AWS INVESTMENT IN SINGAPORE

AWS Economic Impact Study

Contents

Executive Summary

Through 2023

SG$11.5 billion (more than $8.5 billion)[1]

Total investment associated with the AWS Asia Pacific (Singapore) Region through 2023

SG$18.3 billion ($13.6 billion)[2]

Estimated gross domestic product (GDP) contributed to Singapore by the AWS Asia Pacific (Singapore) Region through 2023

More than 4,800 jobs

Estimated average full-time equivalent (FTE) jobs at local businesses annually supported by the AWS Asia Pacific (Singapore) Region through 2023

2024 through 2028

SG$12 billion ($9 billion)[3]

Total planned investment associated with the AWS Asia Pacific (Singapore) Region, 2024–2028

SG$23.7 billion ($17.6 billion)

Estimated GDP contributed to Singapore by the AWS Asia Pacific (Singapore) Region, 2024–2028

More than 12,300 jobs

Estimated average FTE jobs at local businesses annually supported by the AWS Asia Pacific (Singapore) Region, 2024–2028

Amazon Web Services (AWS)[4] launched the AWS Asia Pacific (Singapore) Region in 2010. As AWS invests around the globe, it creates measurable and demonstrable economic growth in those regions and communities. This AWS Economic Impact Study (EIS) describes the impact generated by AWS's investment associated with the AWS Asia Pacific (Singapore) Region, and the ripple effects of that investment throughout Singapore.

AWS investments in Singapore play a vital role in supporting local jobs; driving Amazon's investments and collaborations with local organizations in cloud training and workforce development, community engagement, and renewable energy; and giving Singapore customers access to state-of-the-art technology, empowering them to innovate faster and build nearly anything that they can imagine.

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[1] The local currency values in this report were obtained by using the spot exchange rate of 1.3481 Singapore dollar per U.S. dollar, February 5, 2024, 11:25 a.m. EST. https://www.bloomberg.com/quote/SGDUSD:CUR. In U.S. dollars, the total capital and operational planned investment value is $8.6 billion, and contribution to GDP is $13.6 billion.

[2] These estimates are derived from internal data, the input-output (I-O) model,10 and statistical data provided by the OECD and the Singapore Ministry of Manpower (MOM). The GDP contribution by the AWS Asia Pacific (Singapore) Region reflects the value added by AWS to the IT sector in Singapore, as well as the direct, indirect, and induced effects of AWS purchases from the Singapore data center supply chain.

[3] The local currency values in this report were obtained by using the spot exchange rate of 1.3481 Singapore dollar per U.S. dollar, February 5, 2024, 11:25 a.m. EST. https://www.bloomberg.com/quote/SGDUSD:CUR. In U.S. dollars, the total capital and operational planned investment value is $9.1 billion, and contribution to GDP is $17.6 billion.

[4] References to AWS may relate to various affiliate entities including, but not limited to, Amazon Asia Pacific Resources Pte Ltd and Amazon Web Services Singapore Pte Ltd, and may also refer to AWS services, products, methods, and practices, and the AWS brand and trademark. For more information on AWS generally, see https://aws.amazon.com/what-is-aws/.
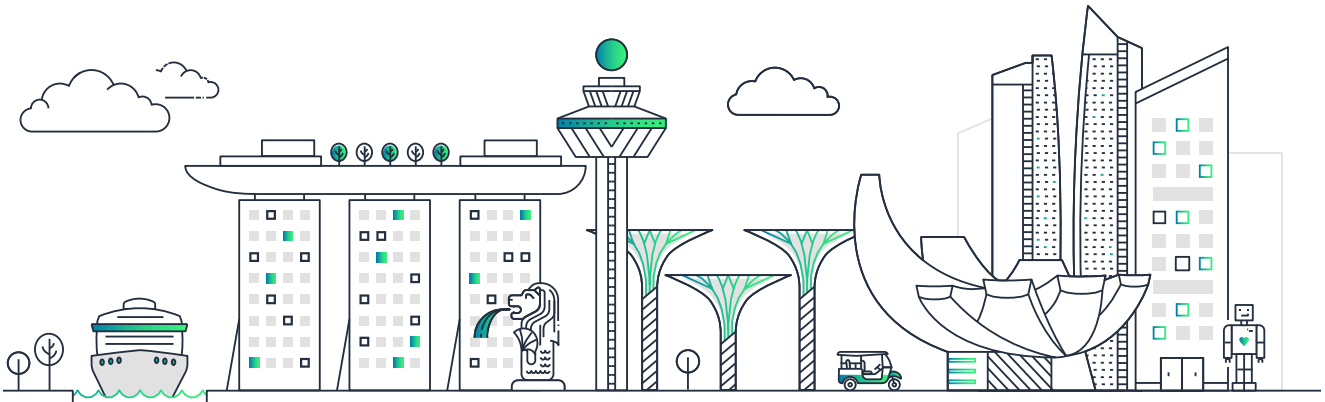
Economic impact of AWS investment in the Asia Pacific (Singapore) Region

AWS has invested extensively to construct, connect, operate, and maintain AWS data centers in the AWS Asia Pacific (Singapore) Region and is planning significant additional investments in Singapore over the next five years. AWS investments have already generated and will continue to propel revenue and job creation across a wide variety of sectors and industries in Singapore across the data center supply chain, including local businesses in industries such as construction, energy, engineering, logistics, maintenance, manufacturing, telecommunications, and security.

- AWS invested **SG$11.5 billion (more than $8.5 billion) in the AWS Asia Pacific (Singapore) Region through 2023, and plans to invest an additional SG$12 billion ($9 billion) in the Asia Pacific (Singapore) Region from 2024 through 2028**, including the capital and operating expenditures associated with constructing, connecting, operating, and maintaining the AWS Region in Singapore. All expenses are directly attributable to this initiative, such as the imports of highly specialized and proprietary equipment and software, in-country spending on construction, data center operations, and salaries for Amazon employees and contractors.

- The investment associated with the AWS Asia Pacific (Singapore) Region contributed an estimated **SG$18.3 billion ($13.6 billion) to Singapore's total GDP through 2023**, and will contribute an estimated **SG$23.7 billion ($17.6 billion) to Singapore's total GDP from 2024 through 2028**. This includes the value added by AWS to Singapore's information technology (IT) sector and in-country spending on goods and services related to AWS data centers in Singapore.

- **AWS investment through 2023** supported an estimated annual average of more than **4,800 full-time equivalent (FTE) jobs at local businesses** in the data center supply chain, and will support an estimated annual average of more than **12,300 FTE jobs at local businesses from 2024 through 2028**. This investment will support local businesses and workers in sectors such as telecommunications, construction, energy and water, and data center operations.

Economic impact of cloud adoption in Singapore

AWS provides enterprises, public sector organizations, small and medium-sized enterprises (SMEs), and startups with the added efficiency, scale, and reach to innovate, transform their business models, and make a meaningful impact in the communities in which they operate. The AWS Asia Pacific (Singapore) Region also enhances access to cutting-edge cloud technologies, providing local customers with the ability to securely store their data locally, solve critical latency challenges, and harness emerging technologies like artificial intelligence (AI)—elevating competitiveness, customer service, and productivity.

- **The AWS Asia Pacific (Singapore) Region will lead to a ripple effect in Singapore through increasing economic growth and cloud adoption and supporting Singapore's Smart Nation goals**. These ripple effects include productivity gains in the Singapore economy, empowering the digital transformation of local businesses, enabling local IT businesses to participate in the AWS Partner Network (APN), upskilling the local digital workforce, developing renewable energy projects, and creating a positive impact in the communities where AWS operates.

- According to the independent research study, "Economic Impact of Cloud Adoption in Asia-Pacific,"[5] commissioned by AWS and conducted by Telecom Advisory Services (TAS), as well as the policy brief "Cloud Computing Policies and Their Economic Impacts in Asia and the Pacific,"[6] as published by the Asian Development Bank Institute, **an increase of 1% in cloud adoption in Singapore would yield an increase of 0.15% in GDP, which is equivalent to $694 million U.S. dollars, representing the highest elasticity of countries that were included in the study**. In 2023, the total economic impact of cloud adoption in Singapore is estimated at 2.23% of Singapore's GDP.

