

GOOGLE DATA CENTERS

Economic Impact and
Community Benefit

APRIL 2018



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EXECUTIVE SUMMARY

As of the date of this report, six data center campuses provide the technological infrastructure necessary to power Google's operations in the United States. The data centers allow Google to provide search engine, cloud computing, and other Web-based services on which so much economic activity now depends. In addition to enabling Google to offer these services to people and businesses throughout the United States, the data centers also contribute significantly to job growth and income gains at both the national and state levels. Even more important are the economic contributions that Google data centers make to the communities in which they are located.

GOOGLE DATA CENTERS



**\$1.3 billion in
economic activity**

**\$750 million in
labor income**

11,000 jobs

In 2016, Google data centers generated \$1.3 billion in economic activity, \$750 million in labor income, and 11,000 jobs throughout the United States. Included in the 11,000 jobs are an estimated 1,900 people directly employed on the data center campuses. This number is based upon the six data centers only and does not include any corporate jobs that support the data centers remotely (e.g., Bay Area, California). In addition, facilities on the data center campuses are regularly upgraded and expanded to meet growing demand and to incorporate the latest technologies. On average, this effort employs more than 1,100 construction workers across the six campuses each year.

Google data centers create economic opportunity well beyond the campus itself.

On-campus activity is further supported by an external supply chain that employs nearly 3,500 additional workers. As those employed directly on campus and in the supply chain spend their wages, a further 4,700 jobs are supported in the wider consumer economy, for example, in retail and leisure establishments. In fact, when these channels are considered, each direct Google data center job is found to support an additional 4.9 jobs throughout the United States (for a national jobs multiplier of 5.9).

The employment impact of Google data centers is widespread at the state level and higher than is often supposed.

In each state hosting a Google data center, job creation attributable to the data center is significant. In fact, when economic activity from all channels is considered, the jobs multiplier attributable to Google at the state level ranges from 3.3 in South Carolina to 4.6 in Georgia.

New analysis in this report finds that the opening of a Google data center has a significant benefit on the local economy.

Through regression analysis, we found measurable local spillover effects within three years of the data center opening. These



Google's commitment to clean energy has spurred **\$2.1 billion** in new investment in renewable energy projects.

benefits include employment gains that went further than those directly connected to the data center campus as well as an increase in county residents holding a bachelor's degree. These results seem to suggest that the opening of a Google data center signals to out-of-county businesses and residents that new opportunities exist in that county (now that a Google data center has opened there).

Google's long-term commitment to take power from renewable energy sources has economic as well as environmental benefit. For example, Google's long-term contract commitments to renewable energy have resulted in \$2.1 billion of investment in eight renewable energy generation projects (wind and solar), to date. The construction phase of these projects required an estimated 2,800 direct jobs. The maintenance and operation of these eight renewable facilities now supports an estimated 520 ongoing jobs (when all channels are considered).

Beyond these measurable effects, the addition of a Google data center also ripples through local economies in other, less easily quantifiable ways. These are no less substantive in their positive impact on the lives of ordinary citizens living in data center communities. For example, Google partners with communities on workforce development and education initiatives that both prepare the current workforce for positions in the new economy and increase engagement with young women and minority students interested in science and math. Our report includes a series of case studies that explore these softer impacts on the counties and surrounding regions where Google data centers are located.

INTRODUCTION

Since 2006, Google has opened six U.S. data center campuses. Each is a state-of-the-art, world-class facility that enables the company to provide the search engine, cloud computing, and other Web-based services on which so much of the modern economy depends.

To date, the company has invested \$10.5 billion in these facilities.

FIGURE 1: Google Data Centers: \$10.5 Billion Invested to Date

Location	Year Opened	Total Investment (billions)
Wasco County, Oregon	2006	\$1.8
Douglas County, Georgia	2006	\$1.2
Caldwell County, North Carolina	2008	\$1.2
Berkeley County, South Carolina	2008	\$1.8
Pottawattamie County, Iowa	2008	\$2.5
Mayes County, Oklahoma	2008	\$2.0

Source: Google LLC

In this report, we examine the economic impact that has resulted from Google's investment and operation of its data center campuses. Our findings are discussed at the national, state, and local levels and are organized as follows:

- **National Economic Impact:** Examines Google's economic impact at the national level. We find, for example, that Google data centers support nearly 11,000 jobs throughout the U.S. economy.
- **State-Level Impact:** Explores Google's economic impact in the six states where the data center campuses are located. Our findings demonstrate that the state jobs multipliers associated with Google data centers are higher than commonly supposed.
- **Local Spillover Effects:** Discusses the local community spillover effects that result in locations with a Google data center campus, including overall employment gains and an increase in the county-level college-educated workforce.
- **Renewable Energy Investment:** Examines the economic impact that has resulted from Google's long-term commitment to take power from renewable energy sources.

METHODOLOGICAL INTRODUCTION: ECONOMIC IMPACT ANALYSIS

National, state, and renewable energy economic impact results were calculated using an input-output model. In making our calculations, we examined three categories of activity associated with each data center and then aggregated these categories to produce our total impact results. The three categories examined were operations, construction, and renewable.

Operations: This is the direct activity that occurs within the four walls of each data center, particularly wages, earnings, and activity of the data center employees. However, our calculations exclude all the production activity associated with manufacturing the information technology equipment utilized within each data center. The value of these equipment purchases is measured in the hundreds of millions of dollars at each data center, and so this decision to exclude the impacts associated with the manufacture of this equipment keeps our calculations conservative.

Construction: Each data center undergoes periodic expansion and renovation as Google updates its infrastructure to meet customer demand and integrate the latest technological advances. The construction figures presented reflect the average annual amount of (actual) construction activity that each data center has experienced since it opened. The impacts presented, therefore, are estimates based on the average amount of annual construction activity that occurs at each data center based on past experience. However, the actual construction pattern historically (and likely in the future), is for periodic bursts of very large-scale construction when major renovation or expansion is required. Therefore during peaks of actual construction, our estimates are low for that year, but in years with no construction, our estimates are high. On average, however, they are accurate estimates of the average

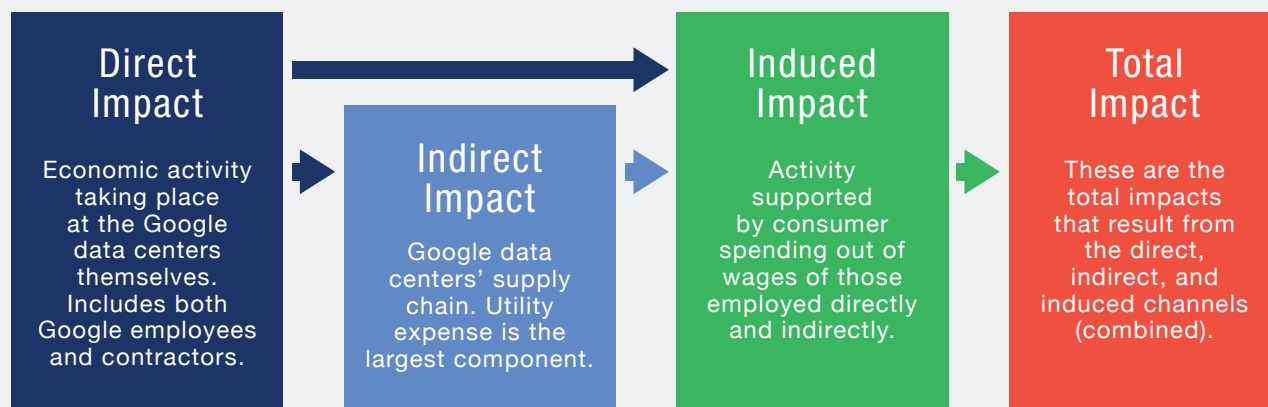
amount of construction activity expected to occur each year.

Renewable: Google's long-term commitment to buying renewable power has resulted in the construction of seven wind projects and one solar project, each of which requires a limited number of personnel to operate and maintain. This section captures the economic impact of the ongoing operations and maintenance of these renewable generation facilities. (The one-time construction impacts associated with the construction of these facilities is separately reported in a later section.)

