AWS Economic Impact Study

AWS Investment in Spain

AWS Economic Development | 2021

Contents

Executive summary

€2.5 billion

Data center investment in Spain over the next 10 years.

€1.8 billion

Increase in GDP due to construction and operation of our data centers over next 10 years.

1,300

Full-time equivalent (FTE) jobs supported through construction and operation of data centers over next 10 years.

In this report, we provide an overview of existing and planned AWS infrastructure investments in Spain and the substantial economic benefits they create for the Spanish economy. Amazon Web Services (AWS) is expected to open an infrastructure region, which consists of clusters of data centers (called Availability Zones), in Spain by middle of 2022. This new AWS region will enable local customers with data residency requirements to store their data in Spain, with the assurance that they retain complete control over the location of their data. Additionally, customers looking to build applications that comply with General Data Protection Regulation (GDPR) requirements will have access to another secure AWS infrastructure region in the European Union (EU) that meets the highest levels of security, compliance, and data protection. In addition to these benefits for AWS customers, the construction, operation and maintenance of AWS data centers will generate direct and spillover effects on Spanish economy. We provide quantitative estimates of these effects.

- AWS is planning to invest up to **€2.5 billion over the next 10 years**, including both capital and operating expenditures, to build new data centers in Aragón, Spain. This investment includes imports of highly specialized and proprietary equipment, as well as in-country (local) spending on construction labor and materials, utilities, etc.

- Our in-country spending on construction and operation of AWS data centers will generate spillovers to the rest of the economy, a benefit for Spanish companies and employees. Using the input-output methodology and the National Statistics Institute (INE) data, we estimate that the construction and operation of data centers **will increase the GDP of Spain by approximately €1.8 billion over the next 10 years**, out of which approximately €500 million will be captured by Aragón. This amount does not include our contribution to the GDP in the form of the added value of cloud services provided by the new AWS Region.

- The construction and operation of the data centers would sustain on average 800 full-time equivalent (FTE) jobs in the first five years, and over 1,300 FTE jobs in the second five years from the start of the project. The majority of these jobs are expected to be in Aragón.

- To offset the carbon footprint of new data centers and support Amazon's Climate Pledge to become net zero carbon by 2040, Amazon has enabled in Spain its first operational photovoltaic project outside the United States, a 149 MW project located southeast of Seville. Amazon also announced a 49 MW solar project in the province of Zaragoza. More recently, Amazon added two projects in Extremadura and Andalusia. Altogether, Amazon has enabled 368MW of capacity in Spain in its renewable energy projects to power Amazon's logistic network and the upcoming AWS data centers in the country.

- In Aragón, AWS collaborates with local Higher Education Institution partners, such as CESTE, to offer training and certification programs of cloud technology that help local workers get jobs in cloud-related professions. Together with the local unemployment agency, Global Knowledge, AWS Authorized Training Partner for Spain, delivered instruction to around 125 young unemployed and held a class last December for more than 100 young students from Aragón.

AWS **overview**

Cloud computing is the on-demand delivery of IT resources over the internet. Instead of buying, owning, and maintaining servers, customers get access to computing power and data storage from a cloud provider like AWS. AWS offers pay-as-you-go pricing, which means that the customer only pays for resources actually used, as opposed to the traditional IT model where computing and storage come as a fixed cost.

Organizations of every type, size, and industry are using the cloud for a wide variety of use cases, such as data backup, disaster recovery, email, virtual desktops, software development and testing, big data analytics, and customer-facing web applications.

Users of cloud computing have easy access to a broad range of the latest technologies so that they can innovate faster, experiment freely and quickly spin up resources as needed. They don't have to over-provision resources upfront to handle peak levels of business activity in the future. Instead they provision the amount of resources that they actually need.

Today, AWS is the world's most comprehensive and broadly adopted cloud service, offering over 200 fully featured services from data centers globally. Millions of customers—ranging from startups to large enterprises and government agencies—are using AWS to lower costs, become more agile, and innovate faster.