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[5] Telecom Advisory Services LLC. 2023. "Economic Impact of Cloud Adoption in Asia-Pacific."
[6] Asian Development Bank Institute. 2024. "Cloud Computing Policies and Their Economic Impacts in Asia and the Pacific."
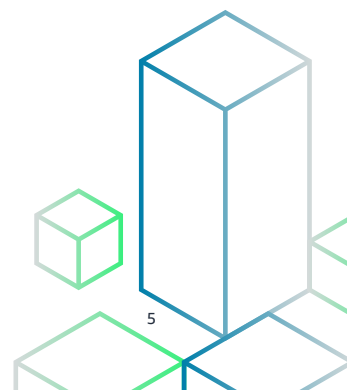
Improving sustainability in Singapore

Amazon is committed to becoming a more sustainable business and reducing our impact on the environment. We are on a path to match all of our global electricity use with 100% renewable energy by 2025, five years ahead of the initial 2030 target. Further illustrating this commitment, AWS plans to be water positive by 2030, returning more water to communities than the company uses in its data center operations.

- **AWS can help lower carbon footprints in Asia-Pacific**. According to a study conducted by 451 Research, S&P Global Market Intelligence, cloud data centers are five times more energy efficient than on-premises data centers in Asia-Pacific. Moreover, migrating IT workloads from on-premises to AWS can reduce associated carbon emissions by an average of nearly 80%, and up to 96% once AWS operates on 100% renewable energy by 2025. For Singapore enterprises and public sector organizations, a transition to the cloud will yield an average workload energy reduction of 76%, equating to an estimated annual carbon reduction of 1,542 metric tons of carbon dioxide equivalent (CO2e) per megawatt (MW) of enterprise data center capacity.[7]

- In Singapore, Amazon has two solar energy projects with **Sembcorp** and **Sunseap** that generate 79.6 megawatts, which is enough to power almost 20,000 Singapore homes every year. In addition to the generation of solar energy, this solar project in Singapore collects and treats up to 170,000 cubic meters of rainwater annually, which is equivalent to the amount required to fill 68 Olympic-sized swimming pools.

[7] S&P Global Market Intelligence. 2021. "The Carbon Reduction Opportunity of Moving to the Cloud for APAC."
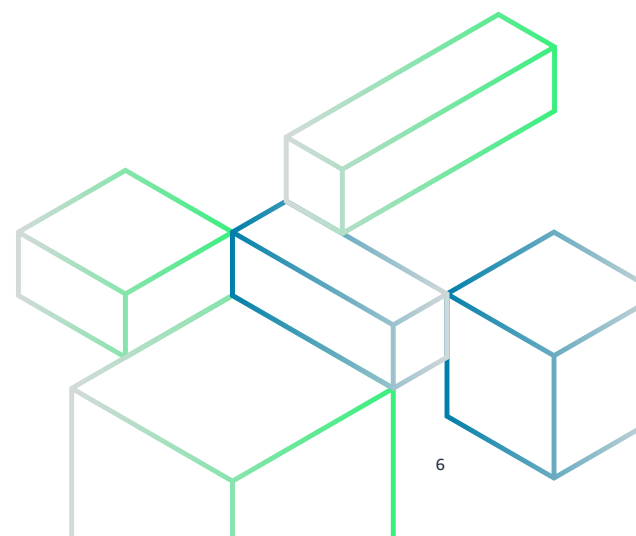
Economic Impact of Cloud Adoption

What is cloud computing?

Cloud computing is the on-demand delivery of IT resources over the internet with pay-as-you-go pricing. Instead of buying, owning, and maintaining physical data centers and servers, customers can access technology services, such as computing power, storage, and databases, on an as-needed basis from AWS.

What are the advantages of cloud computing?

- **Agility:** AWS lets customers quickly spin up resources as they need them, deploying hundreds or even thousands of servers in minutes, leading to faster innovation.

- **Cost savings:** AWS's pay-as-you-go pricing means that the customer only pays for the resources used instead of the traditional IT model, in which expenses come as a fixed cost.

- **Elasticity:** Customers do not have to overprovision resources upfront. Instead, they provision only the resources they need to scale up or down with the needs of their businesses, which reduces costs and improves the ability to meet their users' demands.

- **Innovation:** Customers can innovate faster because they can focus IT resources on developing applications to transform customer experiences instead of managing infrastructure.

- **Scalability:** AWS has the most extensive, reliable, and secure global cloud infrastructure, providing customers with the ability to deploy globally in minutes.

- **Security:** AWS is architected to be the most flexible and secure cloud computing environment available today. Customers can build on the most secure global infrastructure, knowing they always control their data, including the ability to encrypt it, move it, and manage retention at any time.

Enhanced scalability, agility, and resilience coupled with cost savings for startups

Cloud computing is a key enabler of digital transformation, especially for SMEs and startups. One of the most significant obstacles startups experience during the initial stages of business is financial constraints. These constraints are particularly challenging for organizations when facing the high upfront capital expenditure for data storage and processing, which can create hurdles to investing in on-premises computing resources. According to research conducted by the Asian Development Bank (ADB), as outlined in its paper "Cloud Computing as a Key Enabler for Tech Start-Ups across Asia and the Pacific," cloud services provide a cost-effective IT solution for startups by enabling access to advanced computing resources without this upfront capital expenditure.

The elasticity of cloud computing, underscored by "pay-as-you-go" and "pay-as-you-grow" operational strategies, improves a startup's ability to meet its growth demands. Further, reliable cloud infrastructure allows founders and startups to concentrate their efforts on areas of priority and focus less on the operations and maintenance of information and communications technology (ICT) infrastructure. This scalable nature of cloud computing provides a foundation for startups to grow and expand into new business areas and regions globally. The ADB noted that "the scalability of cloud services means that start-ups can be agile and responsive to better meet customer demands and market needs quickly and cost efficiently, which improves their responsiveness and reliability."[8]

Additionally, the ability of cloud infrastructure to provide backup systems in the case of unexpected disruptions, such as disasters triggered by natural hazards, significantly bolsters the resilience of startups. The ADB further concluded that "using cloud computing ensures that companies can ensure that business continuity plans are augmented with strong data storage."

> **"The scalability of cloud services means that start-ups can be agile and responsive to better meet customer demands and market needs quickly and cost efficiently, which improves their responsiveness and reliability."**
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> — **The Asian Development Bank,** "Cloud Computing as a Key Enabler for Tech Start-ups across Asia and the Pacific"

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[8] Thomas Abell, Husar Arndt, and May-Ann Lim. 2021. "Cloud Computing as a Key Enabler for Tech Startups across Asia and the Pacific." Asian Development Bank, 79.

Economic impact of cloud adoption in Singapore

Cloud adoption, by enhancing agility, innovation, scalability, and security, as well as reducing costs, will create ripple effects throughout the entire Singapore economy. This section summarizes the independent research study, "Economic Impact of Cloud Adoption in Asia-Pacific," commissioned by AWS and conducted by Telecom Advisory Services. Based on this study, the Asian Development Bank Institute (ADBI) published the policy brief "Cloud Computing Policies and Their Economic Impacts in Asia and the Pacific." The study measures the economic impact of cloud adoption in Asia-Pacific, including Singapore, encompassing AWS and other cloud service providers. Furthermore, it estimates the total contribution of cloud adoption relative to GDP as the sum of cloud spending in the country and the efficiency gains and economic growth enabled by cloud adoption, defined as the "spillover effects."

The study noted that Singapore has a high level of cloud adoption, including in the public sector, which has a cloud-first policy and as of 2022, had moved approximately 60% of eligible government systems onto the commercial cloud. As a result, the study found that cloud adoption in Singapore already generates a substantial contribution to the country's GDP. In 2023, **the total economic impact in Singapore from cloud adoption was calculated at 2.23% of Singapore's GDP**, amounting to **$13.8 billion of economic value**. Telecom Advisory Services further estimated that an **increase of 1% in cloud penetration in Singapore would yield an increase of 0.15% in GDP ($694 million)**, representing the highest elasticity of countries that were included in the study.

The report also stated the spillover effects of cloud adoption are expected to continue growing as the public and private sectors transition from low maturity levels of cloud usage, such as email and collaborative tools, to more sophisticated usage levels, for example artificial intelligence and machine learning. Research by Telecom Advisory Services suggests the existence of "return to scale" effects, where the marginal economic impact of cloud adoption is greater for countries with higher cloud adoption, and the productivity effect of firms achieving more advanced use of cloud applications is higher than those in lower maturity use cases.

