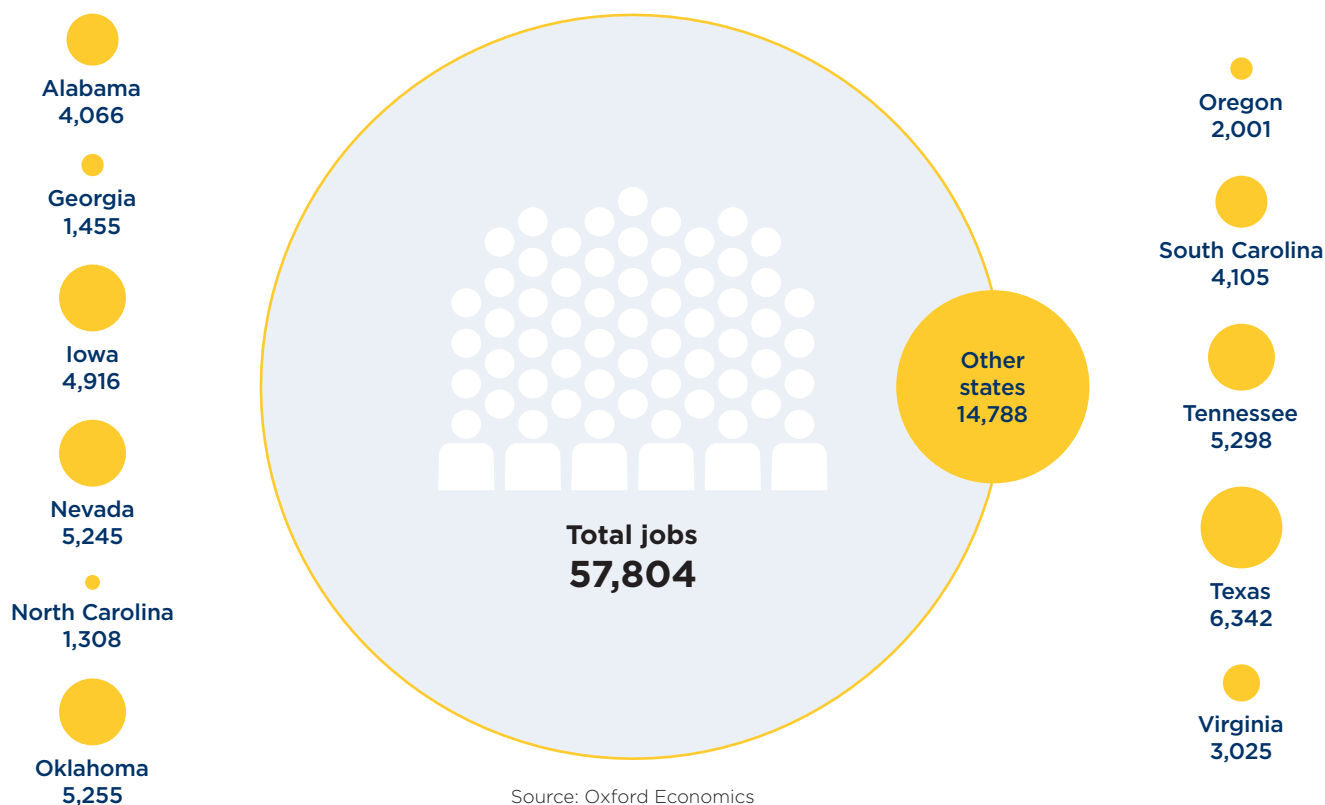


FIGURE 8: Geographic distribution of jobs³



For each job attributable to data center operations,

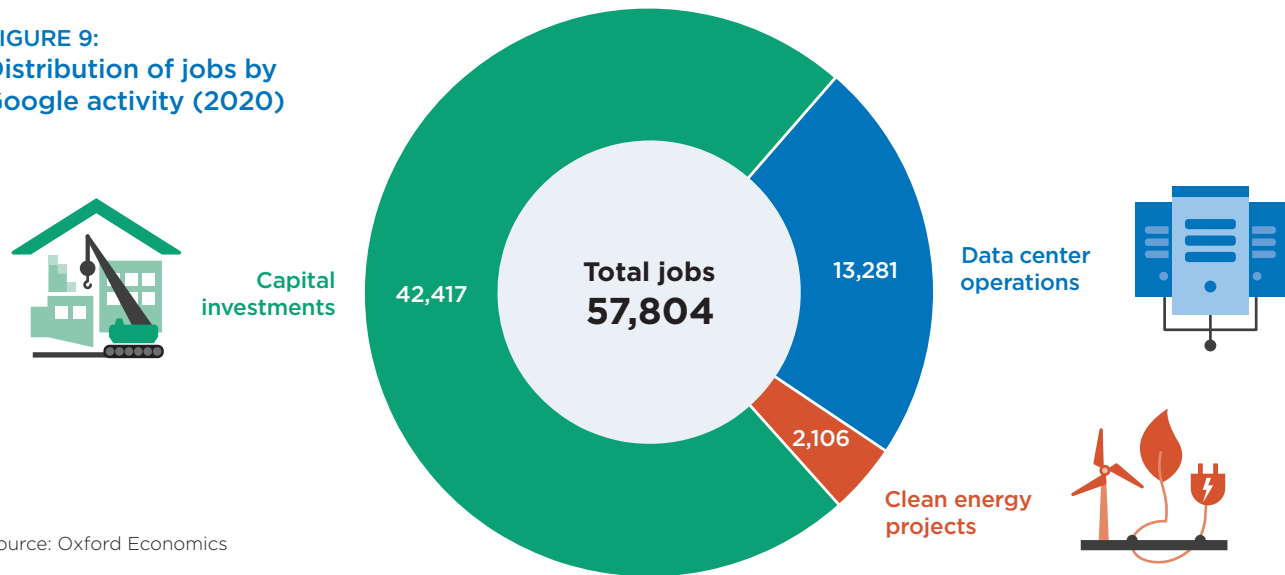
more than 3 additional jobs are supported by Google's clean energy and capital investments.

In addition to the geographically disperse distribution of jobs that it supports, Google's economic impact spills over through the economic ecosystem that its data centers support. Google regularly makes significant capital investments in its data centers. Each time an investment is made, workers are brought on site to install or construct new infrastructure or equipment on that campus. The clean energy projects that Google makes in support of its data centers generates still more economic impact. While data centers are the driving force behind Google's

³ Because the state-level economic modeling only captures the supply chain within that state, and in particular does not capture when the supply chain of one Google data center uses inputs from a state with another Google data center, the impacts in the named states are slightly underestimated and the impacts in "Other states," which are calculated by subtracting state-level impacts from the national impacts, are equivalently overestimated.

economic impact, the related investments that support data center operations make a major contribution. In fact, for each job supported by data center operations, another 3.4 jobs are attributable to Google's ongoing investments in its data centers.

FIGURE 9:
Distribution of jobs by
Google activity (2020)



Source: Oxford Economics

2.1 CLEAN ENERGY PROJECTS

Through its purchases of wind and solar power, Google has become one of the largest corporate purchasers of clean energy.⁴ In addition to bringing environmental benefit, the company's clean energy projects produce substantial economic impact and in 2020 supported 2,106 jobs and generated \$178 million in income for those workers.

FIGURE 10: Jobs supported by clean energy projects in the United States

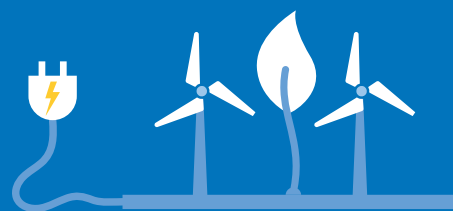
	Direct	Indirect	Induced	Total
Jobs	183	931	992	2,106
Income (millions)	\$31	\$90	\$57	\$178

Source: Oxford Economics

Google's clean energy commitments have resulted in the investment of new wind and solar farms. Google provided Oxford Economics with data on 26 wind and solar projects throughout the United States that are supported by its clean energy commitments. Each year, these projects require people to operate and maintain the infrastructure and keep the electricity produced by these projects connected to the electrical grid. The 2,106 jobs and \$178 million in income that is described in Figure 10 are attributable to those workers whose jobs each year are supported by Google's clean energy projects. Of these workers, 183 are employed directly in the clean energy industry, another 931 in the supply chain that supports that industry, and a further 992 jobs supported as a result of employees spending their wages and earnings in the economy.

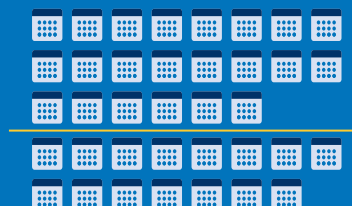
⁴ Schechner, Sam. "Amazon and other tech giants race to buy up renewable energy." *The Wall Street Journal*, June 23, 2021.

Each year, Google's clean energy projects support **2,106 jobs** throughout the United States.



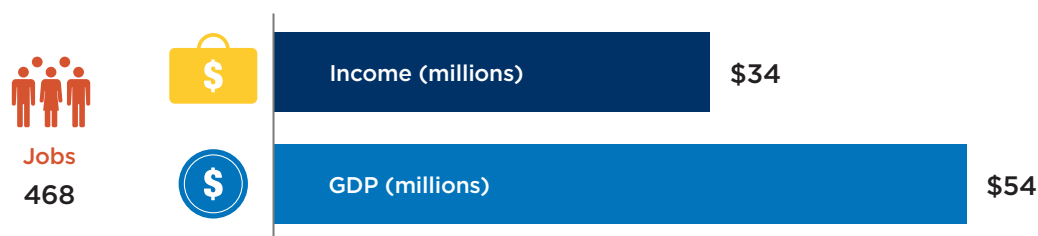
21,739 people-years were spent building and installing **wind and solar projects** supported by Google's clean energy projects in the United States.

Another 14,790 people-years were supported through spillover effects.