In describing our results, we refer to the following three "channels" of economic activity. These channels are intended to distinguish Google's direct operations, those of its supply chain, and the wider impacts as the employees from the first two channels (Google and its suppliers) spend their wages in the broader economy. The three channels are defined as follows:

1. **Direct:** These are the jobs and activity attributable directly to Google's operational and capital expenditures.
2. **Indirect:** These are the employment and value-added contributions that are supported through Google data centers' supply chain (and in turn its suppliers).
3. **Induced:** This is commonly referred to as the "multiplier effect" and is the economic benefit that results as Google employees and vendors (and their employees) spend their incomes in the local community.

The relationship among the direct, indirect and induced channels is depicted in the schematic below:



NATIONAL ECONOMIC IMPACT

GOOGLE DATA CENTERS SUPPORT JOBS, GDP, AND INCOME GROWTH

In this section, we examine how Google data centers contribute to jobs, GDP, and income at the national level. From Figure 2, we see that Google directly employs 1,900 workers in its six data centers.¹ In addition, in an average year, there are more than 1,100 construction workers engaged on site working to expand or upgrade the facilities on the six campuses (combined). Finally, we note the estimated 70 workers engaged in the operation and maintenance of the renewable energy facilities that were built on behalf of Google. Although these workers can all be considered “direct,” unless otherwise noted, in this report, we will consider only the 1,900 operations workers as “direct employees.”

Each of the three channels of activity (operations, construction, and renewable) has its own supply chain (i.e., the indirect column). From Figure 2, we see that the total employment in the supply chain that supports these three channels includes more than 3,400 jobs. Workers employed on campus, or in the supply chain, go on to spend their wages in the broader economy. As they do, we see that nearly 4,700 further jobs are supported (in the induced column).

FIGURE 2: Supporting 11,000 Jobs Nationwide

	Direct	Indirect	Induced	Total
Operations	1,900	2,620	3,510	8,030
Construction	1,140	600	950	2,690
Renewable	70	210	240	520
Total	3,110	3,430	4,700	11,240

Source: Oxford Economics, IMPLAN

¹ Operational information regarding Google data centers is largely confidential. For example, precise employment counts are not routinely disclosed publicly by the company. To complete our analysis, Google provided Oxford Economics with sufficient information to allow us to calculate economic impact results accurately. However, in presenting our findings, we include as direct employment numbers only what the company has previously disclosed publicly about employment at each location. This adjustment in presentation has no effect on any impact calculation herein reported, except of course on the direct employment figures themselves. In our opinion, this presentation accommodation does not result in any overstatement of economic impact, nor to our knowledge does it result in any overstatement of actual employment on any of the data center campuses. For a more complete discussion on personnel calculations, please see Appendix A (Economic Impact Methodology).

Figure 3 provides detail on the \$1.3 billion contribution made by the data centers to national GDP. Seventy percent of this benefit is attributable to the operations of the data centers themselves, with the balance split between the ongoing construction activity and renewable energy program. In the next section, we will examine how this benefit is distributed among the states hosting data center campuses.

FIGURE 3: Contributing \$1.3 Billion to GDP

	GDP (\$millions)			
	Direct	Indirect	Induced	Total
Operations	\$200	\$413	\$317	\$930
Construction	\$83	\$63	\$86	\$232
Renewable	\$119	\$23	\$21	\$163
Total	\$402	\$499	\$424	\$1,325

Source: Oxford Economics, IMPLAN

The \$1.3 billion in added GDP is not just an abstract concept. It results in \$750 million in additional income that brings widespread benefit to workers throughout the economy (see Figure 4).

FIGURE 4: Generating \$750 Million in Income

	Income (\$millions)			
	Direct	Indirect	Induced	Total
Operations	\$179	\$200	\$182	\$561
Construction	\$64	\$39	\$49	\$152
Renewable	\$11	\$15	\$12	\$38
Total	\$254	\$254	\$243	\$750

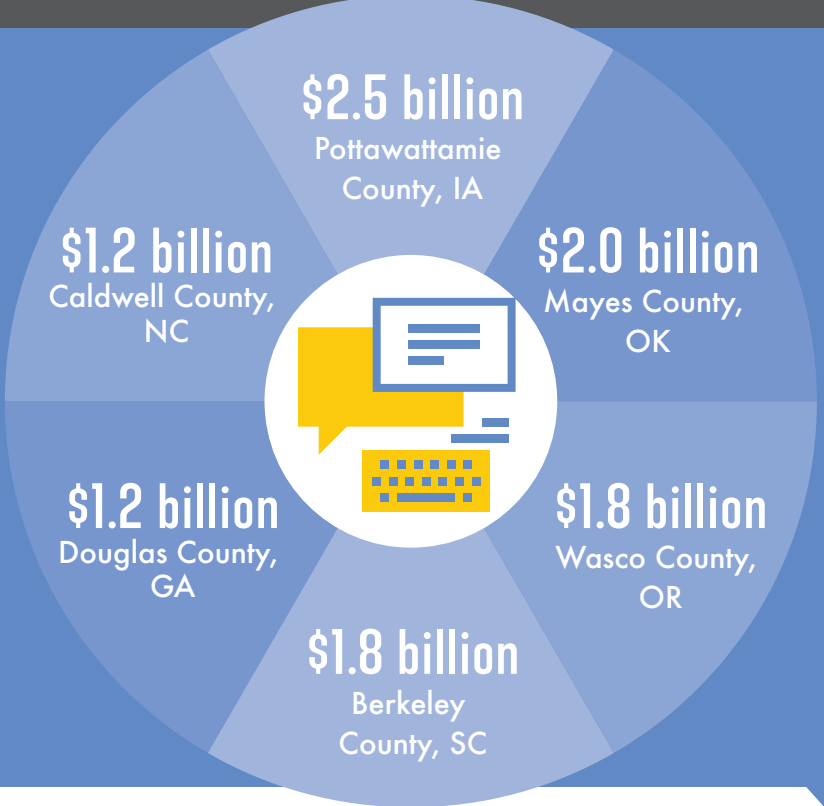
Source: Oxford Economics, IMPLAN
(some totals do not add due to rounding)

CENTERS OF VALUE

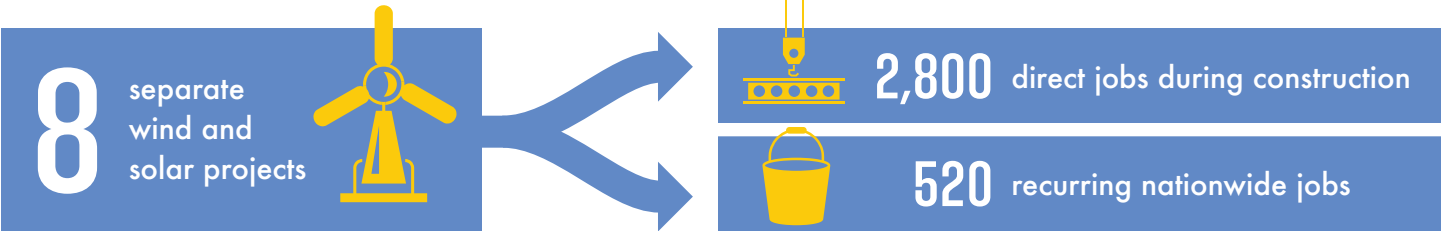
How six Google campuses spur economic growth



Google has invested **\$10.5 billion** equipping data centers to deliver its state-of-the-art search engine, cloud computing, and Web-based services...



...and spurred **\$2.1 billion** in renewable energy generation projects.



These Google data centers generate significant income and economic activity for the communities around them...

\$750 million
in labor income



\$1.3 billion
in economic activity



...and have created **11,000 jobs** throughout the United States.





Google's
GDP multiplier
is large because
wages at the
data centers
are high and the
supply chain
is large.

EXAMINING WIDER IMPACTS IN THE ECONOMY

In this section, we examine the national jobs multiplier associated with the data centers and then turn our attention to how the economic impact previously described spreads from the data center campus to the broader economy.

Multipliers: Multipliers are a commonly used measurement for comparing the economic impacts of different industries. Figures 2 and 3 provide us with the information needed to calculate both the jobs and GDP multiplier for the Google data centers, and the precise methodology for making this calculation is included in the footnote below.²

The result of this calculation is that Google data centers (at the national level) have a jobs multiplier of 5.9 and a GDP multiplier of 6.6 when all recurring impacts are considered. In Figure 5 we compare these multipliers to those of other industries.