AWS enables business formation and supports business growth. Access to cloud computing lowers the cost of starting new businesses, encourages innovation and the development of new technologies and intellectual property, attracts more funding for start-ups, and generates further economic growth. Researchers from Harvard and MIT find AWS lowers the cost of starting new businesses by 15–27%, encourages innovation, and attracts more funding for start-ups. Their study affirms "the introduction of cloud computing services by Amazon is seen by many practitioners as a defining moment that dramatically lowered the initial cost of starting internet and web-based startups".[1]

In addition to economic gains, replacing in-house computing with cloud technology is also good for the environment. In 2019 Amazon co-founded The Climate Pledge—a commitment to be net zero-carbon across our business by 2040, 10 years ahead of the Paris Agreement. Since then, more than 100 companies worldwide have signed The Climate Pledge, including Spanish AWS customers such as Telefónica, Prosegur, Acciona or Cabify. Amazon is on path to be powered with 100% renewable energy by 2025. AWS is contributing towards these goals by constantly improving the energy efficiency of our computing resources, and by increasing the share of renewable energy in total consumption by our data centers. As a result, the carbon footprint of AWS cloud computing is much lower than that of in-house computing as well as most other data center providers (see AWS and Sustainability on page 10). By adopting AWS cloud technology, governments and private firms can take advantage of the energy efficiency and clean energy goals of AWS to meet their own computing needs.

[1] Ewens M, Nanda R, Rhodes-Kropf M. Cost of Experimentation and the Evolution of Venture Capital. NBER Publications. National Bureau of Economic Research. 2018.

AWS in **Spain**

The upcoming new infrastructure region adds to AWS's ongoing investment in the country. We opened our first AWS Edge location in Madrid in 2012; since then we added another AWS Edge location, as well as two Direct Connect locations in the same city, all to support the rapid growth of demand for AWS services in the area. The purpose of Edge locations is to improve latency for Spanish users, while the Direct Connect allows Spanish users to establish a dedicated network connection between on-premises computing and AWS. The addition of the new AWS region will offer a full set of services to Spanish applications that critically depend on low latency. Today, AWS is also Esquema Nacional de Seguridad (ENS) High-certified, meaning its infrastructure meets the highest levels of security and compliance for government agencies and public organizations in Spain.

To help offset the carbon footprint of new data centers, Amazon is investing in renewable energy projects in Spain. Amazon has enabled four solar off-site projects: a 149 megawatts (MW) solar farm near Seville, which is already in commercial operation, a 49MW solar project in the province of Zaragoza, expected to be operational in 2021, and two projects in Extremadura and Andalusia. Altogether, Amazon is enabling 368MW of solar power capacity in Spain, which translates into 778,000 MWh of renewable energy annually. This is enough to power 243,000 Spanish homes.

Amazon now has corporate offices in Barcelona and in Madrid. Amazon has over 12,000 full time employees in Spain. Among them, AWS employs over 700 solutions architects, data center technicians, account managers, sales representatives, professional services consultants, technical account managers, software development engineers, and cloud experts. In addition, AWS maintains a Partner Network in Spain, a set of third-party consulting companies and cloud professionals. Together, AWS employees and partners help Spanish AWS customers adapt cloud technology to their needs.

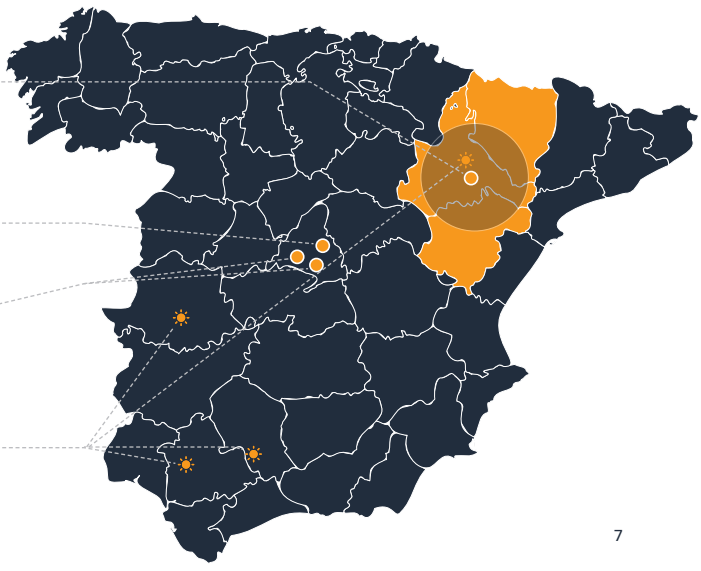
AWS locations in Spain

New AWS infrastructure region (Aragón)

Amazon offices (Madrid, Barcelona)

AWS Edge and Direct Connect locations (Madrid)