Constructing and installing each of these clean energy projects also generated economic impact which was estimated by first examining the capital investment made in each of the 26 projects. Once we calculated an average investment cost for each project, we then estimated that on average each project took three years to complete from the time construction began on its components until it was fully operational and connected to the utility grid. Based on that methodology we found that each project generated the following economic impact during each of the three years that it was being developed:

FIGURE 11: Annual construction impact per project (total jobs supported)



Source: Oxford Economics

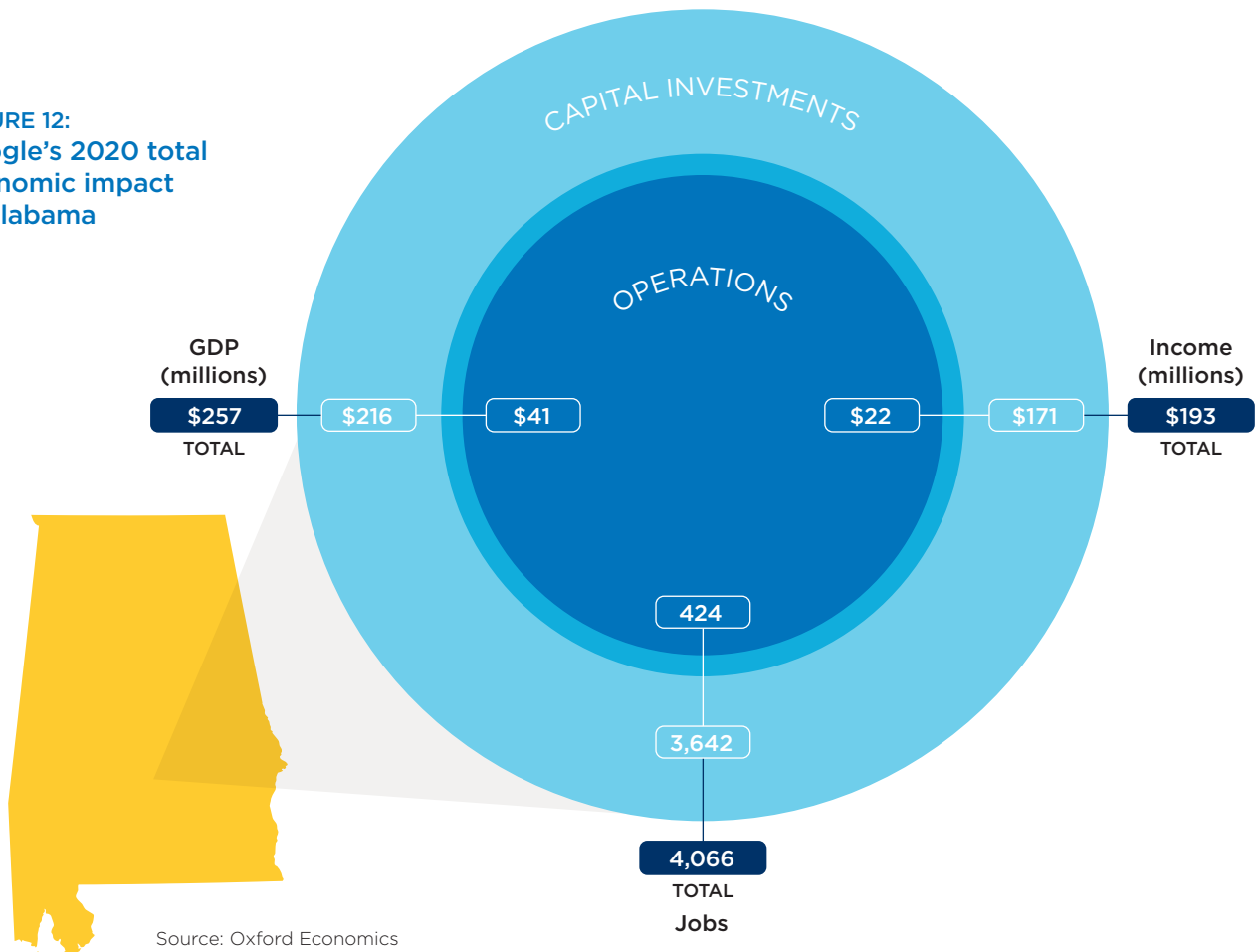
We found that on average, each new wind or solar project supported by Google generated 468 jobs, \$34 million in income for workers, and contributed \$54 million to GDP during each of the three years that the project was in development. When all 26 projects are considered, we calculate that Google's clean energy projects supported the equivalent of 36,504 people-years of work, when accounting for direct, indirect and induced effects. In a concrete way, Google investments are helping to build the clean energy industry in the United States.⁵

⁵ Google has a stated goal to operate on 24/7 carbon-free energy, everywhere and at all times by 2030. It is expected that Google will increasingly be sourcing carbon-free energy in the same countries where it has data center operations to enable the company to meet its commitment to source carbon-free energy on the same grids where it operates its data centers.

3. ALABAMA

The Bridgeport data center opened in Jackson County, Alabama, in 2019. Today, the campus represents a \$600 million Google investment that contributes broadly to Alabama's economy. In 2020 operations at Bridgeport supported 4,066 jobs in Alabama, generated \$193 million in income for workers, and added \$257 million to state GDP.

FIGURE 12:
Google's 2020 total
economic impact
in Alabama



In 2020, the Bridgeport data center supported **4,066 total jobs** and generated **\$193 million** in income for workers in Alabama.

3.1 JACKSON COUNTY

Most of the economic impact attributable to the Bridgeport data center is concentrated in Jackson County. In 2020, the data center supported 3,349 jobs and generated \$134 million in income for workers in the county. When compared to state figures, this means that 82% of the jobs supported by Google in Alabama are located in Jackson County.

As seen in Figure 13, capital investments make an especially important contribution at the local level. As a relatively new data center, these have been particularly large at the Bridgeport data center.

FIGURE 13: Google's 2020 economic impact in Jackson County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	362	\$33	\$17
Capital investments	2,987	\$137	\$117
Total	3,349	\$170	\$134

Source: Oxford Economics

When we examine the 2,987 jobs supported by capital investments in more detail, we find that 2,532 are in the construction industry. Much of Google's economic impact at the county level is the result of the ongoing investments that Google makes in the data center. As a result, for each job supported by data center operations in Jackson County an additional 7.2 jobs are supported by capital investments in the facility.



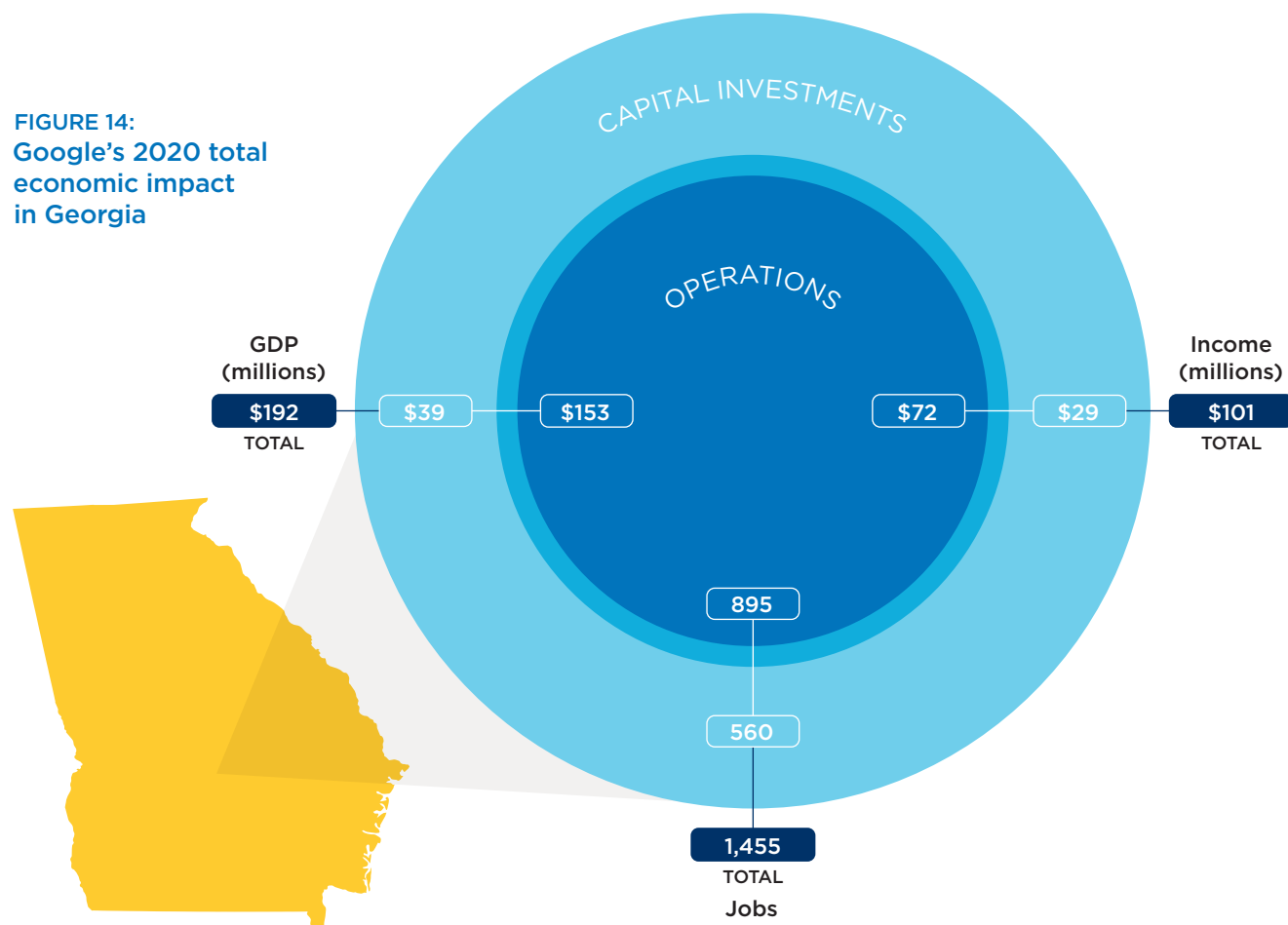
On average, Google's capital investments annually support **over 2,500 construction jobs** in Jackson County.



4. GEORGIA

The Lithia Springs data center opened in Douglas County, Georgia, in 2006. Today, the campus represents a \$2.4 billion investment that contributes broadly to Georgia's economy. In 2020, operations at Lithia Springs supported 1,455 jobs in the state, generated \$101 million in income for workers, and added \$192 million to state GDP.

FIGURE 14:
Google's 2020 total
economic impact
in Georgia



Source: Oxford Economics



In 2020, the Lithia Springs data center supported **1,455 total jobs** and generated **\$101 million** in income for workers in Georgia.

4.1 DOUGLAS COUNTY

Most of the economic impact attributable to the Lithia Springs data center is concentrated in Douglas County. In total the data center supports 1,106 jobs in the county and generates \$68 million in income for workers in the county. When compared to state figures, this means that 76% of the jobs supported by Google in Georgia are located in Douglas County.

As seen in Figure 15 most of the economic impact in Douglas County is attributable to data center operations. Still, ongoing capital investments at the data center support additional economic activity in the county. Based on the historic amount of capital investment occurring in Lithia Springs, we estimate that during an average year this activity supports 434 jobs in the county. Of these, 343 are in the construction industry.