FIGURE 5: Google's Multipliers Compared to Other Industries

Description	Multipliers	
	Jobs	GDP
Computer storage device mfg	9.8	2.7
Electronic computer mfg	8.9	2.6
Semiconductor machinery mfg	6.8	3.6
Google data centers (operations, recurring construction and renewable)	5.9	6.6
Scientific research and development services	4.0	2.9
Legal services	2.5	2.0
Gambling industries (except casino hotels)	2.3	2.4

Source: Oxford Economics, IMPLAN

Scientific and legal services are included in Figure 5 to allow comparison to typical business service industries. Gambling was included given its high profile in many local economic development efforts. From this comparison, we see that in terms of multipliers, the data centers have a greater economic impact than either relatively well-paying professional service industries or more commonly recruited economic development projects.

Electronic computer and semiconductor manufacturing are each included in our comparison because these are important industries in the Google supply chain. In addition, their inclusion in Figure 5 helps illustrate an important point regarding the conservative nature of our impact

² Jobs multiplier equals total jobs supported by Google data centers from all channels (11,240) divided by the number of Google direct jobs (1,900), which equals 5.9. The GDP multiplier is the total GDP supported by Google data centers from all channels (\$1,325 million) divided by the direct GDP contribution of data center operations (\$200 million), which equals 6.6. The same methodology is used in calculating the state multipliers presented in the next section. It is important to note the inclusion of ongoing construction impacts in our multiplier calculations. In traditional multiplier calculations, construction would not be included. The decision to include recurring construction and renewable impacts in the multiplier calculation is intended to capture the recurring nature of this activity at Google data center campuses. When considering only the operations channel, Google's multipliers are still high (4.2 jobs and 4.6 GDP).

calculations. As previously noted, Google invests billions of dollars-worth of equipment in each data center campus. As seen in Figure 5, the jobs multipliers (and hence economic impacts) associated with the manufacturing of this equipment are quite large. However, none of this extra economic impact is included in our results. Specifically, we excluded all impact associated with the manufacturing of computer, telecom, or other equipment placed into service at the data centers. This was done to keep our results conservative and to make sure that our impact calculations only measure the contribution of the data center campuses themselves.

It is also interesting to note that Google's GDP multiplier (6.6) is higher than that of any of the other industries presented. This is a function of the relatively high wages associated with many of the data center positions and the high contribution of economic activity associated with the Google supply chain.

How Economic Impact Spreads: As economic activity spreads from the data center campuses through the external supply chain and then to the broader economy, two things happen:

1. The economic impact grows larger as direct, indirect, and induced channels are considered. Each channel feeds on the previous one(s).
2. The industries that benefit from the economic impact become more diverse as the economic impact moves toward the broader economy.

FIGURE 6: Measuring How Google's Impact Spreads

	GDP (millions)				Labor Income (millions)				Employment			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Natural Resources and Mining	\$0	\$33	\$9	\$43	\$0	\$17	\$6	\$24	0	173	111	284
Construction	\$83	\$5	\$4	\$92	\$64	\$4	\$3	\$71	1,143	65	57	1,266
Manufacturing	\$0	\$40	\$36	\$77	\$0	\$22	\$17	\$39	0	303	226	529
Trade, Transport, and Utilities	\$119	\$217	\$79	\$416	\$11	\$81	\$46	\$138	70	864	955	1,890
Information Technology	\$200	\$30	\$21	\$251	\$179	\$15	\$9	\$203	1,900	128	80	2,109
Financial Activities	\$0	\$50	\$120	\$170	\$0	\$17	\$33	\$50	0	304	560	864
Professional and Business Services	\$0	\$78	\$44	\$123	\$0	\$69	\$36	\$105	0	990	589	1,580
Education and Health Services	\$0	\$0	\$59	\$59	\$0	\$0	\$54	\$54	0	4	957	961
Leisure and Hospitality	\$0	\$16	\$28	\$43	\$0	\$11	\$18	\$29	0	399	684	1,083
Other Services	\$0	\$9	\$18	\$27	\$0	\$7	\$17	\$24	0	116	439	555
Government	\$0	\$21	\$4	\$25	\$0	\$10	\$3	\$14	0	90	39	129
Total	\$402	\$500	\$424	\$1,326	\$254	\$254	\$243	\$750	3,113	3,438	4,698	11,249

Source: Oxford Economics, IMPLAN
(some totals do not add due to rounding)

Figure 6 provides a description of how the economic impact grows and then spreads throughout more industries as we move from direct (on campus), to indirect (supply chain), and then to the broader economy (induced).

Examining the employment columns in Figure 6 helps demonstrate how impact both increases and spreads as different channels are added.

- When just the *direct channel* is considered, we see most of the on-campus (direct) jobs are in either information technology (1,900) or construction (1,143) industries.
- When the *supply chain* (indirect) is considered, we see big jumps in trade and utilities (864) and professional and business services (990).
- By the time *induced channel* (broad economy) is considered, both leisure and hospitality (684) and education (957) show large gains in the employment that is supported by Google.

In fact, when all channels are considered we note that less than 20% of the more than 11,000 jobs supported by Google data centers are even in the information technology industry. The economic impact is both large and widespread.



CREATING THE FUTURE

How Google supports the next-generation economy in data center communities

THE greatest value of landing a Google data center may come from seeding future economic growth and diversification in regions that need a boost. Google's impact on its host communities starts with construction spending and data center jobs, but the ripple effects include broad-based workforce development, new revenue streams, and a reputation as a good place to do

business, says Deborah Murray, executive director at the Caldwell County Economic Development Commission in Lenoir, North Carolina.

When Google arrived a decade ago, the town was struggling with the loss of furniture jobs, which had sustained its economy for generations. Since then, the unemployment rate has plummeted, unused industrial square footage has decreased more than 90%, and median household income growth outpaced the rest of the

state in 2016. The economy has diversified to include a meaningful advanced manufacturing component, and the workforce has reskilled to support what Ms. Murray calls "twenty-first and twenty-second century jobs."

"I'm not going to tell you that Google is responsible for all of this, but they helped us learn about our capabilities," Ms. Murray says. "The world has changed, and Google helped us change with it."

One catalyst has been a program at Caldwell Community College, created after local leaders visited Google's Mountain View, California, headquarters. The initiative began with specialized training for potential data center employees and has expanded to support numerous other industries. "It gives us the ability to respond when we are courting a company with particular needs or when a company needs certain skills to fill a new-economy position," she says. "Google allowed us to demonstrate what we can do with that kind of specialized training." The school also offers popular online courses in cloud software.

Another benefit to the state as a whole is attracting companies looking to locate their own data centers. "Google gave us the credibility to compete," Ms. Murray says. In recent years, the region around Caldwell County—from the Appalachian foothills to the Piedmont—has become known as the North Carolina Data Center Corridor, a hotspot for major facilities operated by some of the biggest names in technology and other industries.

Similar stories are playing out in other Google communities. In Iowa, Google sparked a big-company, data-center boom with its Council Bluffs operation, and the same dynamic is in effect along the Columbia River in Oregon, where Google's first data center opened in The Dalles in 2006. These operations generate franchise fee revenue for host communities and some also share Google's focus on renewable energy, helping to spur growth in that industry state-wide.

Meanwhile, in Pryor Creek, Oklahoma, a rising generation is finding jobs in a rural area that must compete for talent with nearby Tulsa and other cities. Scott Fry is Director of Workforce Development at Pryor Creek's MidAmerica Industrial Park, home to a Google data center and dozens of other companies.

With local school districts bolstered by Google support and the park's visibility enhanced by its high-profile tenant, students are increasingly aware of opportunities in technical fields and the possibility of good work at Google or neighboring businesses. "We are getting great feedback from employers, with more young talent entering the workforce right out of high school," Mr. Fry says. "Having Google in our community is a game changer."

"Google gave us the credibility to compete."

—Deborah Murray
Executive Director,
Caldwell County Economic
Development Commission
Lenoir, NC

"More young talent [is] entering the workforce... Having Google in our community is a game changer."