"**After living and working in the U.S. for 14 years, I returned home in 2007. Since then, I've seen Singapore grow as a Smart Nation and tech hub. I've been with AWS for nearly 8 years now, and my job is to make sure that our infrastructure is ready to support our customers 24 hours per day, 7 seven days a week. That means I need to hire and develop the best possible team to work in our data centers. I'm proud to see so many Singaporeans raise the bar day after day.**"

— Simon Tan
Director of Data Center Operations, South ASEAN, AWS
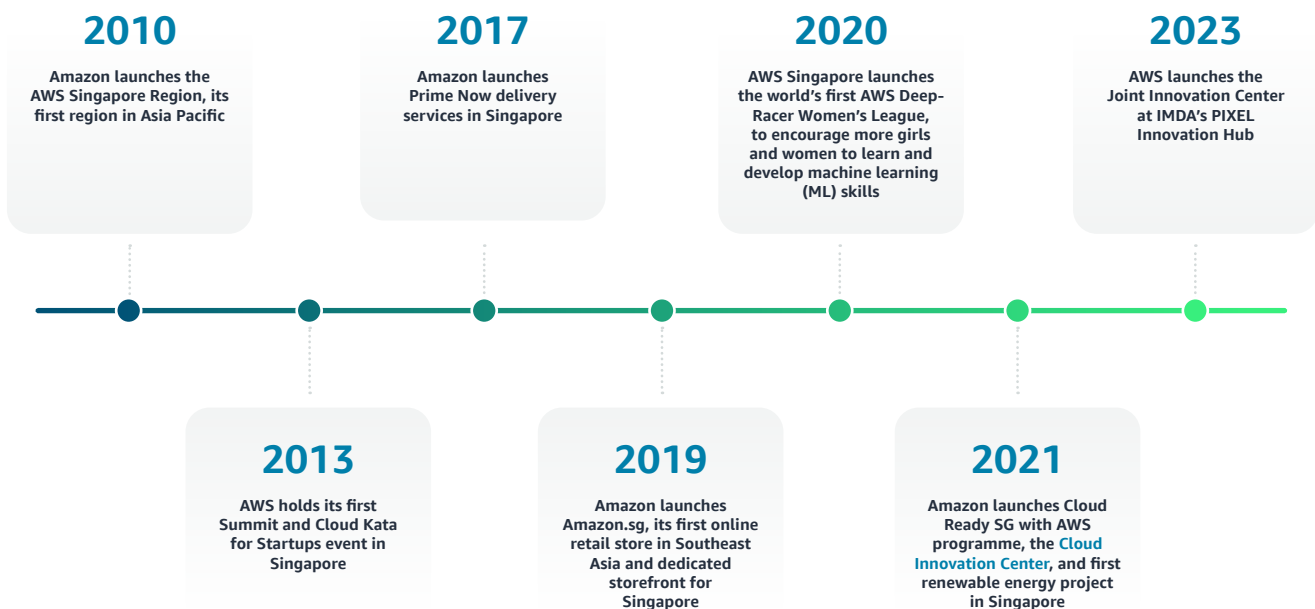
Economic Impact of AWS Investment in Singapore

What is AWS?

Since 2006, Amazon Web Services has been the world's most comprehensive and broadly adopted cloud. AWS has been continually expanding its services to support virtually any workload, and it now has more than 240 fully featured services for compute, storage, databases, networking, analytics, machine learning (ML) and artificial intelligence (AI), Internet of Things (IoT), mobile, security, hybrid, media, and application development, deployment, and management from 105 Availability Zones within 33 geographic regions, with announced plans for 18 more Availability Zones and six more AWS Regions, including in Malaysia, Mexico, New Zealand, the Kingdom of Saudi Arabia, Thailand, and the AWS European Sovereign Cloud. Millions of customers—including the fastest-growing startups, largest enterprises, and leading government agencies—trust AWS to power their infrastructure, become more agile, and lower costs.
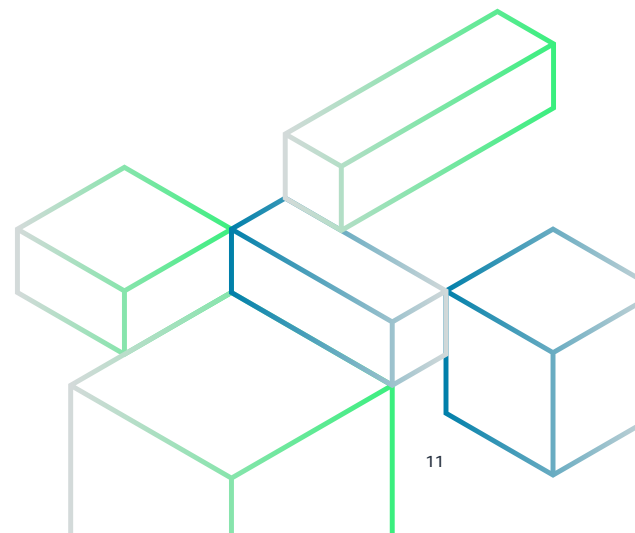
AWS offers the most proven operational expertise of any cloud service provider, including the most functionality, the most flexible and secure cloud computing environment, the fastest pace of innovation, and the largest community of customers and partners, including millions of active customers and more than 130,000 AWS Partners globally.

AWS in Singapore

Singapore is recognized as a highly digitally connected country with an internet penetration rate of 96%, according to the World Bank.[9] This high level of connectivity represents one of the critical technical prerequisites for cloud services. To meet high customer demand in Singapore and Asia, AWS launched the Asia Pacific (Singapore) Region in 2010, the first AWS Region in Asia. AWS infrastructure in Singapore also includes Amazon CloudFront edge locations. AWS's advanced capabilities are used by thousands of Singapore customers each month, accelerating innovation, increasing agility, and facilitating cost savings. Numerous Singapore public sector organizations rely on AWS to enable digital transformation, enhance citizen services, and scale their impact.

2010
Amazon launches the AWS Singapore Region, its first region in Asia Pacific

2017
Amazon launches Prime Now delivery services in Singapore

2020
AWS Singapore launches the world's first AWS Deep-Racer Women's League, to encourage more girls and women to learn and develop machine learning (ML) skills

2023
AWS launches the Joint Innovation Center at IMDA's PIXEL Innovation Hub

2013
AWS holds its first Summit and Cloud Kata for Startups event in Singapore

2019
Amazon launches Amazon.sg, its first online retail store in Southeast Asia and dedicated storefront for Singapore

2021
Amazon launches Cloud Ready SG with AWS programme, the Cloud Innovation Center, and first renewable energy project in Singapore

AWS Asia Pacific (Singapore) Region

An AWS Region refers to a geographical location around the world where we cluster data centers. We call each group of logical data centers an Availability Zone (AZ). Each AWS Region, including the Asia Pacific (Singapore) Region, has at least three isolated and physically separated AZs. Each AZ consists of one or more discrete data centers with redundant power, cooling, and physical security. AZs are physically separated by a meaningful distance to mitigate the impact of the most common disasters that could affect data centers, are connected by high-bandwidth, low-latency networking, over fully redundant, dedicated metro fiber, sufficient to accomplish synchronous replication between AZs. This unique design of AWS Regions and Availability Zones gives customers the ability to operate production applications and databases that are more highly available, fault tolerant, and scalable than would be possible from a single data center.

AWS's investment in establishing three Availability Zones in the Asia Pacific (Singapore) Region provides Singapore customers with enhanced resiliency and access to AWS technology.[10] Singapore customers use AWS to innovate, accelerate their businesses, and develop new activities, thus bolstering Singapore's economy.

The AWS Region in Singapore is used by large enterprises government agencies, academic institutions, SMEs, and startups, affirming AWS's commitment to support all industries in Singapore. AWS has corporate offices in Singapore, which are home to software developers, AI scientists, engineers, sales representatives, marketing teams, and business development professionals for our local customers and channel partners.