FIGURE 15: Google's 2020 economic impact in Douglas County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	672	\$121	\$54
Capital investments	434	\$20	\$14
Total	1,106	\$141	\$68

Source: Oxford Economics



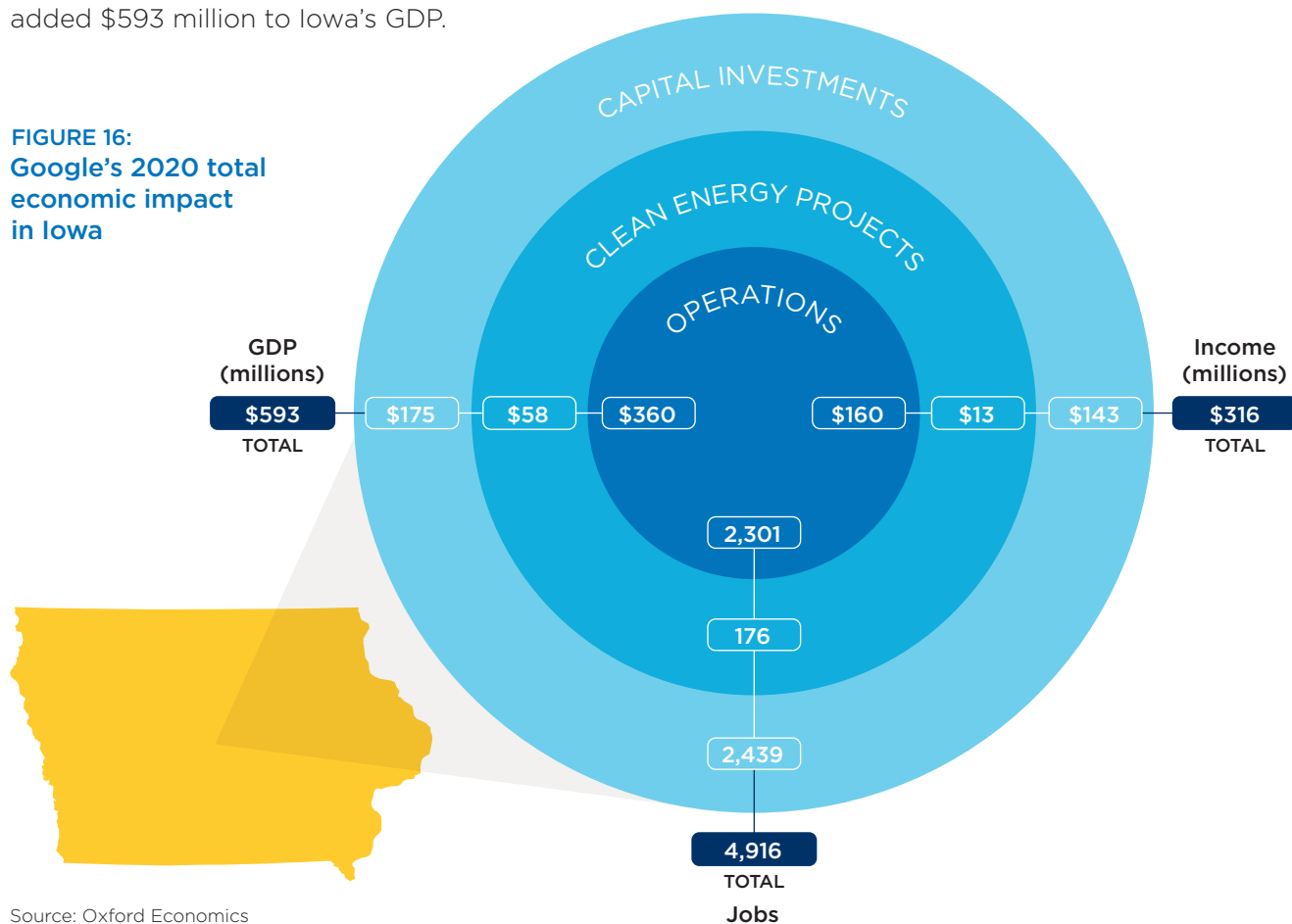
On average, Google's capital investments annually support **343 construction jobs** in Douglas County.



5. IOWA

The first Council Bluffs data center opened in Pottawattamie County, Iowa, in 2006. In 2012, Google significantly expanded its operations in Council Bluffs with the addition of an adjacent campus. In our report, we refer to these combined operations as the Council Bluffs data center campus. Today, the campus represents a \$2.5 billion investment that contributes broadly to Iowa's economy. In 2020, operations at Council Bluffs ultimately supported 4,916 jobs, generated \$316 million in income for workers in the state, and added \$593 million to Iowa's GDP.

FIGURE 16:
Google's 2020 total
economic impact
in Iowa



In 2020, the Council Bluffs data center supported **4,916 total jobs** and generated **\$316 million** in income for workers in Iowa.

Data center operations and capital investment contribute most to Google’s economic impact in the state, but the company’s in-state clean energy projects also support 176 total jobs. Of these, an estimated 126 are in the clean energy industry itself (including its supply chain).

5.1 POTTAWATTAMIE COUNTY

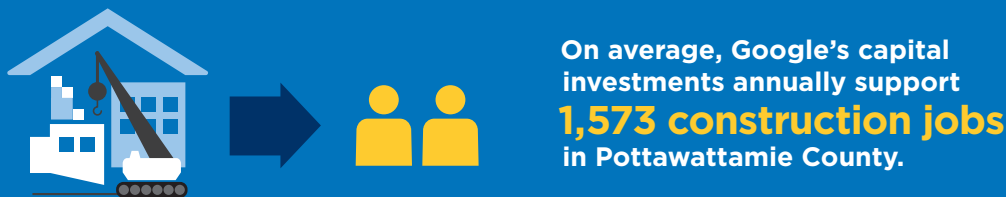
Most of the in-state economic impact attributable to the Council Bluffs data center campus is concentrated in Pottawattamie County. In total, the data center supports 3,690 jobs and generates \$235 million in income for workers in the county. When compared to state figures, this means that 75% of the jobs supported by Google in Iowa are located in Pottawattamie County.

FIGURE 17: Google’s 2020 economic impact in Pottawattamie County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	1,682	\$249	\$113
Capital investments	2,008	\$139	\$122
Total	3,690	\$388	\$235

Source: Oxford Economics

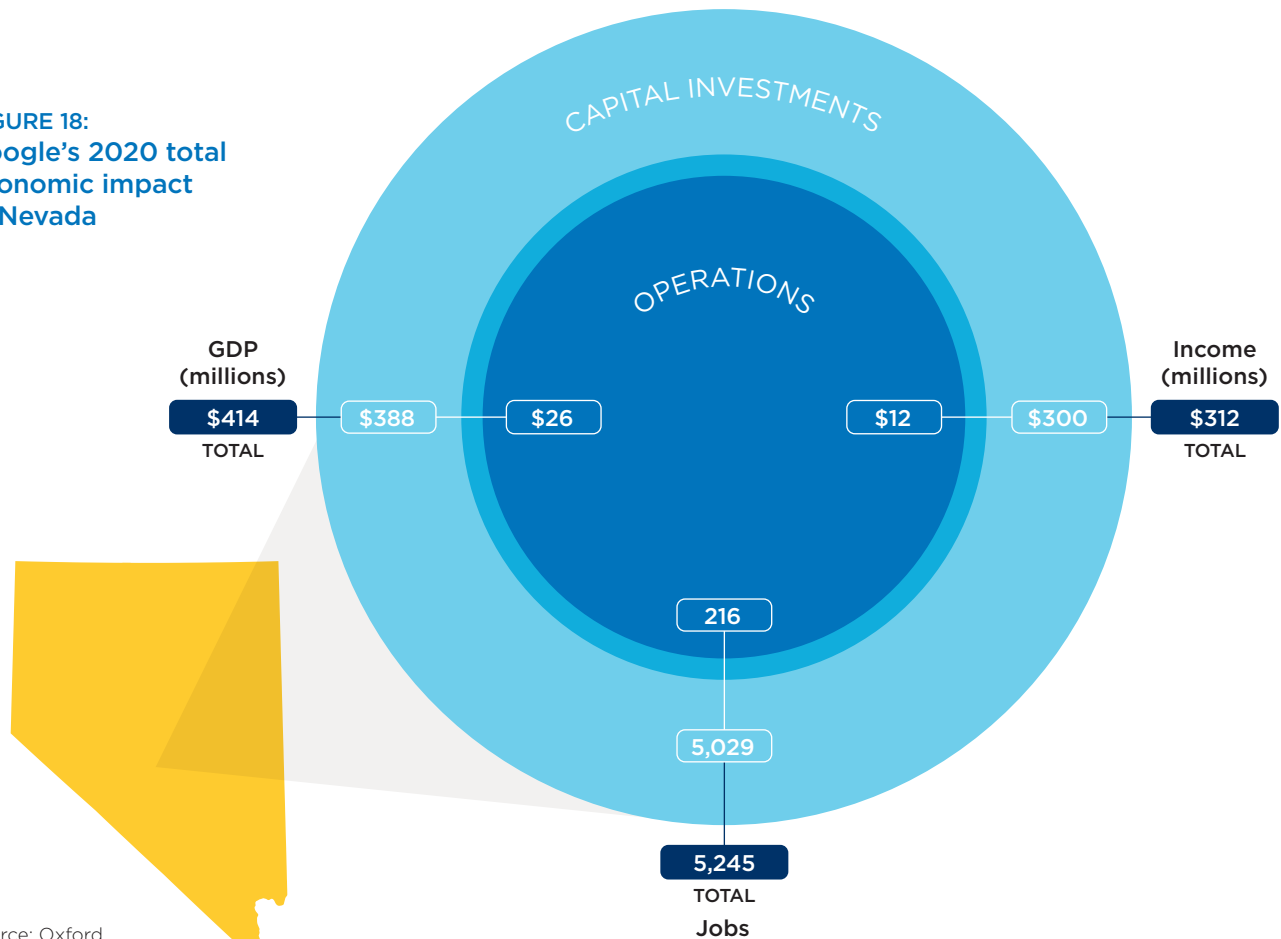
As seen in the figure above, capital improvements make an especially important contribution at the local level. Based on the historic amount of capital investment occurring in Council Bluffs, we estimate that during an average year this activity supports 2,008 jobs in the county. Of these, 1,573 are in the construction industry.



6. NEVADA

The Henderson data center opened in Clark County, Nevada, in 2019. Today, the campus represents a \$1.2 billion investment that contributes broadly to Nevada’s economy. In 2020, operations at the Henderson data center supported 5,245 jobs, generated \$312 million in income for Nevada workers, and added \$414 million to state GDP.

FIGURE 18:
Google’s 2020 total
economic impact
in Nevada



Source: Oxford Economics



In 2020, the Henderson data center supported over **5,245 total jobs** and generated **\$312 million** in income for workers in Nevada.

6.1 CLARK COUNTY

Almost all of Henderson's economic impact is concentrated in Clark County, where the data center and most of its in-state supply chain are located. In total, 5,208 jobs are supported in the county, and most of these (4,992) are attributable to the capital investments made by Google in the data center campus.

When capital investments are examined in more detail, we find that 3,292 of the jobs supported in Clark County are in the construction industry.