—Scott Fry
Director, Workforce Development
MidAmerica Industrial Park
Pryor Creek, Oklahoma

STATE-LEVEL IMPACT

Google data centers significantly contribute to the growth of jobs, income, and economic activity in each state where a campus is located, and in this section we examine key state-level economic impacts. (More detail on the economic impact in each of these states is included in Appendix B).

FIGURE 7: Key State-Level Economic Impact Results

	(millions)				
State	GDP	Income	Jobs (Direct)	Jobs (Total)	Jobs Multiplier
Georgia	\$121	\$80	250	1,147	4.6
Iowa	\$189	\$111	400	1,743	4.4
North Carolina	\$103	\$61	250	1,024	4.1
Oklahoma	\$203	\$99	400	1,598	4.0
Oregon	\$67	\$46	200	696	3.5
South Carolina	\$112	\$72	400	1,335	3.3

Source: Oxford Economics, IMPLAN

GDP, INCOME, AND JOBS

In general, the size of state economic impacts varies based on the data center size and the amount of Google's supply chain that is located in the state:

- *The bigger the data center, the bigger will be the economic impact, other things being equal.* For example, the bigger the data center, the bigger will be the economic impact found in that state's direct channel.
- *The greater the concentration of the data center's supply chain that is located in the state, the greater will be the economic impact in that state.* More specifically, the bigger the in-state supply chain, the bigger will be the economic impact found in that state's indirect channel.

Differences in either of these variables get amplified as we consider the induced effects occurring in the broader economy. That is because as either the amount of in-state direct or indirect economic activity increases, the greater is the amount of induced in-state economic

activity that occurs in the state as well. Stated simply, the more workers that are located in the state (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 on home improvement, health care, or entertainment close to where they live.

As was true at the national level, state jobs multipliers are useful as a common denominator with which to compare impacts between states because they show how many additional jobs are supported by each Google worker located in that state, regardless of the size of the data center itself. State jobs multipliers are almost always smaller than national jobs multipliers because, by definition, the state jobs multipliers capture only the economic activity associated with that state, whereas the national jobs multiplier captures all the economic activity occurring within the entire country. Although smaller than Google's national jobs multiplier of 5.9, we see from Figure 7 (see previous page) that Google's state jobs multipliers are all significant and range from 3.3 in South Carolina to 4.6 in Georgia (with the variance again largely attributable to the size of the data center and the amount of supply chain activity located in the state).



LOCAL CONTROL

Google's approach to philanthropy and community involvement

GOOGLE manages its local philanthropic involvement with a light touch, but that does not mean the company shies away from difficult issues. In Berkeley County, South Carolina, for example, the 2015 shooting of Walter Scott by a police officer and the 2015 massacre at Charleston's Emanuel African Methodist Episcopal Church led Google to grant the College of Charleston Foundation \$125,000 to found the Race and Social Justice Initiative (RSJI) at the college's Avery Research Center for African American History and Culture. This organization's goal is to promote public awareness and dialogue about race and socioeconomic issues in Charleston and beyond. In 2016, Google increased its support and donated \$200,000.

Local control matters. "We don't want to run a grassroots initiative like this with corporate oversight. Google trusts us to run with it," says Daron Lee Calhoun II, RSJI coordinator. "It's a blessing for Google to run this the way they do."

Mr. Calhoun has been associated with the college since 2012 and has been heavily involved in social justice activism protests since then.

The results of the center's work have been notable. "We've held international conferences" Mr. Calhoun says. Nationally known speakers at RSJI events have included author Ta-Nehisi Coates and Dr. Lonnie G. Bunch III, director of the Smithsonian's National Museum of African American History and Culture.

The Avery Research Center is just one example of Google's presence in the community. Among various volunteer efforts in the region, the Black Googler Network—one of the many affinity groups within Google—traveled to Charleston to participate in an educational event that included lectures, seminars, and

even mock interviews with black students at the college. Google also has granted funds to nonprofits including MUSC Children's Hospital, SC Together (formerly the South Carolina Association of Nonprofit Organizations), and the Coastal Community Foundation of South Carolina. And Google's employees have become deeply rooted in other community initiatives since the data center opened in 2007.

Much of the work done by Google in its host cities and towns across the country is done through the GoogleServe program, an initiative that encourages Google employees to get involved in community life.

Google workers in Council Bluffs, Iowa, have cleaned and refurbished computer labs and re-imaged, installed, and inventoried computer equipment at local high schools. The work makes a difference, said David Fringer, the Council Bluffs Community School District's chief technology officer, in an article in a local newspaper.

"They will have pushed us weeks ahead of what we could have done without their help. This has become a tradition with this Google team."

The same energy is on display in other Google communities. In The Dalles, Oregon, for example, employees have volunteered with a wide range of organizations including Home at Last Humane Society, Wonderworks Children's Museum of the Gorge, and the Celilo Cancer Center.

Google's presence in communities where it has built data centers has sparked meaningful, ongoing change. "We would not be able to do the work that we do without the monetary and educational support from Google, period," Mr. Calhoun says.

"It's a blessing for Google to run this the way they do."

—Daron Lee Calhoun II,
Avery Research Center for
African American History and Culture

LOCAL SPILLOVER EFFECTS

Google has located each of its six data center campuses in small population counties located some distance away from a major city center. Oxford Economics set out to test the hypothesis that the opening of a Google data center in a small county, some distance from a major city, would improve the economic trajectory of that county relative to a comparable group of counties that did not host a data center campus. What our research uncovered was that, in fact, for most of the counties hosting a Google data center, there was measurable improvement at the county level in overall employment or education, measured by the number of county residents holding a bachelor's degree. These local spillover effects were measured independently of the economic impact calculations previously described.



Most counties quickly experience a jump in employment or an increase in college-educated residents shortly after a Google data center opens.

To calculate these effects, Oxford Economics utilized econometric techniques (regression analysis) that are more fully described in Appendix C. Regression work allows us to compare the economic experience in counties where Google opened a data center to a comparable group of counties that does not host a Google data center during a given time period. The counties share many key characteristics and then are divided between those where Google opened a data center and those where it did not. The experiences of the two groups of counties following the date that the data center opened, are then compared. The group of counties selected for comparison to those hosting a data center is called the “control group.” In selecting our control group, we considered population, state tax policy, electric rates, proximity to a large city, as well as several other variables.³

Our initial goal was to test a range of socioeconomic variables, including home prices, retail activity, and concentrations of technology workers. Data limitations forced us to drop these variables from consideration. However, available data did allow us to examine employment and educational level of county residents, and for each of these variables, positive local spillover effects attributable to the Google data center campus were found. One process by which an anchor institution (like the Google data center) functions as a magnet that attracts even more economic activity is called an agglomeration effect and that might partially explain the source of some of this additional growth.⁴

- 3 The selection of the control group of counties is discussed more thoroughly in Appendix C. Here it is important to note that the control group constitutes a selection of counties that shared key characteristics with the counties that now host a Google data center, except that in fact Google did not open a data center in any of those counties.
- 4 The concept of agglomeration economies dates to the 1890s, when Alfred Marshall's agglomeration theory sought to explain the geographic co-location, or “clustering,” of similar industries and often competing businesses. These agglomeration economies generate a local pool of skilled talent, local supplier linkages, and local knowledge spillovers. Quite possibly, some of the employment gains are attributable to these effects, while other gains might be in totally unrelated fields such as restaurants or hotels.

EMPLOYMENT EFFECT

Using our regression framework, counties hosting a Google data center were found to have experienced more job growth than the matched control counties. The impact began approximately one to two years prior to opening of the data center (presumably due to site acquisition, construction, and related activities) and continued throughout the period that we tested (three years beyond the opening date). As a group, the counties where the data center opened before 2008 had greater additional job growth than those that opened in 2008.⁵

- Counties where the data center opened *before 2008* experienced employment gains of 2,405.
- Counties where the data center opened *in 2008* experienced employment gains of 580.

We speculate that the national recession that followed the data center openings in 2008 stunted the additional economic benefit for these locations.