AWS locations in Singapore

Amazon offices: *SIN1 / SIN11 / SIN13 / SIN16*

AWS Region: *Asia Pacific (Singapore)*

AWS Direct Connect: *View locations*

AWS Edge Location: *View locations*

Regional edge caches: *View locations*

Renewable energy projects: *View locations*

[10] https://aws.amazon.com/about-aws/global-infrastructure/regions_az/

Economic impact of AWS investment in Singapore through 2028

AWS investments have a measurable economic impact in Singapore through the construction, connection, operation, and maintenance of AWS data centers. In Singapore, **AWS invested SG$11.5 billion (more than $8.5 billion) in the AWS Asia Pacific (Singapore) Region through 2023, and plans to invest an additional SG$12 billion ($9 billion) in the Asia Pacific (Singapore) Region from 2024 through 2028**. The investment includes all expenses directly attributable to the AWS Asia Pacific (Singapore) Region, including imports of highly specialized and proprietary equipment and software, as well as in-country spending.

AWS is committed to a progressive expansion of the local infrastructure and development of corporate operations to meet the projected demand for AWS technology in Singapore and across Asia-Pacific. Local spending in Singapore encompasses both capital expenditures as well as recurring operating expenditures, such as compensation for Amazon employees and contractors in Singapore.

This study estimates that the planned investment associated with the AWS Asia Pacific (Singapore) Region **contributed SG$18.3 billion ($13.6 billion) to Singapore's total GDP through 2023 and will contribute SG$23.7 billion ($17.6 billion) to Singapore's total GDP from 2024 through 2028**. These estimates are derived from internal data, the input-output (I-O) model,[11] and statistical data provided by the OECD and the Singapore Ministry of Manpower (MOM). The GDP contribution by the AWS Asia Pacific (Singapore) Region reflects the value added by AWS to the IT sector in Singapore, as well as the direct, indirect, and induced effects of AWS purchases from the Singapore data center supply chain.

This study estimates that the in-country portion of AWS investment **supported an annual average of more than 4,800 FTE jobs at local businesses in Singapore through 2023**, which includes:
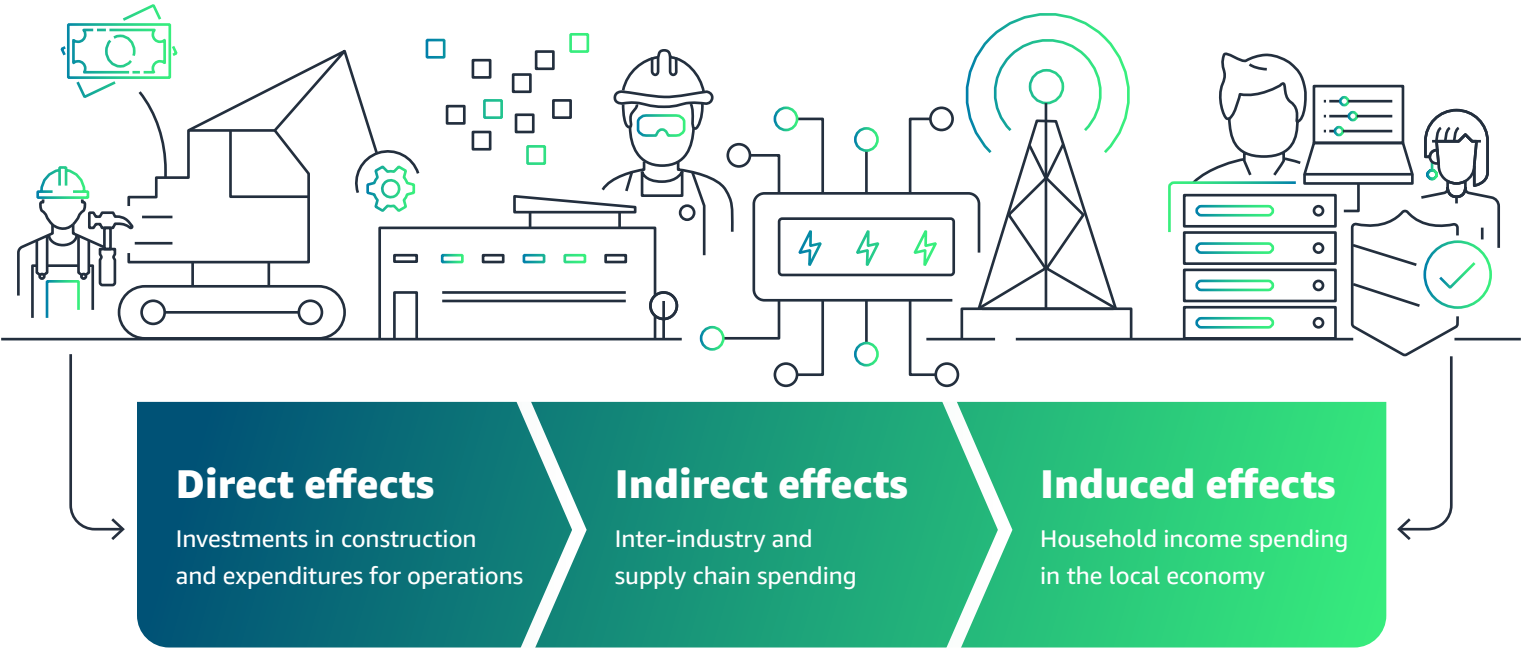
- **More than 2,200 jobs annually supported by the direct effects**—These jobs exist within AWS suppliers, which tend to be local businesses that are directly supported by AWS investment. These jobs are generally in industries such as non-residential construction, facilities maintenance, electricity generation, and telecommunications.

- **More than 1,400 jobs annually supported by the indirect effects**—These jobs reside in the AWS supply chain that are indirectly supported by business-to-business transactions resulting from AWS investment. This includes jobs that supply the skilled labor and services needed to fulfill work for AWS, which means they are likely to be local to Singapore, as well.

- **More than 1,200 jobs annually supported by the induced effects**—These are jobs in the broader Singapore economy supported by the household consumption of workers receiving compensation from AWS and the AWS supply chain. This includes jobs in industries that supply consumer goods and services to Singapore households.

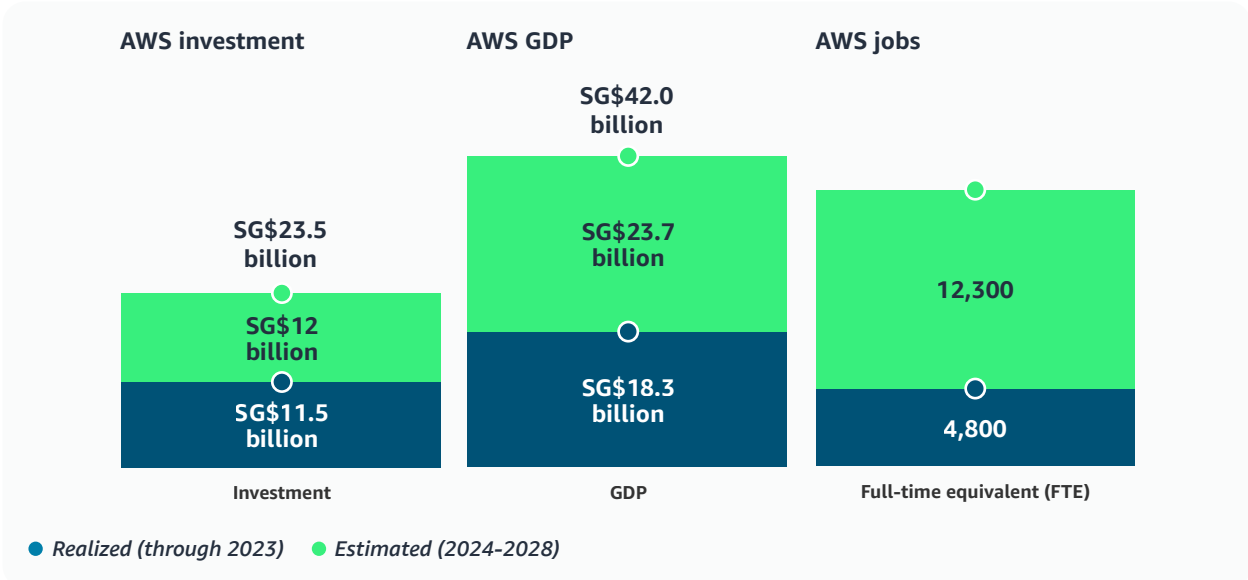[11] Refer to the section titled "EIS Methodology" for further detail.