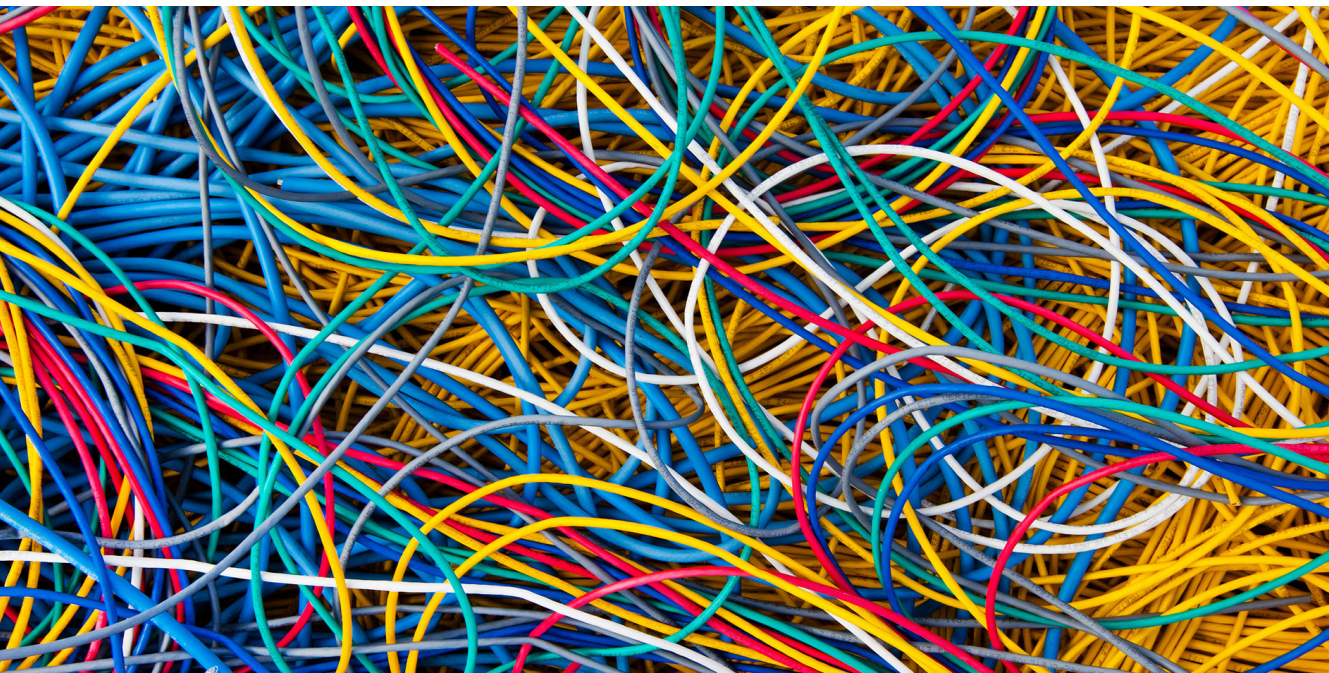
FIGURE 19: Google's 2020 economic impact in Clark County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	216	\$25	\$12
Capital investments	4,992	\$376	\$290
Total	5,208	\$401	\$302

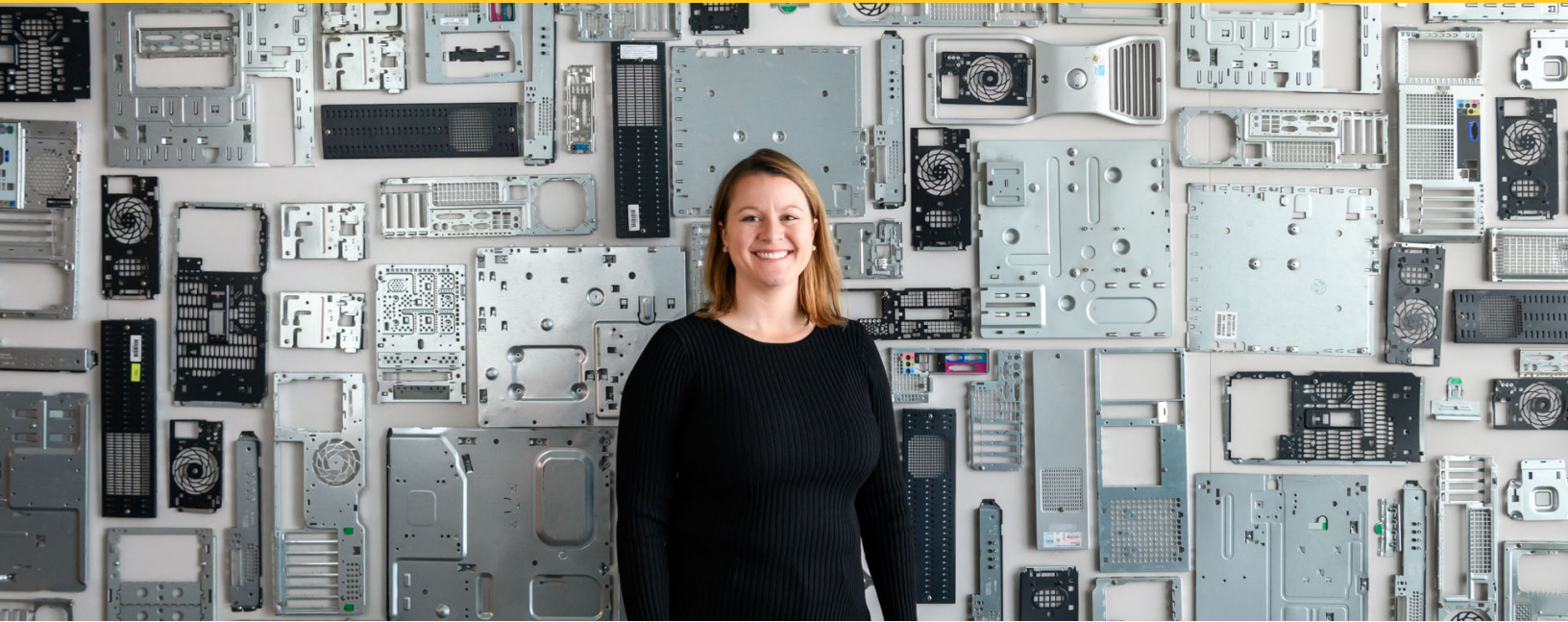
Source: Oxford Economics



On average, Google's capital investments annually support **3,292 construction jobs** in Clark County.



Transforming classroom learning



Heather Crawford-Ferre believes that technology can help students learn but that significant preparation is required to get the most out of digital tools. “We need to get teachers up to speed,” says Dr. Crawford-Ferre. “Our teachers don’t necessarily have any formal training in how best to use technology for their teaching, and we want them to have digital fluency in the classroom.”

Dr. Crawford-Ferre, a mathematics teacher herself, serves as State Coordinator for the Nevada Ready 21 program, an initiative of the Nevada Department of Education that focuses on technology, equity, and building a future-ready workforce. The program has support from Google, which operates two data centers in the state and is sponsoring an ambitious effort to help train up to 10,000 of Nevada’s 17,000 primary- and secondary-school teachers on how to use the latest software tools to enhance classroom learning.

Nevada Ready 21 offers teachers the training needed to achieve Level 1 in the Google for

Education certification program, which provides instruction on the use of a suite of digital tools designed for the classroom. An additional training path leads more advanced teachers to gain Level 3 certification, which equips them to train their fellow educators.

This is specialized training on an everyday topic, according to Amy Mayer, the founder and CEO of friEdTechnology, a Texas-based professional development firm hired by the state of Nevada to help train its first cohort of Google-certified teachers. “It’s not that those teachers come in ignorant of how to use technology,” says Ms. Mayer. “But knowing how to use it to transform learning is a big and different thing.” The model of what a teacher should be has changed. “Now we need to be guides on the side, not sages on the stage.”

The pandemic helped clarify the importance of mastering new forms of learning for students and teachers alike. The friEdTechnology training is carried out through a series of online video sessions and some individualized learning, which

TRANSFORMING CLASSROOM LEARNING, continued

teachers can access at their own pace. Teachers in Nevada must spend between 12 and 20 hours on their own to master the material. While they are not paid for their time, teachers who gain formal certification could eventually see a boost in their salary.

Students, meanwhile, are adept with the technology required to watch videos or consume social media, but those are just the first steps to successful implementation in the classroom. “They know how to consume media, but don’t know how to use digital technologies in order to learn,” says Ms. Mayer. For example, as part of its formal educational goals, the state now expects 8th grade students to create digital work that includes text and video, and 12th graders to edit and critique audio, video, and other digital media.

In Carson City, LeAnn Morris, a former first-grade teacher who is now a certified Google trainer, is excited about the ability to create individualized lesson plans for each student in a classroom. “Having resources available for teachers to be able to customize a student’s learning is a very powerful motivation to use this technology,” says Dr. Morris.

With all 7,600 students in the school district using networked notebook computers, teachers

can get real-time feedback on how well their lesson plans are working. That might mean seeing real-time results of a pop quiz or whiteboard exercise or assessing how much each individual student actually contributed to a group project. “It’s one of the most powerful things about working with this technology,” says Dr. Morris.

Last school year, seven of Carson City’s 486 K-12 teachers received their Level 1 certifications, and now that Dr. Morris has become a certified trainer, she hopes to help at least five more teachers reach the first level during the program’s next round.

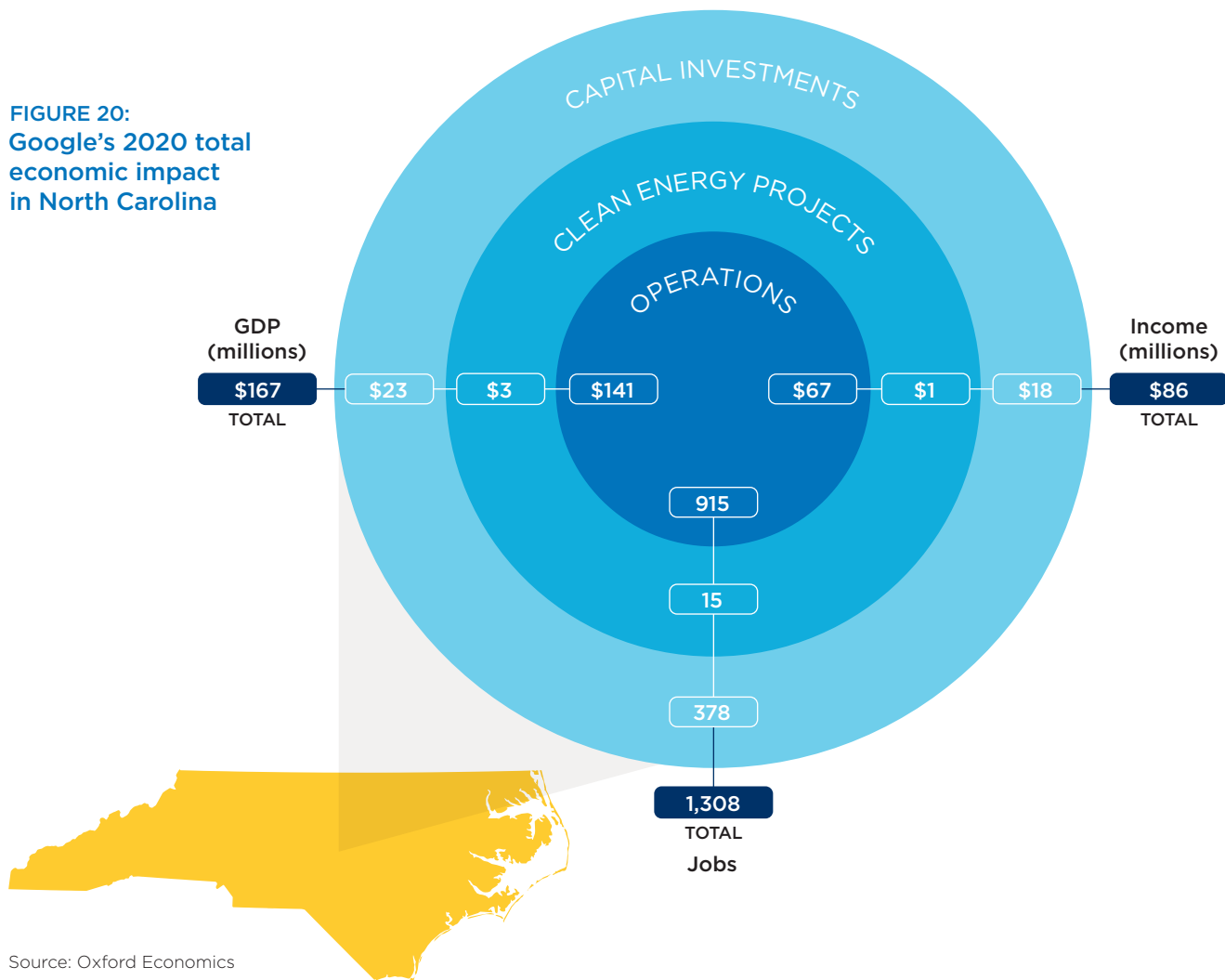
“To know the ins and outs of these Google apps so I could use them more effectively is something I have been wanting to do for a long time,” Dr. Morris says. Before she undertook the training, she didn’t understand how much she could transform classroom learning by using new tools.