Amazon Solar Farms



AWS customers **in Spain**

Government
- Ministry of Agriculture
- Ministry of Infrastructure

Financial Services
- Banco Santander
- BBVA

Start-ups
- Cabify
- Glovo
- Fintonic
- Flywire

Industry & Energy
- Cepsa
- CAF

Education
- CEU
- Santillana
- Genially
- Ediciones

Travel & Hospitality
- NH Hoteles
- Meliá Hotels International

Already over 75% of companies listed on IBEX35, the Spanish stock market index, are using AWS. Major Spanish customers include financial services companies such as BBVA, Banco Santander or insurance companies, such as Mapfre. AWS provides a backbone to the Spanish hotel and travel industries, providing a scalable solution to customers like Meliá Hotels International, or NH Hotels.

Additionally, the Spanish government has already begun transition to the AWS with public sector customers that have included the option to transform regional government services with the cloud, such as the Ministry of Infrastructure, the Ministry for Agriculture, Fisheries and Food, the government of Aragón and Correos. Also, AWS is helping Education customers as Santillana, Ediciones SM, and CEU achieve their digital transformation.

> "We chose to work with AWS because innovation is part of our DNA. At Cepsa, we believe that technology will drive the future of sustainable energy production and we look forward to leveraging AWS to create value, become more competitive, and improve the efficiency of our operations and the quality of our products."
>
> - Philippe Boisseau, CEO of Cepsa.

AWS cloud offerings enable the creation of new businesses in Spain. Several leading Spanish startups leverage AWS, including Cabify, Glovo or Fintonic. As an example, RavenPack, a Spain-based fintech company, started using an interactive serverless query service, Amazon Athena, to run customers' analytics requests in 2018. "At peak times, for instance, when markets open in New York—we can get hundreds of API calls simultaneously from clients. Athena handles them easily. We can serve double the data and provide 25 times more client requests," says Jose Luis Cruz, director of IT operations. Overall, using AWS, RavenPack managed to double the data served daily, run 25 times more simultaneous requests with one-tenth of the cost of competition, which saves time and enables expansion of their business.

AWS cloud offerings also help existing enterprises achieve greater efficiency while reducing carbon footprint. For example, Cepsa, a Spanish energy and chemical company, selected AWS as its preferred cloud provider. Cepsa is using AWS to get valuable insights from more than 300,000 sensors running AWS IoT located in its manufacturing, refining, and energy production facilities. By applying AWS analytics and machine-learning services to the massive amount of data produced by these sensors each day, Cepsa can track operational trends, improve supply forecasting, and quickly identify inefficiencies to reduce waste and energy use while increasing the output of refined products. By utilizing AWS technology in its chemical plant in Huelva, Spain, Cepsa was able to reduce carbon dioxide emissions by 1,500 metric tons per year.

AWS investment in Aragón

AWS is planning to launch a new AWS Region in Spain by mid-2022. Regions are physical locations around the world with clusters data centers. We call each group of logical data centers an Availability Zone. Each AWS Region consists of multiple, isolated, and physically separate AZ's within a geographic area. Unlike other cloud providers, who often define a region as a single data center, the multiple AZ design of every AWS Region offers advantages for customers. Each AZ has independent power, cooling, and physical security and is connected via redundant, ultra-low-latency networks. AWS customers focused on high availability can design their applications to run in multiple AZ's to achieve even greater fault-tolerance. AWS infrastructure Regions meet the highest levels of security, compliance, and data protection.

The unique organization of AWS infrastructure fosters continued development in the local economy, as the capacity is progressively expanded to support growing customer demand. AWS plans to make continuous investment in the Aragón region, cumulating to €2.5 billion over the next 10 years. The planned investment includes imports of highly specialized and proprietary equipment, as well as in-country (local) spending. The local spending involves capital expenditures on construction labor and materials, as well as millions of euros of recurring operating expenditures, such as compensation for employees and contractors, spending on utilities, facility costs, and purchases of goods and services from regional businesses. Furthermore, in order to better support the operation of our data centers, we also invest in improving local public infrastructure such as roads, water, sewer, power, and fiber.

The key contribution of our investment to the Spanish economy is the value that AWS customers in Spain will obtain from access to the latest cloud technology made available by the new AWS region. From the experience of our existing customers in Spain and elsewhere, we know this value is likely to be significant (as illustrated by examples in the previous section), but reliable estimates are not yet available due to the forward-looking of this impact.