This study estimates that the in-country portion of AWS investment **will support an annual average of more than 12,300 FTE jobs at local businesses in Singapore from 2024 through 2028**, which includes:

- More than **5,800 jobs** annually supported by **the direct effects**
- More than **3,400 jobs** annually supported by **the indirect effects**
- More than **3,100 jobs** annually supported by **the induced effects**

The illustration presents a conceptual breakdown of the supply chain impacts segmented into direct, indirect, and induced effects.

Direct effects
Investments in construction and expenditures for operations

Indirect effects
Inter-industry and supply chain spending

Induced effects
Household income spending in the local economy

Economic impact of AWS investment in Singapore

AWS investment

SG$23.5 billion

SG$12 billion

SG$11.5 billion

Investment

AWS GDP

SG$42.0 billion

SG$23.7 billion

SG$18.3 billion

GDP

AWS jobs

12,300

4,800

Full-time equivalent (FTE)

● *Realized (through 2023)* ● *Estimated (2024-2028)*

Empowering Public and Private Sector Digital Transformation

Supporting AWS customers with AWS technology

Each month, thousands of Singapore customers use AWS services to accelerate their digital transformation. Through the ripple effect created by AWS investment in the AWS Asia Pacific (Singapore) Region, customers have been able to become more agile, increase security, reduce their IT operating costs, scale their businesses globally, and advance innovation through AWS.

AWS is especially proud to observe Singapore organizations—including the fastest-growing startups, largest enterprises, and leading government agencies—use AWS to power their digital transformation and scale their impact to support citizens and customers.
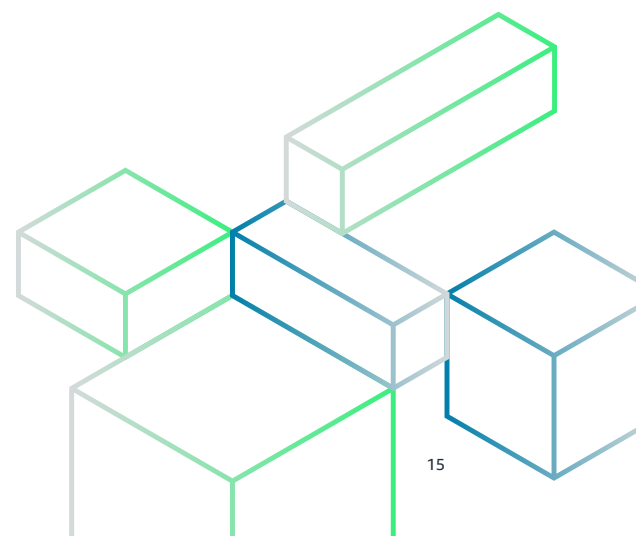
Public sector

In Singapore, and around the world, government, education, health care, and nonprofit organizations face unique challenges to accomplish complex missions with limited resources. Public sector leaders rely on the power and speed of AWS to serve citizens more effectively, accelerate innovation and digital transformation, and dedicate more of their time and resources to their core missions.

- The Singapore Government's **Smart Nation Group** (SNG) spearheads Singapore's digital government transformation and development of the public sector's engineering capabilities. SNG was the first customer to deploy AWS Dedicated Local Zones.

> "AWS is a strategic partner and has been since the beginning of our cloud journey. SNG collaborated with AWS to define and build Dedicated Local Zones to help us meet our stringent data isolation and security requirements, enabling Singapore to run more sensitive workloads in the cloud securely. In addition to helping the Singapore Government meet its cybersecurity requirements, the Dedicated Local Zones enable us to offer its agencies a seamless and consistent cloud experience."
>
> **— Chan Cheow Hoe**
> Government Chief Digital Technology Officer of Singapore

- **GovTech** is a statutory board of the Government of Singapore responsible for the delivery of digital services to the public. In 2021, GovTech launched **GovWallet**, a digital wallet for Singaporeans to securely receive payouts from various government agencies. Through this platform, citizens can use their digital wallets to shop at more than 164,000 merchants that have the Singapore Quick Response Code (SGQR) with PayNow and more than 43,000 merchants that have NETS QR across Singapore. GovWallet is fully built and deployed on AWS. In November 2021, within the first nine months of its launch, GovWallet facilitated more than 1 million disbursement transactions and about 900,000 payment transactions totaling more than SG$41 million.

> "Our team's initial target was to digitize government payout schemes for at least 50,000 recipients across three agencies by the end of 2021. The speed of innovation afforded by AWS has helped us exceed that goal, and we now have eight government payout schemes and more than 1 million users on our platform. This is a major milestone for Singapore's Smart Nation Initiative."
>
> **— Patricia Zhao**
> Deputy Director at GovTech

"I studied Computer Science at NUS, and I've been with AWS in Singapore since 2010. Currently, I lead a diverse global team that includes both tech and non-tech talent. I love how diverse they are—altogether, my team speaks more than 30 languages. But most of all, I'm happy to have hired many other Singaporeans from all walks of life, offering them the opportunity to build the future one innovative product, service, and idea at a time."

— Livian Soo
Director, Global Demand and Solutions Center, AWS

- Another of **GovTech's** Smart Nation initiatives using AWS Cloud is the implementation of Singapore's National Digital Identity (NDI), a platform that brings various digital initiatives like Singpass Mobile, MyInfo, and MyInfo Business together to provide greater online convenience and transactional security for citizens and businesses. With AWS, GovTech successfully leveraged cloud technologies to deliver a citizen-centric digital identity system that consistently brings benefits to the lives of Singapore residents via NDI, which allows Singaporeans to use secure, password-less credentials to carry out transactions in both public and private sectors. The NDI platform uses AWS security measures and tools like AWS Key Management Service (KMS), and is architected across three Availability Zones in the AWS Asia Pacific (Singapore) Region for high resilience and fault tolerance.

- Singapore's **National University Health System** (NUHS), one of three public health care clusters in Singapore, is working with AWS to test the use of Amazon Bedrock to build a generative AI solution to automate the creation of patient discharge summaries that document a patient's stay in a health care facility, as well as their diagnosis, treatment, and follow-up care instructions.

"Documentation is a particularly time-consuming effort for health care professionals, and automating this process will enable our clinicians to focus on their consultation with patients."

— Associate Professor Ngiam Kee Yuan
Group Chief Technology Officer of NUHS

Financial institutions

AWS is a pioneer at the intersection of financial services and technology, enabling our customers to optimize operations and accelerate innovation through the broadest set of services and partner solutions—all while adapting to ever-changing regulations. Thousands of financial services firms, from the fastest-growing fintechs to systemically important financial institutions, are redefining their future on AWS, including DBS Bank, DirectAsia Insurance, SC Ventures, and Singapore Exchange.

- **Banking Computer Services** (BCS), a subsidiary of NETS Group, manages and operates the national clearing and payment infrastructure in Singapore. BCS worked with AWS to introduce a cloud-based solution to digital cross-border payments between Singapore and India, driving innovation, cost reduction, and community effectiveness. This linkage between Singapore's PayNow and India's Unified Payments Interface (UPI), launched by both countries' prime ministers and central banks, enables real-time fund transfers using mobile phone numbers, UPI identities, or virtual payment addresses. It is the world's first real-time payment system to use scalable cloud-based infrastructure. BCS aims to extend its cross-border payment services beyond peer-to-peer transactions, venturing into consumer-to-business and business-to-business payments, and to launch linkages with Malaysia and five ASEAN countries, enhancing regional financial connectivity.

   Ricky Lim, CEO of BCS, emphasized that the collaboration with AWS has allowed BCS to harness cloud technologies to enhance the scalability, resilience, and innovation of its real-time payment solutions.

- **Singlife**, a homegrown financial services company, has exited its on-premises data centers and migrated its entire IT infrastructure to AWS. This enhances Singlife's digital capabilities, enabling the company to more efficiently meet growing consumer demands for hyper-personalized digital financial services, while also supporting Singlife's environmental, social, and corporate governance (ESG) objectives.