“I feel like I can make the classroom more interactive and engaging for teachers and students alike,” she notes. “Getting real-time feedback on whatever the assignment the student is working on is a very powerful resource.”

7. NORTH CAROLINA

The Lenoir data center opened in Caldwell County, North Carolina, in 2008. Today, the campus represents a \$1.2 billion investment that contributes broadly to North Carolina's economy. In 2020, the data center supported 1,308 jobs, generated \$86 million in income for North Carolina workers, and added \$167 million to state GDP.

FIGURE 20:
Google's 2020 total
economic impact
in North Carolina



Source: Oxford Economics

Data center operations contribute most to Google's economic impact in North Carolina but as we will explore more below, so do the regular capital investments that the company makes in Lenoir. In addition, clean energy projects in North Carolina add to Google's in-state economic impact.



In 2020, the Lenoir data center supported **1,308 total jobs** and generated **\$86 million** in income for workers in North Carolina.

7.1 CALDWELL COUNTY

Most of the North Carolina economic impact attributable to the Lenoir data center is concentrated in Caldwell County, where the data center is located. In total, the data center supports 888 jobs and generates \$56 million in income for workers in the county. When compared to state figures, this means that 68% of the jobs supported by Google in North Carolina are located in Caldwell County.

As seen in Figure 21, both data center operations and capital investments make important contributions at the county level and support a diverse range of jobs. For example, when we examine the 308 jobs supported by capital investments in Caldwell County in more detail, we find that 257 are in the construction industry.

FIGURE 21: Google's 2020 economic impact in Caldwell County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	580	\$93	\$45
Capital investments	308	\$14	\$11
Total	888	\$107	\$56

Source: Oxford Economics



On average, Google's capital investments annually support **257 construction jobs** in Caldwell County.

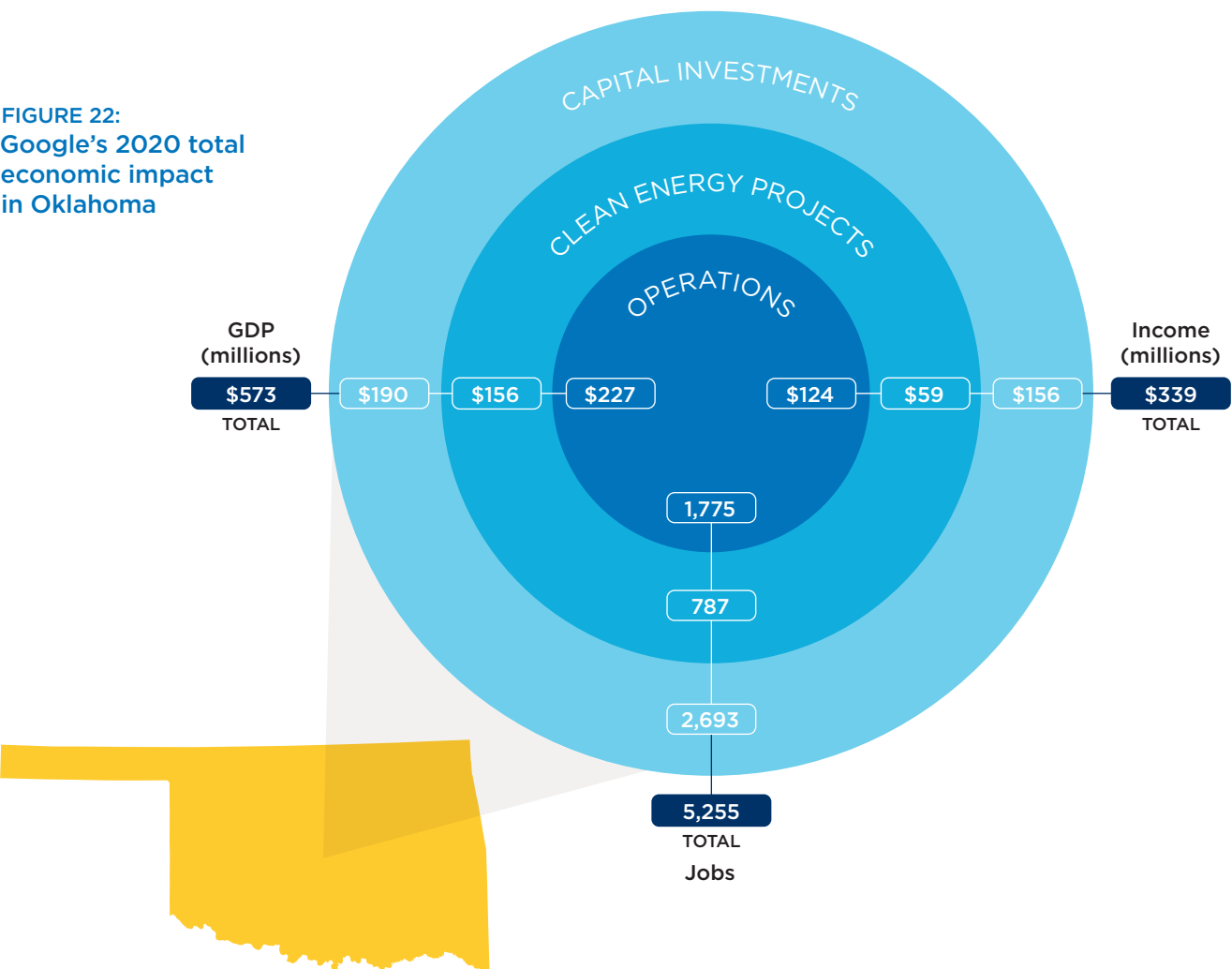


8. OKLAHOMA

The Pryor Creek data center opened in Mayes County, Oklahoma, in 2008. Today, the campus represents a \$3.0 billion investment that contributes broadly to Oklahoma's economy. In 2020, operations at the Pryor Creek data center supported 5,255 jobs, generated nearly \$339 million in income for workers in Oklahoma, and added \$573 million to state GDP.

Operations, clean energy, and capital investments each significantly contribute to Google's economic impact in Oklahoma. Capital investments are analyzed more in our discussion on Mayes County (below). At the state level, we examined the 787 jobs supported by Google's clean energy projects in more detail. We found that 551 of these positions are in the clean energy industry itself (including its supply chain).

FIGURE 22:
Google's 2020 total
economic impact
in Oklahoma



Source: Oxford Economics



In 2020, the Pryor Creek data center supported **5,255 total jobs** and generated **\$339 million** in income for workers in Oklahoma.

8.1 MAYES COUNTY

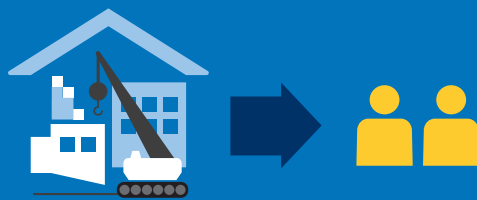
A substantial amount of Pryor Creek’s economic impact is concentrated in Mayes County, where the data center supports over 3,347 jobs and generates \$215 million in income for workers. When compared to state figures, this means that 64% of the jobs supported by Google in Oklahoma are in Mayes County.

As seen in Figure 23, both data center operations and capital investments make important contributions to Google’s in-county economic impact and support a diverse range of jobs. For example, when we examine the 1,962 jobs supported by Google’s capital investments in more detail, we find that 1,520 of these jobs are in the construction industry.

FIGURE 23: Google’s 2020 economic impact in Mayes County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	1,385	\$159	\$89
Capital investments	1,962	\$143	\$126
Total	3,347	\$302	\$215

Source: Oxford Economics



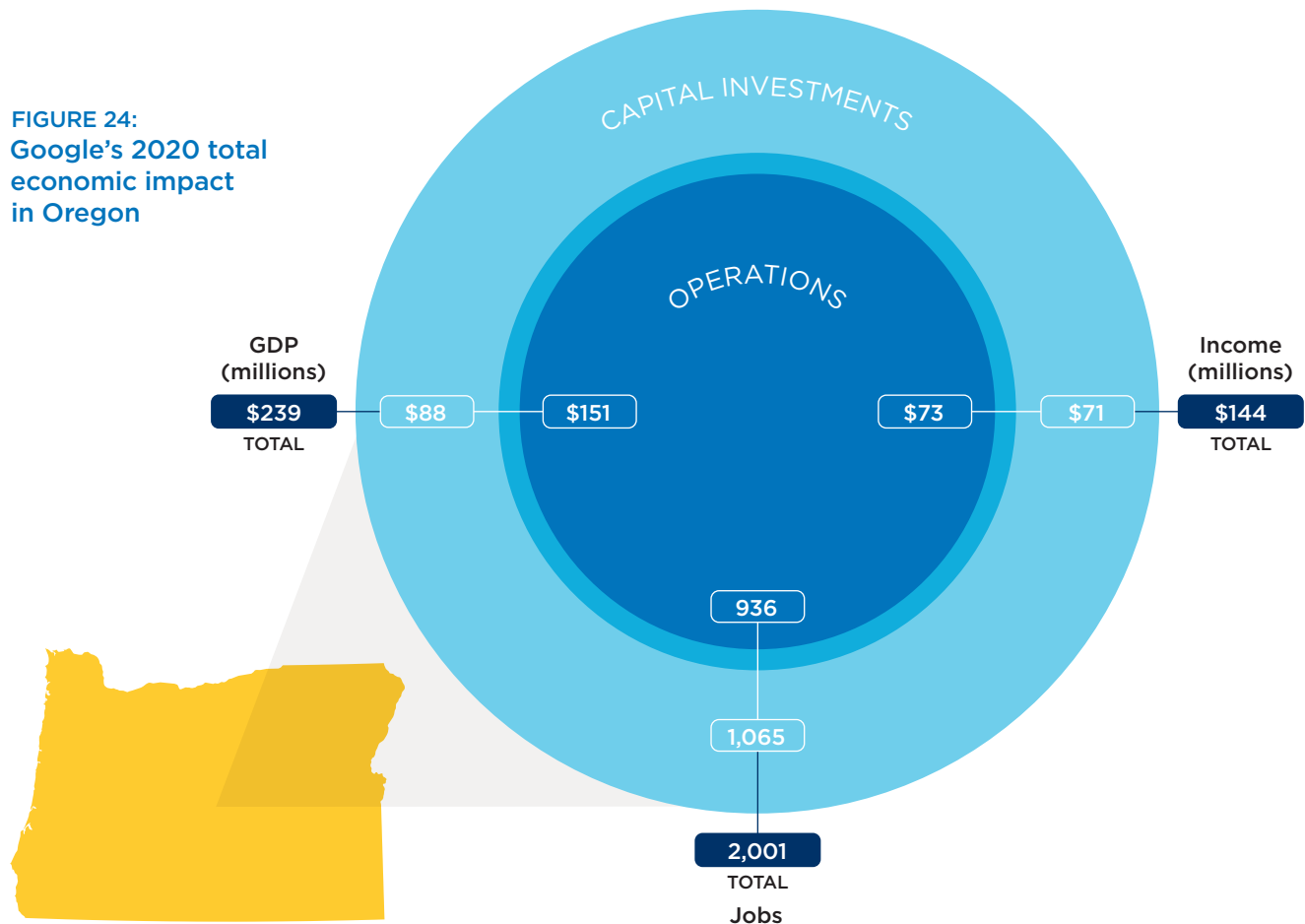
On average, Google’s capital investments annually support **1,520 construction jobs** in Mayes County.