When counties were examined individually, it was discovered that counties located near a large city experienced the greatest local spillover effect in employment. For example, in Figure 8 we see that the largest net employment impacts were in the counties that are a part of a metropolitan statistical area (i.e., the data center counties whose economies are most tightly integrated with that of a major city). Metropolitan statistical areas (MSAs) are regions defined by the US government. They comprise a group of counties with a high population density at its core.

FIGURE 8: Counties with Significant Employment Gains

County	Part of MSA	Employment Gain
Berkeley (SC)	Charleston	2,378
Pottawattamie (IA)	Omaha-Council Bluffs	1,185
Douglas (GA)	Atlanta	5,595

Source: Oxford Economics

The results were less significant (both statistically and in terms of employment gains) for the other three counties not shown in Figure 8, none of which is a part of a MSA. Counties near a major city captured more local spillover effect than did those that are too far removed from a major city to be included in the metropolitan statistical area.

⁵ As previously reported in Figure 1, the counties where Google opened its data center prior to 2008 are Wasco, Oregon, and Douglas, Georgia. The other four counties all opened in 2008 (Berkeley, South Carolina; Pottawattamie, Iowa; Caldwell, North Carolina; Mayes, Oklahoma).



Counties hosting a Google data center quickly become **more attractive locations** for college-educated workers.

EDUCATION EFFECT

Our analysis found that counties hosting a data center experienced a 1.1 percentage point increase in the number of residents with a four-year college degree (four years after the data center opened), relative to the control group. For technical reasons having to do with the availability of data and appropriate control groups, this impact was only measured in three counties. Based on the average population of these counties over this period (2005-2015), this average 1.1 percentage point increase in bachelor's degree holders is equivalent to the following numbers of additional residents holding a four-year college degree than would have been experienced had Google not opened a data center in that county.

FIGURE 9: Counties with Extra Degree Holders

County	Extra Degree Holders
Douglas (GA)	895
Berkeley (SC)	1,234
Caldwell (NC)	620

Source: Oxford Economics

It is possible that a similar benefit was experienced in the other three counties, however, we lacked the data to properly test the hypothesis in those counties.

Given that these results are for four years past the opening of the Google data center, it cannot reasonably be inferred that Google has encouraged more residents to pursue a four-year college degree. Rather, this finding suggests that for whatever reason, the counties hosting a Google data center quickly became more attractive locations for college-educated workers to buy homes or take up residence.

Taken together, these results demonstrate that counties hosting a Google data center experience exciting local spillover benefits that are in addition to the employment gains attributable to the data center itself. **Importantly, these measured benefits occurred within a few years of the data center opening. Moreover, it is reasonable to suspect that these benefits persist and grow over time. In fact, some of the anecdotal evidence reported in our case studies seems to support this hypothesis.**



BEYOND THE WALLS

How Google campuses help communities thrive

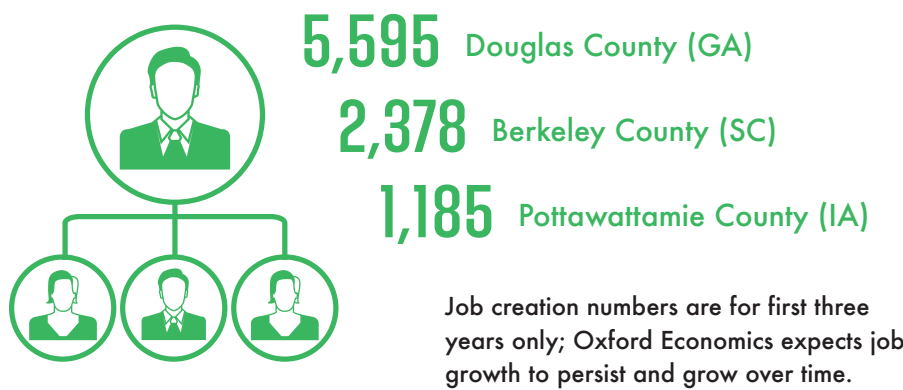
Google drives job growth across different sectors

INDUSTRIES WITH NEW JOBS SUPPORTED BY GOOGLE DATA CENTERS:



After Google arrives, more jobs follow

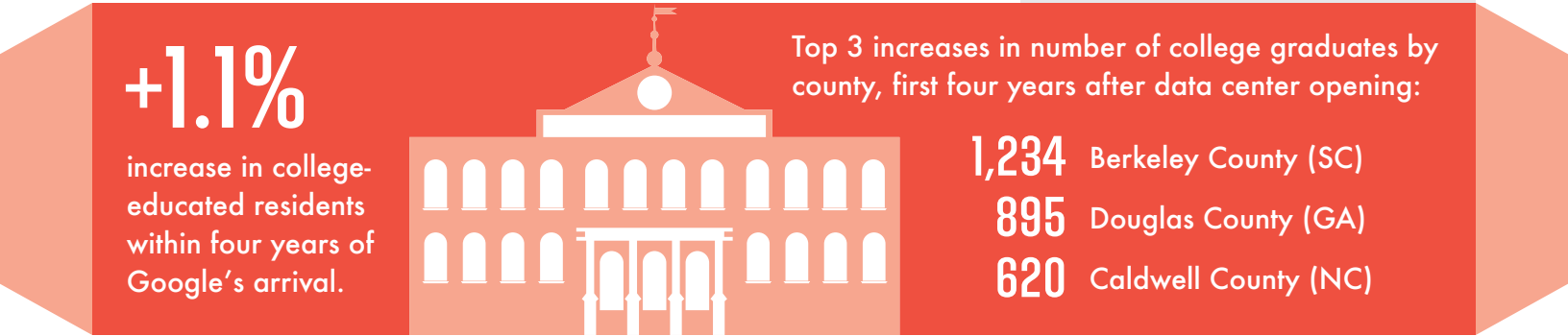
Within three years of a data center opening, employment increases attributable to the Google arrival by county include:



“The world has changed, and Google helped us change with it.”

—Deborah Murray,
Executive Director, Caldwell
County Economic Development
Commission (Lenoir, NC)

The data centers also raise education levels in the area



RENEWABLE ENERGY INVESTMENT

RENEWABLE CAPITAL INVESTMENT OVERVIEW

To satisfy its commitment to renewable energy, Google has made long-term contractual commitments that have resulted in \$2.1 billion of investment in the construction of eight new renewable energy generation facilities. In addition to the obvious and important environmental benefit, these investments also resulted in one-time construction activity that generated additional economic impacts.

FIGURE 10: One-Time Renewable Construction Impact

	(millions)		
	GDP	Income	Employment
UNITED STATES			
Direct	\$242.5	\$168.8	2,878
Indirect	\$114.6	\$70.0	1,020
Induced	\$198.1	\$113.4	2,195
Total	\$555.2	\$352.2	6,093
IOWA			
Direct	\$36.1	\$27.7	491
Indirect	\$7.2	\$4.5	81
Induced	\$13.3	\$7.1	181
Total	\$56.6	\$39.3	753
NORTH CAROLINA			
Direct	\$14.0	\$10.5	233
Indirect	\$4.4	\$2.7	49
Induced	\$6.8	\$3.6	87
Total	\$25.2	\$16.8	369
OKLAHOMA			
Direct	\$91.9	\$71.3	1,263
Indirect	\$24.9	\$15.3	266
Induced	\$36.1	\$20.4	486
Total	\$152.9	\$107.0	2,015

Source: Oxford Economics, IMPLAN

To calculate the one-time economic impact that resulted from the construction of the eight renewable projects Google invested in, Oxford Economics first estimated the percentage of the \$2.1 billion investment that went toward construction activity including site preparation, on site construction, and other related on site activity. Based on published sources, we estimate that nearly 15% of the investment cost went toward construction activity.⁶ The balance of the investment was assigned to equipment costs, and these were excluded from our impact calculations.

As described in Figure 10, construction of these eight projects created an estimated 2,878 construction jobs (one-time, temporary job creation). Moreover, nearly 70% of those construction jobs were in a state that also hosts a data center (Iowa, North Carolina, Oklahoma). They are not included in the impact calculations presented elsewhere in the report because these jobs are temporary.