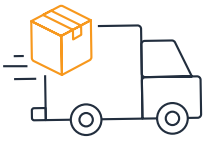
In this study, we provide quantitative estimates of the additional economic impact produced by our significant expenditures associated with the continuous construction and operation of AWS data centers in Aragón. Using input-output methodology and the National Statistics Institute (INE) data, we estimate that the construction and operation of data centers would result in an increase in GDP by approximately €1.8 billion over the next 10 years in Spain, out of which €500 million to be captured by the economy of Aragón. This is the value of final goods and services that Spanish firms will produce as a result of our in-country expenditures over the next 10 years. The illustration below provides a conceptual breakdown of this impact into direct, indirect and induced effects.

AWS investment in Aragón is a large scale, complex project that will support many jobs, the majority of which are expected to be in Aragón. Over the next 10 years, the construction and operation of the data centers would on average sustain approximately: 800 full-time equivalent (FTE) jobs in the first half of the decade, rising up to 1,300 jobs in the second half. These jobs include AWS's own data center employees as well as the projected growth in AWS sales organization. They also include non-AWS jobs, such as onsite contractors (security guards, etc.), and jobs supported in related industries such as construction, electricity sector, logistics and transportation, hospitality, etc. Within Aragón, the impacts on jobs and GDP will be allocated equally among three municipalities where future data centers will be located, because the amount invested in each municipality will be approximately the same.

Measuring Economic Impact

Direct Effects

Investments in construction and expenditures for operations



Indirect Effects

Inter-industry and supply chain spending

Induced Effects

Household income spending in local economy

Additional benefits of AWS investment

The opening of AWS region in Aragón will likely generate additional economic impacts in the form of technology agglomeration. For example, after AWS announced the opening of a Spain Region in 2019, other cloud service providers also announced plans to open cloud infrastructure region in Spain in 2020. As a contrast, these cloud service providers will leverage existing data centers, whereas AWS is building its own hyperscale Region, as a substantial long-term capital investment. Hyperscale AWS regions often result in agglomeration effects as other technology companies who need infrastructure to host and process their data, as well as share the same pool of skilled talent, are attracted to the area.

Opening the AWS Spanish Region will also have a positive impact on the ability of AWS suppliers in Spain and Aragón to specialize and achieve the scale required to open up significant export opportunities. By working with AWS in other regions, many companies have been able to develop specialist, world-leading expertise, meaning those firms are now market leaders in providing materials and services to data centers globally. AWS also helps enhance skills in its supplier network, especially in high-demand areas such as engineering and electronics, giving them the opportunity to become globally recognized specialists and growing Spanish businesses internationally.

AWS maintains a Partner Network of technology and consulting businesses in Spain and Aragón, which provides cloud technology support to local businesses and organizations. These businesses that joined the Partner Network in turn grow their businesses and create additional jobs. For example, Everis, with its Aragón HQ in Zaragoza, has recently announced a Strategic Collaboration Agreement with AWS to collaborate in the development of digital enterprise solutions built on AWS, with a focus on accelerating enterprise client's digital transformation in EMEA and LATAM. As an advanced consulting partner in the AWS Partner Network, Everis receives training and certifications from AWS, and further utilizes their cloud technology expertise to support and advise local companies on the adoption of the most cutting-edge technologies (e.g., machine learning) offered by AWS. Everis is also one of the top companies employing cloud professionals in Spain.

Local industries benefiting from cloud technologies

The automotive industry, transportation, logistics, and agriculture are key pillars of the Aragón economy. These industries are well positioned to benefit from AWS cloud technologies.

The automotive industry is transitioning towards electric and connected vehicles as well as advanced manufacturing. Aragón's largest employer, Opel Spain, began manufacturing the electric version of Corsa from 2019. The plant in Figueruelas, near Zaragoza, is Opel's first in Europe to make electric vehicles. Leading car manufacturers recognize the importance of cloud technology to help connected vehicles receive, send, and process large amounts of data. For example, AWS is currently powering Volkswagen Industrial Cloud, a cloud-based production platform that connects data from all machines, plants, and systems across Volkswagen's 124 manufacturing plants. In Spain, Grupo CAF utilizes AWS IoT technology to create more effective predictive maintenance models with real-time data to help customers quickly identify potential issues with trains and maximize standards of safety.