9. OREGON

The Dalles data center opened in Wasco County, Oregon, in 2006. Today, the campus represents a \$1.8 billion investment that contributes broadly to Oregon's economy. In 2020, operations at The Dalles supported 2,001 jobs, generated \$144 million in income for workers in Oregon, and added \$239 million to state GDP.

FIGURE 24:
Google's 2020 total
economic impact
in Oregon



Source: Oxford Economics



In 2020, the data center in The Dalles supported **2,001 total jobs** and generated **\$144 million** in income for workers in Oregon.

9.1 WASCO COUNTY

A substantial amount of The Dalles' economic impact is concentrated in Wasco County, where the data center supports 1,661 jobs and generates \$123 million in income for workers. When compared to state figures, this means that 83% of the jobs supported by Google in Oregon are in Wasco County.

As seen in Figure 25, both data center operations and capital investments make nearly equal contributions to Google's in-county economic impact and support a diverse range of jobs. For example, when we examine the 855 jobs supported by Google's capital investments in more detail, we find that 574 of these jobs are in the construction industry.

FIGURE 25: Google's 2020 economic impact in Wasco County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	806	\$129	\$64
Capital investments	855	\$69	\$59
Total	1,661	\$198	\$123

Source: Oxford Economics



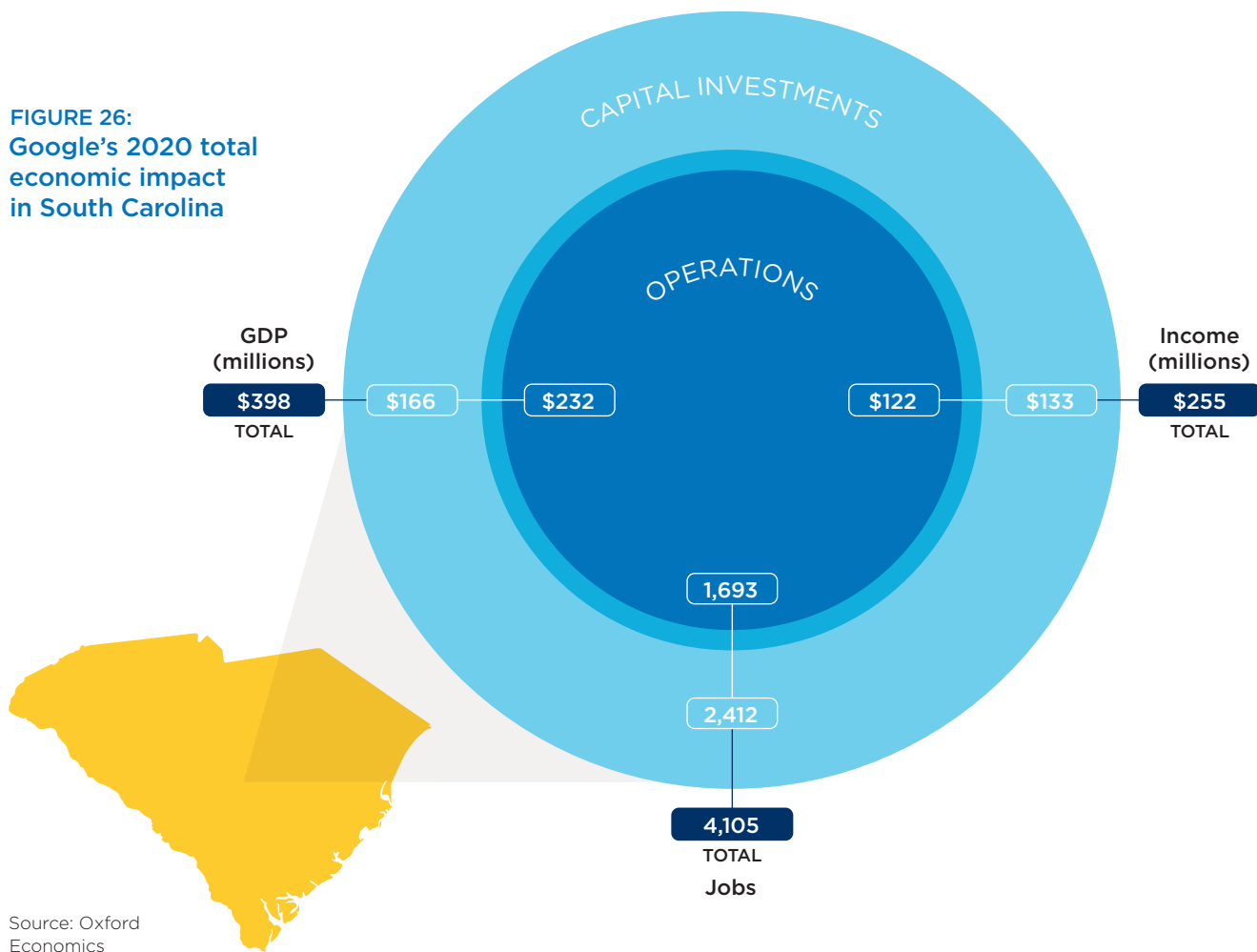
On average, Google's capital investments annually support **574 construction jobs** in Wasco County.



10. SOUTH CAROLINA

The Moncks Corner data center opened in Berkeley County, South Carolina, in 2008. Today, the campus represents a \$2.4 billion investment that contributes broadly to South Carolina's economy. In 2020, operations at Moncks Corner supported 4,105 jobs, generated \$255 million in income for workers, and added \$398 million to state GDP.

FIGURE 26:
Google's 2020 total
economic impact
in South Carolina



In 2020, the Moncks Corner data center supported **4,105 total jobs** and generated **\$255 million** in income for workers in South Carolina.

10.1 BERKELEY COUNTY

A substantial amount of the Moncks Corner economic impact is concentrated in Berkeley County, where the data center supports 3,199 jobs and generates \$206 million in income for workers. When compared to state figures, this means that 78% of the jobs supported by Google in South Carolina are in Berkeley County.

As seen in Figure 27, both data center operations and capital investments make large contributions to Google's in-county economic impact and support a diverse range of jobs. For example, when we examine the 1,960 jobs supported by Google's capital investments in more detail, we find that 1,501 of these jobs are in the construction industry.

FIGURE 27: Google's 2020 economic impact in Berkeley County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	1,239	\$180	\$95
Capital investments	1,960	\$132	\$111
Total	3,199	\$312	\$206

Source: Oxford Economics



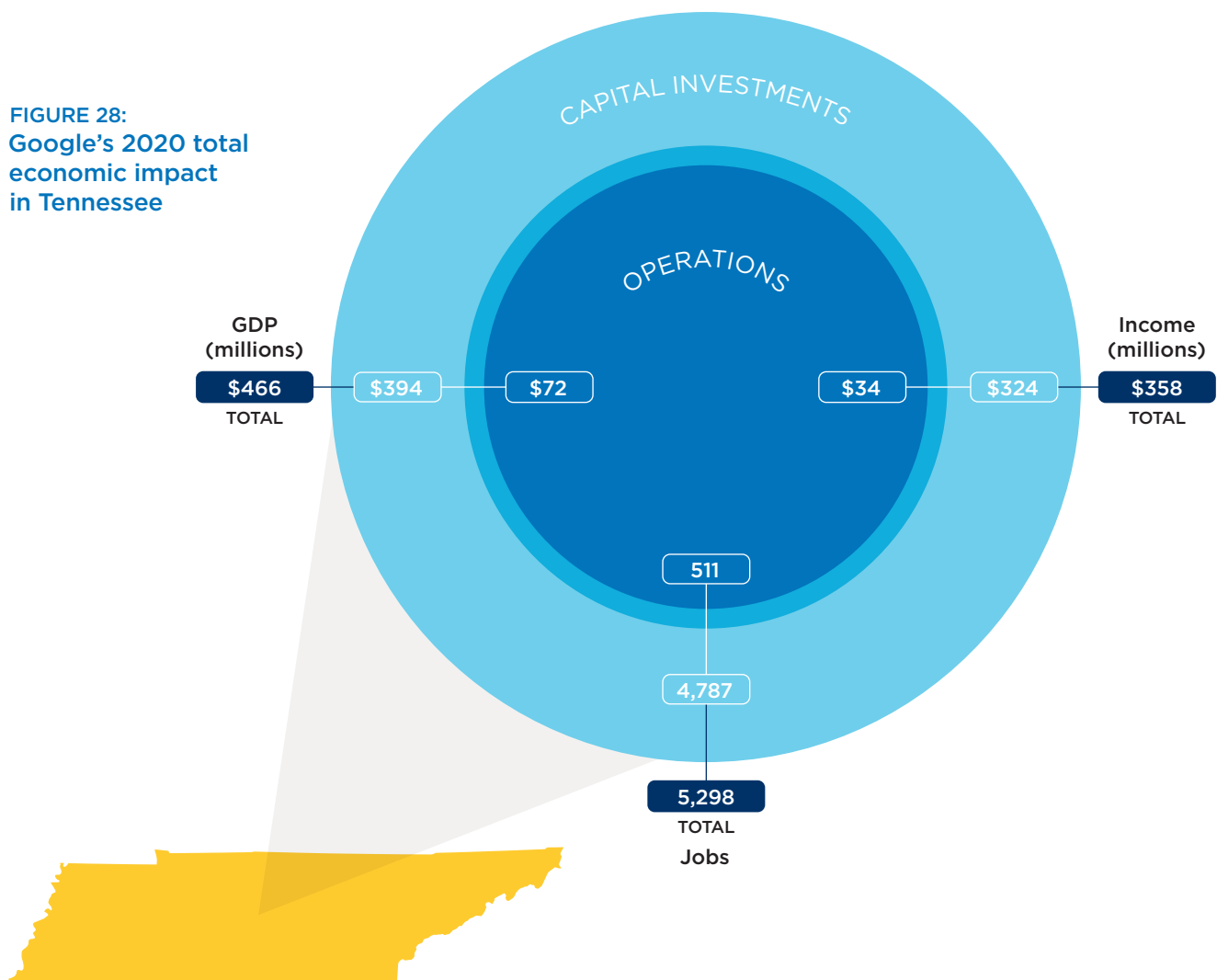
On average, Google's capital investments annually support **1,501 construction jobs** in Berkeley County.