RECURRING IMPACTS FROM RENEWABLE OPERATIONS

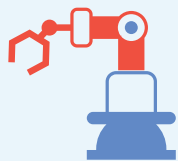
The eight renewable energy projects are sizable operations that require full-time personnel to operate and maintain. According to Google, 70 full-time workers are estimated to be engaged in operation and maintenance, and, as shown in Figure 11, these 70 workers in turn support further (recurring) economic impact.

FIGURE 11: Recurring National Impact (Renewable)

	(millions)		
Renewable (Recurring)	GDP	Income	Employment
Direct	\$119	\$11	70
Indirect	\$23	\$15	214
Induced	\$21	\$12	236
Total	\$163	\$38	520

Source: Oxford Economics, IMPLAN, Google LLC

6 Reategui, Sandra, and Hendrickson, Stephen. "Economic Development Impact of 1,000 MW of Wind Energy in Texas." National Renewable Energy Laboratory. Technical Report: NREL/TP-6A20-50400.



ROBOTS, Wi-Fi, AND MATH

Google's focus on education

AT the first Georgia Gravity Games in 2010, roughly 20 teams of students showed up with cars they had designed and built over the preceding months, ready to try for the fastest run down Church Street in Douglasville, Georgia. By 2017, 60 teams were competing—at least one from every school in the county, including teams with kids from populations

“The Gravity Games have grown so popular that they are approaching the town’s capacity. The street is only so big.”

—Chris Thompson, Associate Director of Technology and Student Activities, Georgia Institute of Technology

that are traditionally underrepresented in engineering and technology. In fact, the program’s growth has been so rapid that Chris Thompson, associate director of technology and student activities for the Center for Education, Integrating Science, Mathematics, and Computing (CEISMC) at the Georgia Institute of Technology and manager of the program, jokes that

it is becoming difficult to accommodate all the participants. “The street is only so big.”

The core goal of the Gravity Games, funded by Google and run by Google, Georgia Tech, and the city of Douglasville, is to spur interest in science, technology, engineering, and math (STEM) among young people in the community. The initiative has accomplished that and more: participating students have not only received hands-on engineering experience through their school clubs, but also have had the opportunity to interact with Georgia Tech students and faculty. One group of participating students even went on to join a robotics team.

The Gravity Games also take place in North Carolina—part of a partnership between Google, Appalachian State University, the University of North Carolina, and the city of Lenoir. And Google funds other types of educational programs around the country, including robotics camps

in Mayes County, Oklahoma; a competition to build the strongest wind turbine in The Dalles, Oregon; and a program, called Rolling Study Halls, that supplies Wi-Fi and educational resources to students in rural communities on their long bus rides to school.

Berkeley County, South Carolina, one area that has implemented these Rolling Study Halls, reports noticeable improvements among students from the program. According to Diane Driggers, chief information and technology officer for the Berkeley County School District, students who participate are more likely to understand and complete their homework, more engaged with the curriculum, and better behaved on the bus. Perhaps most importantly, the program provides Internet access to students in the rural district, many of whom may not have it at home.

Bringing these types of opportunities to underserved communities is the thread running through all of Google’s education initiatives, including Gravity Games, which promotes STEM engagement among minorities and females.

“We have a diverse group participating, including at least one all-female team” Mr. Thompson says. Last year, Georgia Tech sponsored three teams from low-income areas, and local businesses support underrepresented parts of the region. The Douglas County Chamber of Commerce also works to connect businesses with teams that need sponsorships. The hope is that some of these young students will be interested enough in what they see at the Gravity Games to pursue further education and careers in related disciplines. Some may even end up at Georgia Tech.

Students who participate in a Google-funded mobile study hall are more likely to understand and complete homework, engage with the curriculum, and behave on the school bus.

—Berkeley County, SC, School District

CONCLUSION

Google data centers make significant contributions to jobs, incomes, and economic growth at the national, state, and community levels. Nationwide, the six data center campuses support more than 11,000 jobs and \$1.3 billion in economic activity. These are conservative results because only activity occurring on the data center campuses was considered. Excluded from our calculations, for example, were all of the Google personnel and operations that support the data centers but are not located on a data center campus (e.g., all personnel based in California). Moreover, we did not consider the manufacturing impacts associated with the equipment placed into service at the data centers. We used this conservative methodology to more clearly illustrate how Google data centers directly impact the communities and states where they are located.

Google data centers provide important local spillover effects to their host communities. Within a few years of a data center opening, most communities experienced employment gains (beyond those at the data center itself) or increases in the number of college-educated residents.

According to research conducted by Oxford Economics, each of these benefits was spurred by Google's decision to locate a data center in that community. Moreover, it is likely that these benefits persist and continue to grow beyond the first few years of the data center's opening. In fact, the case studies included in this report provide anecdotal evidence from the communities themselves that supports this hypothesis.

Google's commitment to long-term renewable energy has spurred economic gains in addition to the environmental benefits that have resulted from the program. Specifically, because of Google's clean energy commitment, \$2.1 billion was invested in eight new renewable energy projects. The construction of these projects created more than 2,800 (temporary) construction jobs. Moreover, the ongoing operation and maintenance of these projects requires the support of an estimated 70 full-time positions.

Google's \$10.5 billion investment in and the operation of its six data center campuses bring significant direct benefit to the communities in which they operate by increasing jobs, income, and economic activity at the state and local levels. Moreover, most counties experience further increases in employment growth or the number of college-educated residents because of Google's decision to open a data center there. **As reported by the communities themselves, Google's presence helps ensure that the next generation of community residents are prepared to meet tomorrow's challenges and opportunities.**

APPENDIX A: ECONOMIC IMPACT METHODOLOGY

DISCUSSION OF KEY ASSUMPTIONS

Reliance on the IMPLAN⁷ default profile: While a great deal of real-world detail specific to each data center could be incorporated into the model, this was not the approach followed. Instead, in most instances, Google data centers were assumed to resemble the national default profile for data centers that is ultimately derived from U.S. Bureau of Economic Analysis (BEA) data (NAICS code 518210). The Google project team expressed concern that too much specific data regarding data center inputs might reveal too much proprietary information regarding the operation of the data center. Only two pieces of information specific to each data center were used as the basis of our calculations: employment and utility consumption. These two metrics allowed us to make reasonable assumptions regarding the size of the data center. Our assumptions regarding employment at each data center were explicitly reported in the results of our calculations as the direct employment at that data center. Our assumption regarding electricity consumption, although explicit in our calculations, was not explicitly reported out. Instead, the estimated electricity consumption was an important, but not the only, contributor to the indirect impacts that were reported for each data center.

Construction at data centers: We were provided with the cumulative construction hours spent at each data center from inception to the present. These hours were annualized over the life of each data center to give us an average amount of people-years spent on construction throughout the life of the data center. Again, this was used along with sector-specific economic data from BEA to develop a profile of the economic activity (we assumed half the hours were construction of new commercial structures and half repair and maintenance of existing commercial structures). This average annual construction activity was then treated as a recurring input at each data center. This approach was utilized because we know that there are bursts of significant construction activity from time to time at each data center, and we wanted to capture an average, understanding that some amount of this activity will occur annually.

⁷ IMPLAN is an input-output modeling system used to build models at various levels of geography, including national and state. It allows for adjustable assumptions of supply-chain connections and leakages from survey input data and improved accuracy of assumptions. All data are presented in 2016 values. IMPLAN is widely used and recognized by government organizations, nonprofits, economic development organizations, workforce planners, education institutions, and consultants across the U.S. and Canada.

Personnel: We were provided full-time equivalents (FTEs) and payroll information on the direct employees assigned to each data center and the annual amount spent on third-party contractors who are also assigned to each data center. In our model and the results that we report, we treated the contract and the direct Google employees in the same way to reflect that, taken together, we have an accurate estimate of the number of full-time workers employed in each data center.

Renewable: We were provided the one-time overall development cost of each renewable generation facility (seven wind and one solar). We obtained a detailed breakout of a typical wind farm development (see footnote 6). Overall, the breakout was as follows:

- Equipment 78.8%
- Materials (e.g., construction) 13.2%
- Labor 5.5%
- Other (e.g., easements, legal) 2.5%

Labor was embedded in other categories as well, and when all sources were considered, 14.9% of overall project costs were attributed to labor (and this constitutes the most input used in our renewable energy calculations). All equipment was treated as imported.