   > "Digitization is no longer a good-to-have but a must-have. Our cloud-first strategy with AWS allows us to stay true to our digital-first heritage, enabling us to harness the full potential of technology to benefit our consumers. With our upgraded data analytic capabilities, we are now uniquely positioned to provide consumers with hyper-personalized experiences, helping them achieve financial freedom confidently on their own terms."
   >
   > **— Romil Sharma**
   > Group Head of Technology and Operations

- **Trust Bank** is Singapore's first digitally native bank, backed by a partnership between Standard Chartered Bank and FairPrice Group. Trust Bank needed a highly scalable, agile environment that could easily manage large volumes of new consumers and rapidly iterate to provide a seamless and engaging user experience. Built on AWS, Trust Bank has the agility to rapidly improve its offerings based on customer feedback and the scalability to support its fast-growing customer base.

> "Trust aims to provide an easy-to-use, rewarding, and transparent banking experience that brings real value to our customers. In the cloud, we can scale easily to onboard high numbers of new accounts, and using AWS, we can also rapidly take action on customer feedback, which is crucial for a fast-growing, modern, digitally native bank."
>
> **— Rajay Rai**
> Chief Information Officer at Trust Bank

Digitally native businesses and startups

Digitally native businesses, including startups, online businesses, and software-as-a-service (SaaS) providers, are launching and scaling global businesses on AWS. From inception to maturity, home-grown unicorns and fast-growing startups across every industry—like M-DAQ and NIUM in fintech, Allozymes and FathomX in health care and life sciences, and ADDX, BTSE, and Coda Payments in web3 and crypto—are leveraging AWS's comprehensive services to offer new products, technologies, and services. In the age of generative AI, AWS is also supporting emerging startups like ByteGenie, Pebblely, and Quickads.ai to experiment with applying AI to a wide range of use cases, including advertising, image generation, security and monitoring, and SaaS solutions.

- **Endowus**, founded in 2017 and headquartered in Singapore, is the first and largest digital advisor in the region, spanning both private wealth (cash) and public pension savings (the Central Provident Fund [CPF] and Supplementary Retirement Scheme [SRS] in Singapore), helping investors grow their total digital wealth. As its business continued to experience explosive growth in revenue since its inception, Endowus needed technology infrastructure that would be scalable, cost-effective, and secure. Since Endowus migrated to AWS, it has leveraged the flexibility and scalability of AWS Cloud to support its expansion into new geographies, including in Hong Kong. Endowus was able to build an entire cloud environment for its Hong Kong business from scratch in three months, enabling its engineering teams to meet an aggressive business launch timeline of six months. This includes all preproduction environments as well as infrastructure such as code pipelines, application deployment pipelines, security controls and guardrails, and observability services. Endowus is also engaging AWS to build a secure and scalable data lake architecture with Amazon Athena to solve business analytics and operational needs.

- **Kabam Robotics** is a startup based in Singapore, specializing in advanced robotics and connectivity solutions for commercial security, facility management, and hospitality sectors worldwide. With the support of AWS Activate—a flagship global program that provides startups with AWS credits, resources, and expert guidance—Kabam Robotics developed Smart+, a cloud-based platform for managing robots. Kabam's REMI system seamlessly integrates the Claude 2 Large Language Model (LLM) from AWS Partner Anthropic, using the Amazon Bedrock API. This integration enhances the capabilities of Kabam's robots, enabling them to understand and interact with humans using natural speech and emails and to navigate diverse environments. With Amazon SageMaker, Kabam Robotics streamlined the deployment process of an open-source LLM on the cloud, reducing costs by 90% compared to maintaining proprietary hardware. As a result of these advancements, Kabam's robots can be seen at iconic sites in Singapore including Gardens by the Bay, the Fullerton Hotel, and Singapore Changi Airport. These deployments serve as positive demonstrations of the robots' ability to provide concierge services and interact effectively with customers.

- **Razer**, the world's leading lifestyle brand for gamers, aims to enhance engagement with its expanding community of gamers by offering personalized hardware recommendations tailored to various applications and data domains. The company was keen to test the possibilities of machine learning. However, as a small team, it posed a challenge when it needed to maintain the infrastructure that supports and scales the appropriate resources for training and inferencing a recommendation model, all while being accurate and applicable across multiple business domains. Razer turned to AWS for a solution and leveraged Amazon Personalize for intelligent user segmentation and advanced filtering features.

> "Implementing personalized recommendations in Razer Synapse has enabled us to see a click-through-rate 10 times better than industry standards, generating additional revenue for the business. Leveraging ML and Amazon Personalize made it easier and more convenient for us to maintain a personalization system."
>
> — **Hong Jie Wee**
> Big Data Lead at Razer

"I came from a non-tech background, but I've deeply enjoyed working at AWS. Since I first joined the company in 2017, I've worked in three different roles—right now, I collaborate with systems integrators and managed service providers across Asia-Pacific and Japan. I'm proud to have supported so many customers in their cloud adoption journey, and helped them build scalable solutions for citizens and communities."

— **Nadia Roslee**
Partner Programs Manager,
Worldwide Public Sector, AWS

- **Terrascope** is a decarbonization SaaS solution that helps companies build a pathway to net zero. With a focus on food and agriculture value chains and all sectors influenced by land use and management, Terrascope combines data science, AI, and machine learning to address the data, planning, and implementation challenges large enterprises face in decarbonizing their business operations and supply chains. Terrascope's enterprise-grade, end-to-end decarbonization is powered by AWS and equips enterprises with essential data, analytics, and reduction planning tools to measure and reduce carbon emissions, particularly Scope 3. Terrascope also signed The Climate Pledge, co-founded by Amazon with Global Optimism, cementing its commitment to reduce its carbon emissions to net-zero carbon by 2040.

- **Unravel Carbon** built an AI-powered decarbonization platform that helps enterprises to measure, track, reduce, and report their carbon emissions on AWS. Launched on AWS from Day 1, Unravel Carbon has leveraged AWS's highly cost-efficient, agile, and scalable infrastructure to drive innovation in carbon management. Even successful digital businesses can find it challenging to expand internationally, but AWS helps startups unlock new routes to grow and scale globally through the AWS Marketplace and the AWS Partner Network. This has enabled Unravel Carbon to scale beyond its Singapore headquarters to become a global leader in carbon management solutions, serving global brands like AIA, SATS, Global Fashion Group, and Interplex.

Local enterprises

AWS is democratizing access to technology for Singapore businesses to gain savings, security, scalability, and simplicity through delivering custom-built solutions, our dedicated partner community, our world-class infrastructure, and programs like AWS Lift. Digitalization of Singapore businesses also drives industry transformation, helping companies like Castlery to accelerate their growth, deploy globally in minutes, and deliver greater value for consumers.

- **Arth Design Build**, a digital technology partner in the construction industry, was looking to develop new prototypes but faced budget constraints. Through the AWS Lift program, Arth received AWS credits to enhance its offerings without concern relating to IT costs. Arth worked with AWS Partners IBM and Ingram Micro to reduce product development time from 8 weeks to 3 weeks, minimize asset maintenance costs up to 20% for their customers, digitize workflow of business processes and inventory usage, and improve user experience, driving increased adoption and revenue.

- **Hit Refresh**, a Singapore-based robotics and automation specialist for the food & beverage industry, has developed a fully automated fresh food kiosk to offer healthy and affordable food options. To facilitate technology that enables it to keep ingredients fresh at all times as well as offer a first-rate consumer UX/UI, Hit Refresh chose AWS to implement AWS IoT solutions, which easily and securely connect devices to the cloud. Using AWS credits from the AWS Lift program to offset its bill, Hit Refresh was able to quickly start experimenting with AWS IoT solutions to improve location tracking and monitoring food temperatures through cloud-enabled sensors. This has allowed the company to begin scaling in Singapore, and soon internationally.