11. TENNESSEE

The Spring Creek data center opened in Madison County, Tennessee, in 2019. Today, the campus represents a \$600 million investment that contributes broadly to Tennessee's economy. In 2020 operations at Spring Creek supported 5,298 jobs, generated \$358 million in income for workers in Tennessee, and added \$466 million to state GDP.

FIGURE 28:
Google's 2020 total
economic impact
in Tennessee



Source: Oxford Economics



In 2020, the Spring Creek data center supported **5,298 total jobs** and generated **\$358 million** in income for workers in Tennessee.

11.1 MADISON COUNTY

Most of Spring Creek's economic impact in Tennessee is concentrated in Madison County, where the data center supports 4,560 jobs and generates \$298 million in income for workers. When compared to state figures, this means that 86% of the jobs supported by Google in Tennessee are in Madison County,

At the county level, the economic impact resulting from capital improvements is especially important and accounts for 91% of the jobs in total. When this impact is examined in more detail, we find that nearly 2,900 of these jobs are in the construction industry.

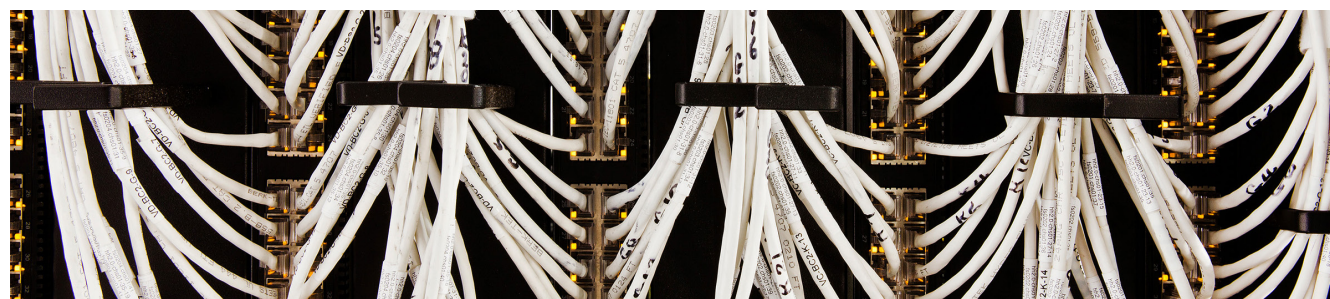
FIGURE 29: Google's 2020 economic impact in Madison County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	432	\$63	\$29
Capital investments	4,128	\$315	\$269
Total	4,560	\$378	\$298

Source: Oxford Economics



On average, Google's capital investments annually support **2,892 construction jobs** in Madison County.

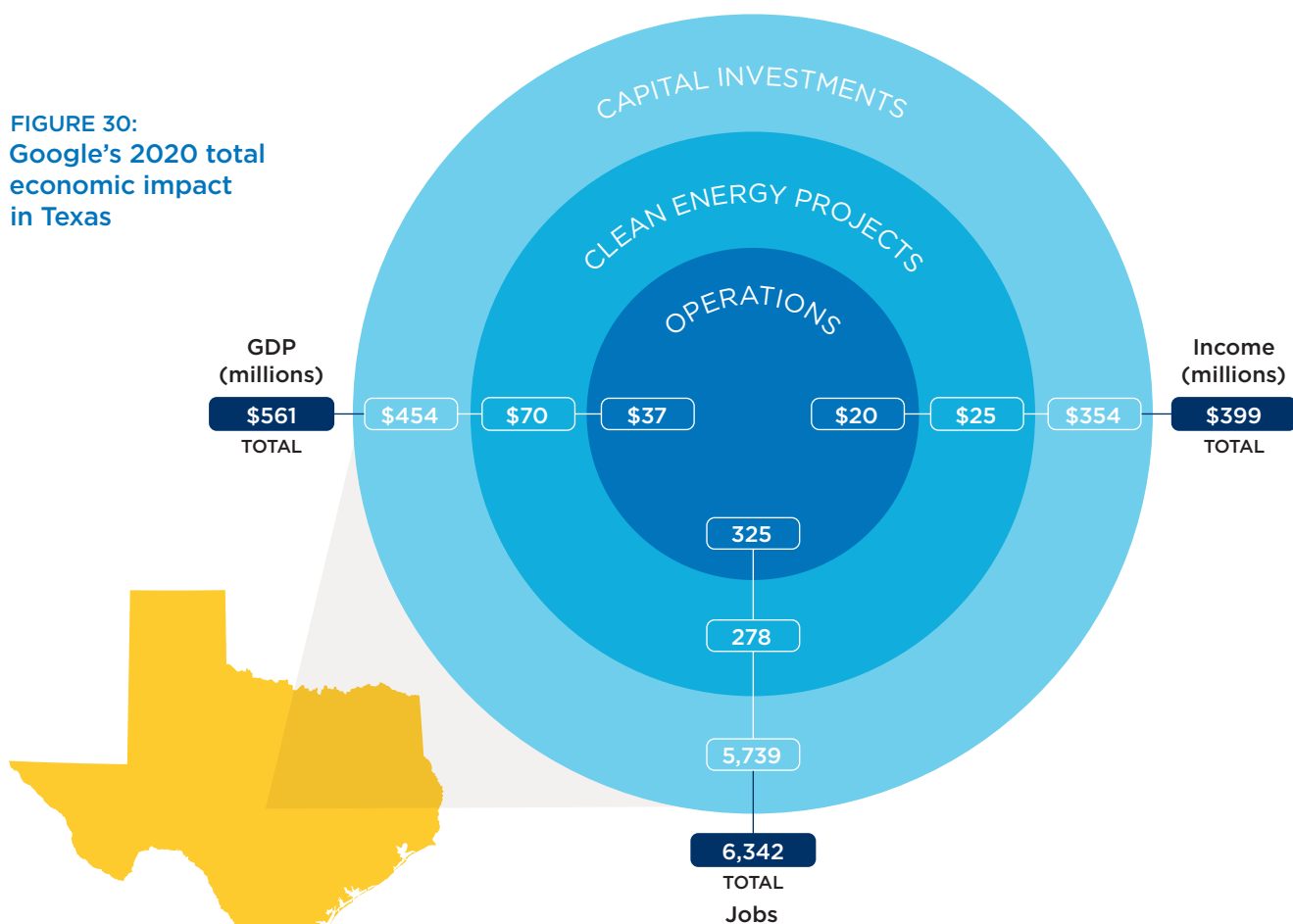


12. TEXAS

The Midlothian data center opened in Ellis County, Texas, in 2019. Today, the campus represents a \$600 million investment that contributes broadly to the Texas economy. In 2020, operations in Midlothian supported 6,342 jobs, generated \$399 million in income for workers, and added \$561 million to state GDP.

As a relatively new data center, capital investments in Midlothian make the largest contribution to Google's economic impact in Texas and this will be discussed in more detail in the following section. At the state level, we examined the 278 jobs supported by Google's clean energy projects in more detail. We found that 168 of these positions are in the clean energy industry itself (including its supply chain).

FIGURE 30:
Google's 2020 total
economic impact
in Texas



Source: Oxford Economics



In 2020, the Midlothian data center supported **6,342 total jobs** and generated **\$399 million** in income for workers in Texas.

12.1 ELLIS COUNTY

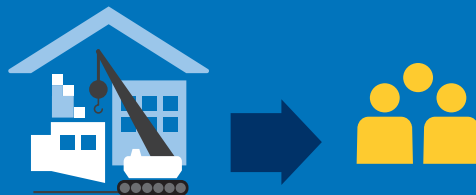
Most of the Midlothian data center's economic impact is concentrated in Ellis County, where the Google campus supports 4,532 jobs and generates \$251 million in income for workers. When compared to state figures, this means that 71% of the jobs supported by Google in Texas are in Ellis County.

At the county level, the economic impact resulting from capital improvements is especially important and accounts for over 94% of the jobs total. When this impact is examined in more detail, we find that 3,371 of these jobs are in the construction industry.

FIGURE 31: Google's 2020 economic impact in Ellis County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	265	\$29	\$16
Capital investments	4,267	\$270	\$235
Total	4,532	\$299	\$251

Source: Oxford Economics

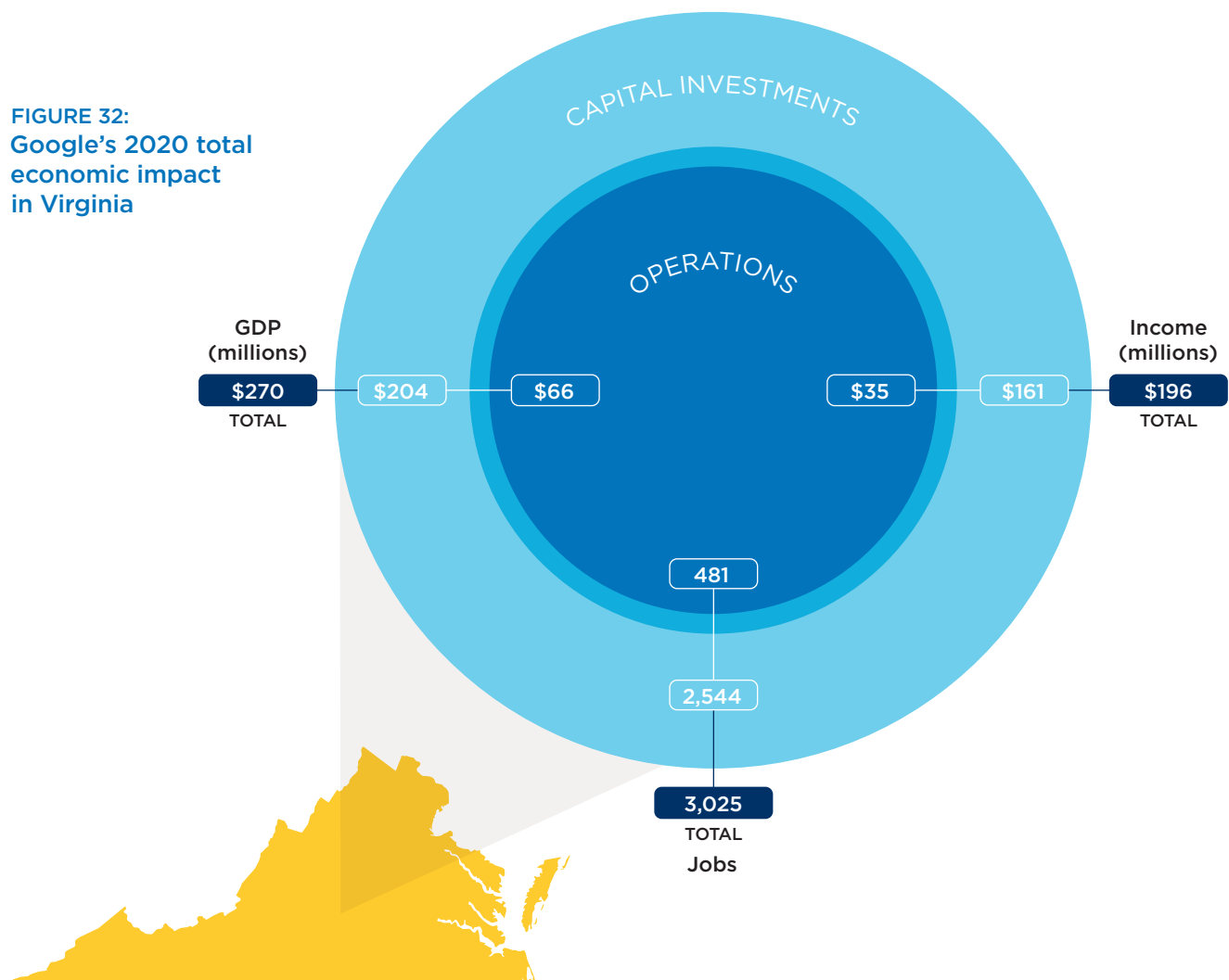


On average, Google's capital investments annually support **3,371 construction jobs** in Ellis County.