> "We are getting real-time data ingestion of temperature, soil, and humidity measurements, so we can more easily understand the traits of seeds and crops."
>
> - Bayer Corp Science AWS IoT Engineer

Agriculture may also benefit from smart technology solutions utilizing cloud computing and analytics. These cloud-based technologies allow real-time data collection and analysis, and help farmers make important decisions such as when to irrigate crops to reduce waste and costs. For example, Bayer Corp Science helps farmers optimize growing conditions in a controlled environment by gaining faster access to field data using AWS IoT. "We are getting real-time data ingestion of temperature, soil, and humidity measurements, so we can more easily understand the traits of seeds and crops," says an IoT product manager from the company.

Consequently, we expect that in the future the automotive and agriculture industries in Aragón will need more employees with cloud technology skills. In reponse, AWS in Spain is ramping up its educational efforts by offering certification and training programs, as reviewed in the next section.

[1] https://www.everis.com/global/en/news/newsroom/everis-announces-strategic-collaboration-aws

AWS workforce development and **community engagement in Spain**

AWS partners with universities and institutions in Spain to prepare the workforce of tomorrow. Our AWS Academy program provides higher education institutions with a free, ready-to-teach cloud computing curriculum that prepares students to pursue industry-recognized AWS certifications and in-demand cloud jobs. Our curriculum helps educators stay at the forefront of cloud innovation so that they can equip students with the skills they need to get hired in one of the fastest-growing industries. To date, AWS Academy has delivered courses to institutions such as ESADE, ISDI, Universidad Europea de Madrid, or the Universidad de Córdoba. Also, via AWS Educate program, students and educators have access to content and programs developed to skill up for cloud careers in growing fields. AWS Educate is present in dozens of Spanish institutions such as Universidad Autónoma de Madrid, Universidad Oberta de Catalunya, Universidad del País Vasco, Universidad de Granada, or Universidad de Alicante. As an example, in September 2020, CEU University launched the Cloud Computing Program (3 years) in collaboration with AWS Educate at three Spanish universities in order to help creating pathways for students to cloud technology careers. Students in the program have a curriculum mapped to skills and competency-based credentials required by AWS and other services for jobs in roles like cloud architecture, data analytics, cybersecurity, software development, and DevOps.

AWS launched AWS re/Start in Spain in November 2020 in collaboration with Cámara de Comercio de Madrid. AWS re/Start is a skills development and job training program which aims to build local talent by providing AWS Cloud skills development and job opportunities at no cost to learners from unemployed, underemployed, and under-represented members of Spanish communities. The AWS re/Start program is designed to accommodate differing levels of experience – even those with no previous technical experience can apply.

AWS empowers builders of the future with the right tools and skillsets. With over 60 workforce development and educational programs, AWS drives impact across the entire ecosystem to ensure that everyone has a chance to success in tomorrow's digital economy, adding economic value to the communities where program participants live and work.

In Aragón, we partnered with the technology cluster IDiA and the local unemployment agency to offer a variety of courses in cloud technology to local unemployed people. Under this agreement, Global Knowledge, AWS Authorized Training Partner for Spain, delivered instruction to around 125 young unemployed and held a class last December for more than 100 young students from Aragón. Learners received training, tutoring and mentoring to be certified for official AWS Cloud Practitioner, Architect, Developer or Machine Learning certifications. Program graduates had the opportunity to receive customized advanced training and earn multiple certifications, to become cloud professionals and boost their employability. Moreover, starting from September 2020, CESTE business school started offering education programs in cloud technology in Aragón, in partnership with AWS Academy. The collaboration program aims to prepare professionals for industry-recognized certifications and high-demand cloud jobs.

Beyond education, AWS is committed to being a good neighbor in communities where we build and operate our data centers. AWS Community Engagement focuses on STEM education, community events, local community workforce development, and employee volunteerism. As part of this commitment, AWS delivered the AWS Tech Week in April 2021, where more than 1,700 young students from more than 12 local schools attended the more than 85 sessions imparted by AWS employees, covering topics such as introduction to AI, to cloud computing, to data centers or to Big Data. AWS Tech Week aims to inspire technology vocations in students and encourage them to study Highly Demand Technology Careers (STEAM).

AWS empowers builders of the future with the right tools and skillsets. With over 60 workforce development and educational programs, AWS drives impact across the entire ecosystem to ensure that everyone has a chance to success in tomorrow's digital economy, adding economic value to the communities where program participants live and work.