- **Spa Esprit Group** is a lifestyle group that runs food and beverage companies like Tiong Bahru Bakery and Common Man Coffee Roasters, and beauty concepts like STRIP and Browhaus. Spa Esprit started migrating its file servers from on-premise to the cloud in 2018 and now runs the majority of its systems on AWS. By migrating to AWS, Spa Esprit can operate a more cost-efficient IT structure with the flexibility to scale based on overall demand. Spa Esprit has been able to speed up its point-of-sale system to serve customers faster and improve the overall customer experience.
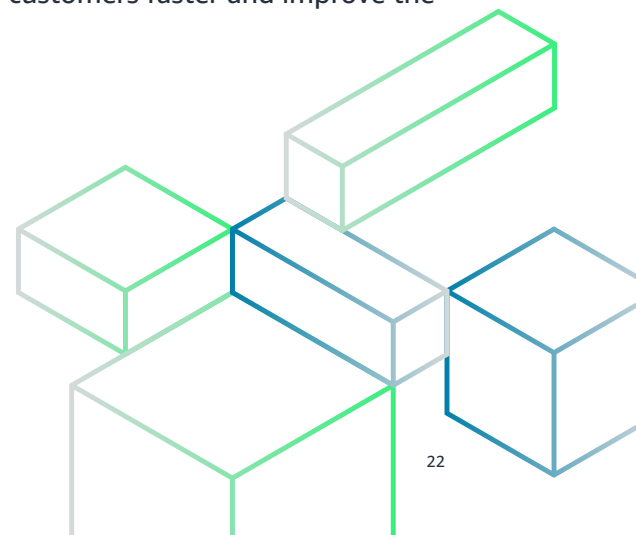
Supporting the AWS Partner Network

The AWS Partner Network (APN) is a global community that leverages AWS technologies, programs, expertise, and tools to build solutions and services for customers. The APN has more than 130,000 partners globally, with almost 70% headquartered outside of the United States. It provides partners with access to a dedicated portal, business and technical support, training, and benefits. Upon joining the APN, AWS Partners can enroll in the AWS Partner Path that best aligns with their organization to validate their offerings and demonstrate their AWS expertise. AWS has a vibrant APN in Singapore, which helps locally owned businesses build innovative solutions and services and enables enterprise and public sector customers to migrate to AWS, deploy mission-critical applications, and provide a full range of monitoring, automation, and management services for customers' environments.

- **Cloud Kinetics** is a leading cloud transformation and managed services partner with deep and extensive hybrid cloud, multi-cloud, application, and data expertise, headquartered in Asia-Pacific. Through cloud-powered innovation, Cloud Kinetics has enabled customers across diverse sectors such as banking and financial services, retail, manufacturing and logistics, and media and entertainment to scale rapidly and solve complex business challenges. As an AWS Premier Partner, Cloud Kinetics has supported major cloud transformation initiatives by leveraging the latest AWS cloud-enabled technologies like AWS Landing Zone, disaster recovery solutions such as AWS Elastic Disaster Recovery (AWS DRS), and observability tools including Amazon CloudWatch, Amazon Managed Grafana, and Amazon Managed Service for Prometheus.

  By leveraging AWS, Cloud Kinetics supported a global solar panel design and manufacturing company, which faced frequent downtime challenges and extended recovery durations with its data center in Singapore. Facilitating a seamless migration of on-premise applications like enterprise resource planning and service-oriented architecture to AWS, Cloud Kinetics was able to support the customer to identify gaps and implement best practices for security, reliability, performance, cost optimization, and operational excellence. The approach resulted in a 20% reduction in application response times by optimizing resource configurations based on the AWS Well-Architected Framework's performance pillar. By using AWS, the customer achieved cost savings of up to 18%. Cloud Kinetics and AWS partnered with the customer to resolve critical operational issues and achieve enhanced agility to rapidly develop solar advancements for residential and commercial customers in more than 100 countries worldwide. This resulted in significant improvement in its speed to market, positioning the customer at the forefront of innovation in solar technology.

Cloud Kinetics also leverages AWS Marketplace to expand its local footprint regionally and globally, including in Australia, Thailand, and the United States. Being part of the AWS Partner Network has helped enable Cloud Kinetics to grow its business significantly in new geographies and achieve triple-digit, year-over-year growth in its professional services revenue throughout the past three years.

- **NCS**, a leading technology services firm with a presence in Asia-Pacific, collaborates with governments and enterprises to advance communities through technology. As an AWS Advanced-Tier Consulting Partner, NCS has implemented major cloud transformation initiatives across the region while leveraging the latest AWS cloud-enabled technologies like generative AI.

  NCS partnered with AWS to develop and pilot an innovative AI solution for the Singapore Ministry of Manpower's (MOM) Contact Centre, which serves as an intelligent assistant for MOM's Contact Center agents, simplifying their task of responding to public queries and enhancing their ability to manage high call volumes efficiently. Powered by Amazon Bedrock and NCS Ins8.ai, the solution provides a real-time speech-to-text transcription tailored to the diverse accents across Singapore and the broader Asia region. The generative AI-powered contact center is one of many innovative solutions that NCS has developed leveraging AWS technologies, which enable governments and enterprises to better serve citizens and customers, optimize organizational efficiency, and increase productivity.

"I graduated from SMU and first joined Amazon as a software engineer in 2016, working in our Seattle HQ. I moved back to Singapore in 2022 for my child's education, and Amazon could not have been more supportive. I'm glad to be back home contributing as a senior software engineer and working on innovative projects while guiding other young technologists on my team."

— **Peh Jun Hao,**
Senior Software Engineer, AWS

AI Singapore brings inclusive generative AI models to Southeast Asia with AWS

In Amazon CTO Werner Vogels' technology predictions for 2024, he envisions a near future where generative AI becomes more culturally aware. This involves training large language models (LLMs), a type of AI algorithm, on a diverse range of data, leading to more nuanced and accurate results. The goal is to make generative AI more accessible and useful to individuals worldwide.

However, LLMs rely on data from the internet, which is mostly associated with high-resource languages. This term typically refers to languages, such as English, that have an abundance of linguistic resources available for natural language processing (NLP) tasks. It is critical that organizations gain the ability to easily customize their LLMs with local data in their native languages to foster social inclusion, stimulate economic growth by opening up new markets, and create improved citizen experiences. Culture influences everything.

Recognizing this, AI Singapore (AISG), a national program launched by Singapore's National Research Foundation to enhance the country's AI capabilities, is making its LLMs more culturally accurate, localized, and tailored to Southeast Asia. Building on AWS's scalable compute infrastructure, AISG developed SEA-LION, a family of LLMs that is specifically pre-trained and instruct-tuned (a powerful fine-tuning method that allows for greater control over LLM behavior) for Southeast Asian languages and cultures.

A first for the region, SEA-LION also serves as the foundation for Singapore's National Multimodal LLM Programme, contributing to the island's capabilities in AI research and innovation. This initiative aligns with the National AI Strategy 2.0 that outlines plans to expand the use of AI in Singapore. The model will focus on more commonly spoken languages in Southeast Asia, including Bahasa Indonesia, Bahasa Melayu, Thai, and Vietnamese, and will eventually be extended to include other Southeast Asian languages like Burmese and Lao. SEA-LION is available on Amazon SageMaker JumpStart, which provides pre-trained, publicly available models to help customers globally get started with machine learning.

> "Building an LLM requires reliable cloud infrastructure that is readily available exactly when needed, and AWS is instrumental in helping us scale cost-effectively. We built a 3 billion parameter LLM in just three months with AWS, and we have since scaled the model to 7 billion parameters, extending its reach to more audiences. By working with AWS, we can focus solely on training our models instead of managing infrastructure. This accelerates the development of unique LLMs that reflect our region's diversity."
>
> **— Dr. Leslie Teo**
> Senior Director of AI Products at AISG

Training and Workforce Development in Singapore

At AWS, we believe the future prosperity of Singapore is tied to its digitally skilled workforce. Digital technology plays a vital role in driving innovation, growth, and productivity, while promoting resilience and agility to pivot quickly to improve operations. Singapore's leadership in the global digital economy will depend on building and maintaining a robust workforce of skilled technology professionals and workers, encompassing digital and technology skills across a range of job functions and industries, to support the pace of innovation in Singapore.

Research indicates the importance of upskilling a digital workforce for the growth of the Singapore economy. A study conducted in partnership with Access Partnership, titled "Accelerating AI Skills: Preparing the Asia-Pacific Workforce for Jobs of the Future," found that when artificial intelligence (AI) is fully harnessed, Singapore workers with AI skills and expertise could receive salary increases of more than 25%. Furthermore, 94% of employers envision their companies becoming AI-driven organizations by 2028, and eight in ten Singapore employers prioritize the recruitment of AI-skilled talent. However, the challenge remains that 74% encounter difficulties finding the needed AI expertise. This underlines both the demand and the significant opportunity to enhance advanced cloud computing and AI skills in Singapore.

In November 2023, AWS launched the Amazon AI Ready skills initiative, offering a suite of complimentary AI and generative AI courses available to all individuals eager to learn skills relevant to in-demand jobs.