13. VIRGINIA

In 2019 Google opened new data centers in Sterling and Leesburg, Virginia. Both of these campuses are located in Loudoun County and together they represent a \$1.2 billion investment that contributes broadly to the state's economy. In 2020, operations at the two data centers supported 3,025 jobs, generated \$196 million in income for workers in Virginia, and added \$270 million to state GDP.

FIGURE 32:
Google's 2020 total
economic impact
in Virginia



Source: Oxford Economics



In 2020, the Loudoun County data centers supported **3,025 total jobs** and generated **\$196 million** in income for workers in Virginia.

13.1 LOUDOUN COUNTY

A substantial amount of Google's economic impact is concentrated in Loudoun County, where the data centers are located and support 2,373 jobs and generate \$167 million in income for workers. When compared to state figures, this means that 78% of the jobs supported by Google in Virginia are in Loudoun County.

At the county level, the economic impact resulting from capital improvements is especially important since these are relatively new campuses. In fact, capital investments account for 84% of the jobs supported by Google in the county. When this impact is examined in more detail, we find that 1,527 of these jobs are in the construction industry.

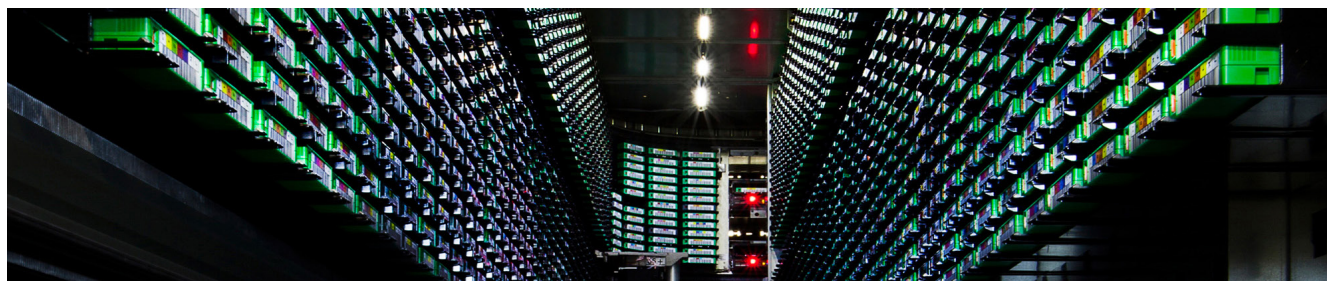
FIGURE 33: Google's 2020 economic impact in Loudoun County

Google activity	Jobs	GDP (millions)	Income (millions)
Operations	388	\$50	\$28
Capital investments	1,985	\$164	\$139
Total	2,373	\$214	\$167

Source: Oxford Economics



On average, Google's capital investments annually support **1,527 construction jobs** in Loudoun County.





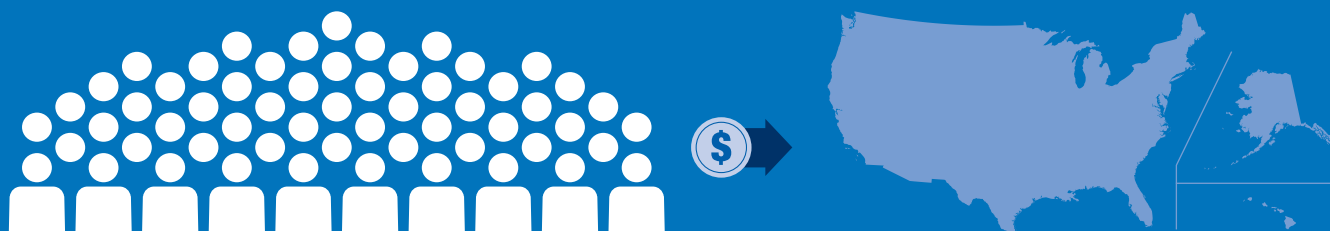
14. CONCLUSION

In 2020, Google's data centers and related infrastructure investments supported 57,804 jobs and generated nearly \$4 billion in income for workers throughout the United States. Most of these jobs are in the states and counties that host a data center. However, one in four jobs are located in other states as a result of the distributed supply chain across the US that provide goods and services supporting Google's data center operations, infrastructure, and clean energy projects. The result of this integrated supply chain is that Google's economic impact cascades throughout the United States.

Google data centers are at the heart of an economic ecosystem that supports job growth in a variety of key industries. For each job supported by Google's data center operations, an additional three jobs are supported by Google's capital and clean energy projects. During 2020, these included nearly 20,000 workers in the

Construction and Utilities industries, more than 8,500 in the Professional Services and Information and Telecommunications industries, and nearly 6,500 more in Trade and Transportation. Workers in a wide range of industries have jobs that are supported by Google data centers.

Google data centers support **57,804 total jobs** throughout the United States and generate nearly **\$4.0 billion** in income for workers in a wide range of industries.



In total, Google data centers generate \$6.4 billion in added economic activity (as measured by GDP). In addition to jobs and income for workers, this level of economic activity results in added tax revenue for all levels of government. Of the \$1.4 billion in tax revenue supported by Google data centers, \$556 million is annual tax revenue for state and local governments throughout the United States.

Google's commitment to long-term clean energy has resulted in investment in 26 wind and solar projects throughout the country. In addition to climate benefits, these clean energy projects also generate economic impact. On a recurring basis, Google's clean energy projects support 1,114 workers in the clean energy industry (including its supply chain). In addition, nearly 22,000 people-years of work were spent building, constructing, and installing the clean energy infrastructure that results from Google's clean energy commitments.

Google's data center operations, capital, and clean energy projects all result in substantial economic impact that is broadly distributed across the United States. In no less important ways, Google's engagement in the communities near where the data centers are located helps residents, schools, and businesses better prepare for the opportunities of today and tomorrow.

15. APPENDIX: METHODOLOGY

15.1 INPUT-OUTPUT MODELS AND ASSUMPTIONS

Google provided Oxford Economics with a great deal of actual (2020) expenditure information specific to each data center campus and its investments in its clean energy commitments. This information was not explicitly included in this report because of proprietary and trade secret concerns (see section 15.2) but was used to keep calculations robust. These and other inputs were analyzed using an input-output model developed by IMPLAN. Google data center operations were assumed to resemble the profile for data centers that is ultimately derived from the US Bureau of Economic Analysis input-output tables for NAICS code 51820.

For certain spend categories, (e.g., computer equipment), Google was not able to provide a breakdown of the location from which the purchased goods or services were sold, only the location of the data center for which it was purchased. For these spend categories, we built assumptions based on national- and industry-specific data within the IO tables themselves.

Sub-national impacts were calculated differently in the United States and the rest of the world. For the United States, impacts were calculated using an input-output model developed by IMPLAN. IMPLAN provides data for assumptions regarding what share of total national expenditures were spent within the county and state in which each data center is located. This is most important for the data centers' largest spend category: electricity. Certain other expenditures, such as catering, were assumed to be 100% spent locally.

Included in our direct employment calculations are all workers located on-site at each data center campus. These include both Google employees and third-party contractors. In previous work with Google, we developed profiles for the types of functions and costs associated with the third-party contractor workforce at some of the company's US data centers. We relied on those earlier profiles to estimate the costs associated with third party contractors at each of the data centers included in this study.

15.2 TREATMENT OF PROPRIETARY INFORMATION

As noted previously, Google provided us with detailed operational and investment data that was used in producing all economic impact calculations presented throughout this report. However, operational information regarding Google data centers is largely confidential and not routinely disclosed by the company. To accommodate this concern, we made one important modification in how we presented our results: specifically, with respect to direct employment on-campus. Our calculations were made using actual on-campus data. In our report, however,

we present as direct employment only figures that are consistent with what the company has previously disclosed publicly about employment at the location. This adjustment in presentation did not affect any calculation that we made, nor did it alter any key conclusion presented but does result in small adjustments to the mix of direct and indirect channels that we present at some locations. Note that total economic impact results and presentation are unaffected by this accommodation.

15.3 CLEAN ENERGY CALCULATIONS

To sustain its commitment to clean energy, Google enters into financial arrangements that result in the construction of new wind and solar projects in many of the countries where it operates its data centers. The nature of these financial commitments is not routinely disclosed publicly. Google provided us with detailed information regarding the amount, timing, and location of wind and solar farms established in response to Google's financial commitments. To calculate the economic impact associated with these investments, we relied upon various statistics published by the International Renewable Energy Agency (IRENA),⁶ These included IRENA estimates for both solar and wind total installed costs by country, and IRENA estimates for the levelized cost of electricity (LCOE) by country or region for both wind and solar projects. Through these published data, we estimated the amount of electrical output produced by these investments and the operating and maintenance costs associated with annual operations. Once annual operational costs were estimated, they were further refined using cost breakouts published by windpowermonthly.com (see "Big Turbines Push down O&M costs," Milborrow, David. May 2020).

The data provided by Google was also used to calculate the economic impact of the capital expenditures associated with its clean energy commitments. In making these calculations, we calculated the average construction expenditure per year over the construction period, which we assumed to be three years.

15.4 DATA CENTER CAPITAL INVESTMENT

Google regularly invests in expansions and improvements to its data center campuses, in addition to the initial investment to construct the data center. We were provided with total investment data on all of these investments, which we annualized by dividing the total amount of investment at each campus by the number of years that campus has been operational. Capital investment data were broken into spending on constructing the data center itself, purchases of computer and electronic equipment for the data center, and professional services in designing the data center. The construction expenditure was assumed to be 100% local; the equipment and professional services expenditures were allocated geographically for each data center based on national and industry-specific data in the input-model used.

⁶ "Renewable Power Generation Costs in 2019." Published by the International Renewable Energy Agency. 2020.

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