AWS and sustainability

At AWS we are committed to running our business in the most environmentally friendly way possible. Our scale allows us to achieve higher resource utilization and energy efficiency than the typical on- premises data center. AWS is continuously working on ways to increase the energy efficiency of its facilities and equipment, and innovating the design and manufacture of its servers, storage, and networking equipment to reduce energy use. In addition to helping our customers increase agility and reduce costs, moving to AWS is also much more sustainable, as customers no longer have to provision for peaks, and AWS's infrastructure is designed to operate efficiently at scale.

The AWS global infrastructure is built on AWS's own custom hardware, and AWS optimizes this hardware for only one set of requirements: workloads run by AWS customers. It is highly utilized and not burdened with unnecessary features.

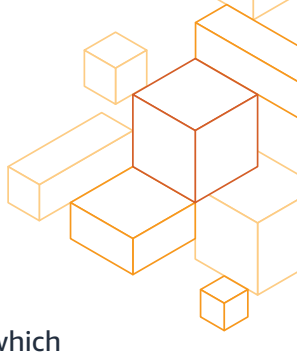
A recent study by 451 Research show that AWS's infrastructure is 3.6 times more energy efficient than the median of the surveyed U.S. enterprise data centers.[2] More than two-thirds of this advantage is attributable to the combination of a more energy efficient server population and much higher server utilization. AWS data centers are also more energy efficient than enterprise sites due to comprehensive efficiency programs that touch every facet of the facility.

To help offset the carbon footprint of new data centers and power Amazon's logistic network, Amazon is investing in renewable energy projects in Spain. Amazon has plans for four solar projects: a 149 megawatts (MW) solar farm near Seville, which is already in commercial operation, a 49MW solar project in the province of Zaragoza, expected to be operational in 2021, and two projects in Extremadura and Andalusia. Altogether, Amazon is enabling 368MW of solar power capacity in Spain, which translates into 778,000 MWh of renewable energy annually. According to REE, this is enough to power 243,000 Spanish homes.[3]

Reducing water usage in AWS data centers

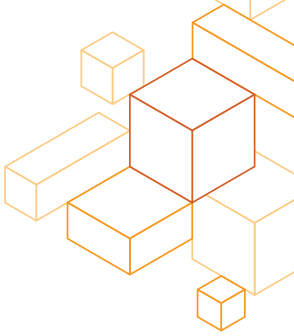
AWS has multiple initiatives to improve our water use efficiency and reduce the use of potable (drinking) water for cooling data centers. AWS develops our water use strategy by evaluating climate patterns for each AWS Region, local water management and availability, and the opportunity to conserve drinking water sources.

[2] The study is available at: https://sustainability.aboutamazon.com/carbon_reduction_aws.pdf
[3] REE estimates that an average Spanish household consumers 3.2MWh of electricity per year.



When evaluating cooling technologies, we assess both water and energy usage to identify the most efficient method and minimize environmental and community impact. We maximize the use of free-air cooling systems that cool servers with outside air without using any water. During peak summer temperatures we utilize direct evaporative cooling, which uses water to cool the air that removes heat from our servers.

AWS has demonstrated its commitment to water stewardship by using reclaimed or recycled water instead of potable (drinking) water. In some Regions AWS installed on-site water treatment systems to remove scale-forming minerals, enabling us to use water for more cycles in our cooling units and continue to reduce our water footprint.



Appendix A: Input-output methodology

To compute the economic impact of data center investments, we use the input-output multiplier methodology. Input-Output models are used to measure the impact of the expansion or contraction of one economic activity on other economic activities and on the local economy as a whole. The Input-Output methodology is credited to Harvard economist Wassily Leontief, who was awarded the Nobel Prize in economics for the development of this method and its applications. In this model, a "local" is typically a country, but could also be a smaller region, e.g., a county, MSA, or State in the US, or a region (e.g., Lombardy) in the EU. The method uses historical data from the country, maintained by the Organization for Economic Co-operation and Development (OECD) or the country's government statistical agency. The data shows the impact of each dollar spent in one industry on all other industries: for example, a US dollar spent on construction might typically be associated with 20 cents spent on electricity and other utilities. We also use internal Amazon projections on how much we will spend on each industry while building and maintaining the data center. We use standard procedures for computing multipliers from OECD's data. See, for example, Ronald Miller and Peter Blair, "Input-Output Analysis: Foundations and Extensions," 2009, Cambridge University Press.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