Equipment: 100% of all business personal property (e.g., computer equipment) placed in service within the four walls of each data center was assumed to be imported. Notably, this is at odds with the IMPLAN default tables, which would suggest that local (U.S.) domestic manufacturing content for many of these components is more than 50%. This assumption likely reduces the national impacts by substantially more than it does most of the states involved. However, in the IMPLAN default tables, most equipment is considered capital rather than operational spending anyway, and so this had a relatively minor effect (given that we did not scale up the model to reflect Google's actual investment in this category). Overall, our key objective in disregarding any domestically produced manufacturing content was to keep results conservative and limited to only activity occurring with the data center facility.

MORE ON THE INPUT-OUTPUT MODEL

Oxford Economics utilized IMPLAN software to calculate the economic impacts presented in these notes. The IMPLAN model was adjusted somewhat to match Google's specific direct and supply chain spend, using what IMPLAN refers to as an analysis by parts. For example, our assumptions regarding 0% domestic content, described above, needed to be reflected in the input model tables used to calculate results.

For each state with a data center, separate models were run for operational impacts and for construction impacts. Where applicable, models were also run for renewable energy operations and construction.

- *The operational model* was based primarily on Google-provided data on employment and compensation of Google employees and additional compensation for contract employees. Contractors were assumed to have the same average salary and were added to the employment totals of direct employees. This employment number was the primary scaler used to estimate data center size. We generally used IMPLAN defaults for data centers (i.e. on a per-worker basis) with the following exceptions:
 - The amount of estimated electricity Google reports using is much greater than the IMPLAN defaults for this industry. We thus scaled up the energy consumption.
 - Because contract workers were treated as direct employees, we also excluded inputs from employment services. Finally, we excluded spending on leasing of intangible assets.
- As discussed above, total construction hours were annualized, converted to FTEs, and ultimately to IMPLAN employment. *Construction impacts* were scaled to construction employment and were split evenly between construction of new commercial structures and maintenance and repair of nonresidential structures.
- *Renewable energy operational impacts* were based on energy employment provided by Google. FTE employment was adjusted to IMPLAN employment and used as a scaling factor for solar (NAICS 221114) or wind (NAICS 221115) power as appropriate.
- *Renewable energy construction impacts* were calculated by assigning a percentage of overall capital spending to construction activities on the renewable plant, as discussed earlier in this report.⁸ This was applied to NAICS 233240, construction of new power and communication structures.

⁸ Per Google's request, the precise percentages applied is withheld from publication to protect confidential data.

APPENDIX B: STATE ECONOMIC IMPACT DETAIL

GEORGIA

The Douglas County data center supports 1,147 jobs throughout Georgia. The state jobs multiplier attributable to the Douglas County data center is 4.6.⁹

FIGURE 12: Georgia Impact Summary

	(millions)		
	GDP	Income	Jobs
GEORGIA RECURRING IMPACTS			
OPERATIONS			
Direct	\$38.7	\$34.0	250
Indirect	\$38.6	\$20.5	338
Induced	\$29.8	\$16.2	372
Operations Total	\$107.1	\$70.7	960
CONSTRUCTION			
Direct	\$6.7	\$5.1	105
Indirect	\$3.1	\$1.9	34
Induced	\$3.8	\$2.1	47
Construction Total	\$13.6	\$9.1	186
ALL CHANNELS			
Direct	\$45.4	\$39.1	355
Indirect	\$41.7	\$22.4	372
Induced	\$33.5	\$18.3	420
All Channels Total	\$120.6	\$79.8	1,147

Source: Oxford Economics, IMPLAN

⁹ The jobs multiplier is calculated by dividing the number of jobs from the “All Channels Total” (1,147) by “Direct” jobs listed in the Operations Channel (250). In this case, that division produces the jobs multiplier of 4.6. In the sections that follow, the jobs multiplier will be stated without repeating this methodology. Recurring construction is included in the state-level impact calculations since we know that the construction activity being captured is specific to each location and represents the average annual amount of construction activity occurring at that location.

IOWA

The Google data center in Pottawattamie County supports 1,743 jobs throughout Iowa. The state jobs multiplier attributable to the Pottawattamie County data center is 4.4. In addition, Google's long-term commitment to take power from renewable energy projects has resulted in the investment of \$330 million in the construction of a wind farm in Iowa.

FIGURE 13: Iowa Impact Summary

	(millions)		
	GDP	Income	Jobs
IOWA RECURRING IMPACTS			
OPERATIONS			
Direct	\$52.7	\$42.8	400
Indirect	\$51.7	\$22.8	380
Induced	\$27.3	\$14.6	371
Operations Total	\$131.7	\$80.2	1,151
CONSTRUCTION			
Direct	\$22.8	\$18.7	341
Indirect	\$7.0	\$4.5	87
Induced	\$9.6	\$5.1	131
Construction Total	\$39.4	\$28.3	559
ALL CHANNELS			
Direct	\$90.6	\$62.7	741
Indirect	\$60.3	\$28.3	488
Induced	\$37.8	\$20.3	514
All Channels Total	\$188.7	\$111.3	1,743

Source: Oxford Economics, IMPLAN

NORTH CAROLINA

The Google data center in Caldwell County, North Carolina, supports a total of 1,024 jobs throughout the state. When all channels of economic activity are considered, Google's data center jobs multiplier in North Carolina is 4.1. In addition, Google's long-term commitment to take power from renewable energy projects has resulted in new investment of \$140 million in the construction of a solar farm in North Carolina.

FIGURE 14: North Carolina Impact Summary

	(millions)		
	GDP	Income	Jobs
NORTH CAROLINA RECURRING IMPACTS			
OPERATIONS			
Direct	\$26.0	\$22.5	250
Indirect	\$39.8	\$16.5	270
Induced	\$20.0	\$10.8	257
Operations Total	\$85.8	\$49.8	777
CONSTRUCTION			
Direct	\$8.0	\$6.5	143
Indirect	\$3.8	\$2.3	44
Induced	\$4.5	\$2.4	57
Construction Total	\$16.3	\$11.2	244
ALL CHANNELS			
Direct	\$34.6	\$29.3	393
Indirect	\$43.6	\$18.7	314
Induced	\$24.6	\$13.3	317
All Channels Total	\$102.8	\$61.3	1,024

Source: Oxford Economics, IMPLAN

OKLAHOMA

In Mayes County, Oklahoma, the Google data center supports 1,598 jobs throughout the state. The jobs multiplier in Oklahoma attributable to the Google data center is 4.0. In addition, Google's long-term commitment to take power from renewable energy projects has resulted in \$845 million in new investment for the construction of four wind farms in Oklahoma.

FIGURE 15: Oklahoma Impact Summary

	(millions)		
	GDP	Income	Jobs
OKLAHOMA RECURRING IMPACTS			
OPERATIONS			
Direct	\$33.2	\$31.5	400
Indirect	\$48.4	\$22.2	322
Induced	\$22.7	\$12.8	305
Operations Total	\$104.3	\$66.5	1,027
CONSTRUCTION			
Direct	\$16.2	\$13.1	256
Indirect	\$6.8	\$4.2	77
Induced	\$7.2	\$4.1	98
Construction Total	\$30.2	\$21.4	431
ALL CHANNELS			
Direct	\$105.6	\$48.4	656
Indirect	\$63.1	\$31.8	487
Induced	\$33.8	\$19.1	455
All Channels Total	\$202.5	\$99.3	1,598

Source: Oxford Economics, IMPLAN

OREGON

The Google data center in Wasco County, Oregon, supports 696 jobs throughout Oregon. The data center's job multiplier is 3.5.

FIGURE 16: Oregon Impact Summary

	(millions)		
	GDP	Income	Jobs
OREGON RECURRING IMPACTS			
OPERATIONS			
Direct	\$22.7	\$20.7	200
Indirect	\$20.8	\$10.3	176
Induced	\$14.5	\$8.4	195
Operations Total	\$57.8	\$39.4	571
CONSTRUCTION			
Direct	\$4.7	\$3.8	71
Indirect	\$1.8	\$1.2	23
Induced	\$2.3	\$1.3	31
Construction Total	\$8.8	\$6.3	125
ALL CHANNELS			
Direct	\$27.4	\$24.6	271
Indirect	\$22.5	\$11.5	199
Induced	\$16.8	\$9.8	226
All Channels Total	\$66.7	\$45.9	696

Source: Oxford Economics, IMPLAN

SOUTH CAROLINA

Google's data center in Berkeley County supports 1,335 jobs throughout the state of South Carolina, and the jobs multiplier in South Carolina is 3.3.

FIGURE 17: South Carolina Impact Summary

	(millions)		
	GDP	Income	Jobs
SOUTH CAROLINA RECURRING IMPACTS			
OPERATIONS			
Direct	\$29.3	\$27.3	400
Indirect	\$37.6	\$17.5	293
Induced	\$19.4	\$10.4	268
Operations Total	\$86.3	\$55.2	961
CONSTRUCTION			
Direct	\$14.6	\$10.3	227
Indirect	\$5.2	\$3.2	66
Induced	\$5.8	\$3.1	81
Construction Total	\$25.6	\$16.6	374
ALL CHANNELS			
Direct	\$43.9	\$37.6	627
Indirect	\$42.8	\$20.7	359
Induced	\$25.2	\$13.5	349
All Channels Total	\$111.9	\$71.8	1,335

Source: Oxford Economics, IMPLAN

APPENDIX C: REGRESSION METHODOLOGY

DIFFERENCE-IN-DIFFERENCES MODEL

To estimate the impact of Google data centers on local (county-level) economies, we used a Difference-in-Differences (DiD) econometric approach. We take two regions (A and B) with similar characteristics such that even if their magnitude is different and changes over time, the differences between them are stable over time (parallel trends assumption). At a given time, a Google data center locates in region A (we call that a treated region) and not in region B (control region) and changes the growth of region A. The difference in the post-event differences in growth rates between the two regions reflects the growth impact of the data center.¹⁰ In other words, only counties that were unaffected by a Google data center were eligible for inclusion in the control group.

HOW THE CONTROL GROUP WAS CHOSEN

Finding two identical regions to replicate a perfectly controlled experiment is difficult because regions can vary in dimensions that are not measurable or observable. If these non-measurable or observable features of the control vary systematically to those of the treated, then the impacts found will not be due to the event we are examining but to these unaccounted differences. Below, we describe the elements in our approach that ensure our estimation of the economic impact is as robust as possible.

The regions used in the control group were selected to ensure they are as similar as possible to the treated regions (regions where data centers are located). The control group is designed to approximate counties that Google might select for a data center if the company were to undertake a site selection search today based upon the characteristics of counties previously selected. An examination of the existing county locations revealed several “rules” derived from publicly available data that were then applied to all counties in the lower 48 states. These rules were:

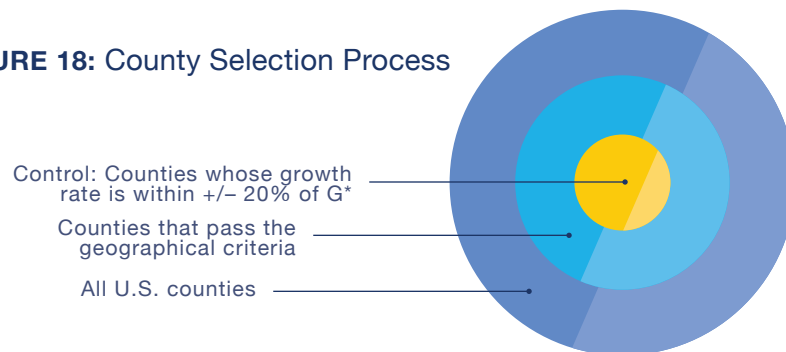
- Always locate in a state that allows sales tax exemptions for data center projects.
- Never locate more than 85 miles from a mid-to-large-sized metropolitan area.
- Never locate in a state with above average commercial electric rates.

10 Angrist, Joshua, and Pischke, Jörn-Steffen. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press, 2009.

- Never locate in a state that is principally desert or abnormally dry (based upon average annual rainfall).
- Never locate in a county with more than 250,000 people.
- Never locate in a state that already hosts a Google data center.

Counties that satisfied these rules were then further screened to make sure that each had growth rates comparable (parallel) to the target counties. For that comparison, a five-year period in growth wages and employment before the data center opening was used.

FIGURE 18: County Selection Process



* G is calculated as the growth rate of treated counties between 2001 and 2005.

One important test to see whether the control group counties and the counties hosting a Google data center allow for a valid comparison is to inspect whether prior to the establishment of the Google data center, the growth patterns between these two groups were similar. This test was satisfactorily completed with growth rates found to be graphically parallel between the target and control groups.

AGGREGATED AND INDIVIDUAL COUNTY ANALYSIS

Our initial analysis grouped the treated counties by the date that the data center opened. One group included the counties where the data center opened prior to 2008; the second group consisted of the counties where the data center opened in 2008.

FIGURE 19: Year Data Center Opened

Data Center County	Year Opened	Intervention Year
Berkeley, SC	2008	2006
Pottawattamie, IA	2008	2006
Douglas, GA	2007	2005
Caldwell, NC	2008	2006
Mayes, OK	2008	2006
Wasco, OR	2006	2004

Source: Oxford Economics, Google LLC

The use of the two groups allowed for a comparison of the average of treated regions with the average of several control regions. The averaging of the growth rates before and after the presence of the data center also reduced the chance that we erroneously attributed the change in the growth rates to Google when it more likely was the consequence of some other event or shock (such as another simultaneous investment). The risk of this type of error is reduced because even if that is the case for one county, the effect should be averaged out when we look at the group's growth.

After completing our analysis of grouped counties, we turned to an examination of the treated counties individually. Individual county tests are trickier because this necessitates the selection of a control group appropriate to each specific target county. In some cases, that was not possible. In those instances, a synthetic control method was used instead of the difference-in-differences method.

The synthetic control method builds an artificial counterfactual using all the counties selected for the control group and assigning weights to each according to how similar it is to the target county before the data center was built. The trajectory of the target county is then compared to that of this synthetic control after the data center is built. To verify that any difference found is significant, we apply this synthetic control method to all the counties (treated and control) and check whether the post-data center trajectory of the treated is significantly different from that of the controls.

OUTCOME VARIABLES AND THE INTERVENTION PERIOD

Using data from the Bureau of Labor Statistics (Quarterly Census of Employment and Wages) for the years 2001-2015, the following outcome variables were examined for each county:

- Total annual wages
- Annual average of quarterly employment
- Annual average weekly wages

Of these, significant results were established for annual wages and annual average of quarterly employment. Arithmetically, it is not surprisingly that having found a positive influence on the level of employment, we also found a positive influence on the level of overall wages. Other things being equal, if more people are working in a county, then one would expect that cumulative county wages would also increase.

Activity surrounding the actual opening of the data center starts well in advance of the opening date. For example, site assemblage, acquisition, infrastructure preparation, and construction activity of the facility itself all obviously occur in advance of opening. In our statistical examination, we found that an intervention period beginning two years prior to the official opening year satisfactorily accounted for this pre-opening activity.

ROBUSTNESS TESTS

The following methods were used to verify robustness of results:

- **Placebo Tests:** Two types of placebo tests were successfully completed, as follows:
 1. We re-estimated the model by falsely modifying the time when the data centers were built. The DiD model based on the made-up events should not find any significant differences between the treatment and control groups unless there are any events not related to the data centers present in the data. The placebo tests are important for giving us confidence that the control and treated groups (counties) were not experiencing differences in growth rates prior to the intervention period.
 2. Prior to estimating the impact of the data centers, we graphically plotted and inspected growth trend lines to visually validate the parallel trends assumption.
- **Dummy Regressions:** We regressed the growth of wage or employment on a dummy equal to one if a county is in the treated group for the period prior to the intervention. This is to check whether the counties in the treatment and control groups are growing at statistically similar rates with respect to the variables of interest prior to Google's decision to operate in the sites. We want the dummy in that regression to be insignificant for the two groups (treated and control) to establish that there are no statistically significant differences.
- **Estimation Procedure:** We estimated the model using fixed effects. Fixed effects estimation controls for the bias that time-invariant characteristics might cause.

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