AWS workforce development and training programs in Singapore

Since 2017, AWS has trained more than 400,000 individuals in Singapore in cloud skills. In collaboration with the Singapore government, AWS has developed a national workforce development program titled Cloud Ready SG with AWS, a holistic digital and cloud technology skilling program curated for Singapore learners across segments. From new graduates and early career workers to mid-career professionals, AWS is working to drive inclusive growth in training the current and future workforce in Singapore.

- **AWS Training and Certification** equips individuals and teams with the skills to use AWS to innovate in the digital world. Since establishing local training operations in Singapore, AWS Training and Certification has delivered training and certification programs to individual learners, customers, and AWS Partners to rapidly build cloud skills and close the skills gap. With programs designed by AWS experts, learners at all levels can build with confidence, enabling leaders to drive transformation and deliver results in their organizations.

I. AWS upskills the existing workforce at scale through programs such as AWS Skills Builder and AWS Skills Guild, where employers collaborate with AWS to train their workforce in new cloud skills.

- **AWS Skill Builder** is a digital learning experience available in more than 200 countries and territories. It provides free skills training to millions of people around the world. Any individual with an internet connection and a desire to learn can quickly and easily access more than 600 free on-demand courses. AWS also offers live, classroom-based training (delivered virtually or in-person) taught by AWS experts using presentations, discussions, and hands-on labs. AWS Skill Builder subscriptions give registered individuals and organizations access to exclusive learning materials built by builders for builders. In addition to more than 500 free courses, AWS has also curated new learning experiences, such as **AWS Builder Labs**, which provides more than 100 hands-on guided exercises to develop practical skills for common cloud scenarios. These experiences help customers develop practical skills to help solve real-world problems.

DPM Heng Swee Keat with a group of Amazonians and Singapore learners, including primary school students and mid-career professionals, who have advanced their cloud skills and careers with AWS.

- **AWS Skills Guild** is a comprehensive enablement program that helps large enterprises with their transformational objectives, both technical and cultural, by building cloud fluency across the business, including at the executive level, driving collaboration and partnership with technologists and accelerating AWS adoption.

II. AWS builds a diverse talent pool through custom programs supported by the government and industry.

- **AWS re/Start** is a free full-time, classroom-based skills development and training program that prepares individuals for careers in the cloud and connects them to potential employers. The program aims to build local talent and is designed for unemployed and underemployed individuals, with no technical experience required to apply. In 2022, AWS collaborated with Lithan Academy, NTUC Employment and Employability Institute (e2i), and the Tech Talent Assembly to launch AWS re/Start in Singapore, offering a full-time, 12-week training focused on AWS fundamentals, and practical, professional skills. Learners undergo scenario-based training, hands-on labs, and coursework to gain required skills for entry-level cloud roles. Participants also receive resume and interview coaching to help them prepare for meetings with potential employers.

III. AWS nurtures the diverse talent pool of the future through its education programs.

- **AWS Academy** empowers higher education institutions to prepare students for careers in the cloud by providing a free, ready-to-teach cloud computing curriculum. The curriculum prepares students to pursue industry-recognized certifications and in-demand cloud jobs. AWS Academy helps educators stay at the forefront of AWS innovation so they can equip students with the skills they need to get hired in one of the fastest-growing industries. AWS Academy courses include AWS Academy Cloud Foundations, AWS Academy Cloud Architecting, AWS Academy Machine Learning, and AWS Academy Data Analytics. In Singapore, there are currently 21 AWS Academy program members, which include the Institute of Technical Education (ITE), all five local polytechnics, Nanyang Technological University (NTU), National University of Singapore (NUS), and Singapore Management University (SMU).

Higher education institutions in Singapore play a key role in preparing students for the workplace of the future. Ngee Ann Polytechnic is working with Singapore's Infocomm Media Development Authority as a Training Partner to reskill approximately 18,000 people in tech roles over the next three years.

In January, Ngee Ann Polytechnic unveiled its Gen.AI Hub, established with AWS, to help students explore the possibilities of generative AI, learn critical AI and cloud computing skills, and showcase their AI innovations. There, students can experience first-hand generative AI tools like Amazon Bedrock, a fully managed service that offers organizations a choice of high-performing foundation models, along with a broad set of capabilities needed to build generative AI applications with security and privacy based on responsible AI principles.

> "In Singapore, there is an increasing skills gap in artificial intelligence skills. AI-skilled talent is a priority for employers, but they are unable to meet the need for talent. As businesses accelerate transformation with artificial intelligence, education institutions are critical to ensure that today's learners are equipped with skillsets for the workplace of the future. At Ngee Ann Polytechnic, we work with industry leaders like AWS to help students learn critical skills through specialized courses like the Diploma in Data Science and Specialist Diploma in Applied Generative AI. We have also established a Gen AI Hub, which allows students to use services like Amazon Bedrock to explore the possibilities that emerging technologies bring."
>
> **— Patrice Choong**
> Senior Director (Technology, Innovation, and Entrepreneurship),
> Ngee Ann Polytechnic

In 2023, AWS also collaborated with the SMU Academy and SkillsFuture Singapore to launch a new SkillsFuture Career Transition Program. The program aims to offer training to 100 mid-career professionals to support their transition into software development careers over two years.

- **AWS Educate** offers free, self-paced digital training to individual learners who are self-motivated to learn about the cloud. Through AWS Educate, students as young as 13 years old can access hundreds of hours of training and resources curated specifically for new-to-the-cloud learners. Training content is organized into six groups, including Most Popular Courses and Labs, Cloud Skill Basics, Cloud Skill Advanced, Prepare for Workplaces, Learn on Twitch, and Young Learner. AWS Educate also offers free hands-on labs to learn, practice, and evaluate cloud skills in the AWS Management Console.

AWS Cloud Innovation Centre

In 2021, AWS launched the AWS Singapore Cloud Innovation Centre (CIC), which is a first in ASEAN. The CIC is an innovation network consisting of AWS Singapore and our co-innovation partner labs. This forms a collection of innovation resources that AWS has established to collaborate with nonprofits, education institutions, and government agencies on their most pressing challenges, test new ideas with Amazon's innovation process, and provide access to its technology expertise.

Since its launch, the AWS Singapore CIC has launched co-innovation labs with NCS Pte Ltd and Synapxe.

AWS-IMDA Joint Innovation Center @ PIXEL

- To incubate promising new startups, and support enterprises and public sector agencies to accelerate industry innovation by leveraging technologies such as the cloud, AWS collaborated with the Singapore government's Infocomm Media Development Authority (IMDA) to launch a Joint Innovation Center (JIC) in Singapore, located at IMDA's PIXEL Innovation Hub. An extension of the AWS Singapore CIC and IMDA's PIXEL and Open Innovation Platform (OIP) initiatives, the AWS-IMDA JIC @ PIXEL serves as an innovation hub for enterprises, startups, and governments in Singapore and Southeast Asia and provides Singapore-based technology companies with access to the latest AWS technologies and resources to create and scale innovative solutions.

   AWS-IMDA JIC provides dedicated support to IMDA Accredited and IMDA Spark companies by providing direct connections to AWS's customers and partners across all sectors, including enterprises and public sector agencies in government, education, and health care. The AWS-IMDA JIC also showcases AWS Partners' technology, facilitates business activities like meetings, workshops, and training sessions, and makes available PIXEL facilities like specialized labs and equipment to JIC participants, AWS, and the OIP.

   Since the launch of the JIC, AWS and IMDA have hosted delegations from global governments and trade missions, universities and think tanks, and startups and established enterprises. This initiative helps to nurture Singapore's burgeoning tech space by promoting cloud technology across industries, enabling local startups to scale their marketing in a low-cost and effective manner.

"IMDA is excited to collaborate with AWS to set up its first JIC in Southeast Asia at IMDA PIXEL, which will serve as a strong platform for startups, enterprises, and governments to innovate digitally. We are delighted that IMDA is recognized as a key community enabler within Singapore and the region, and PIXEL as an innovation hub for all types of partners to connect and build world-class products for global markets. We look forward to bringing AWS's resources and networks to our Singapore-based companies under our IMDA Accreditation and IMDA Spark programmes to further accelerate their growth."

— Justin Ang
Assistant Chief Executive, IMDA
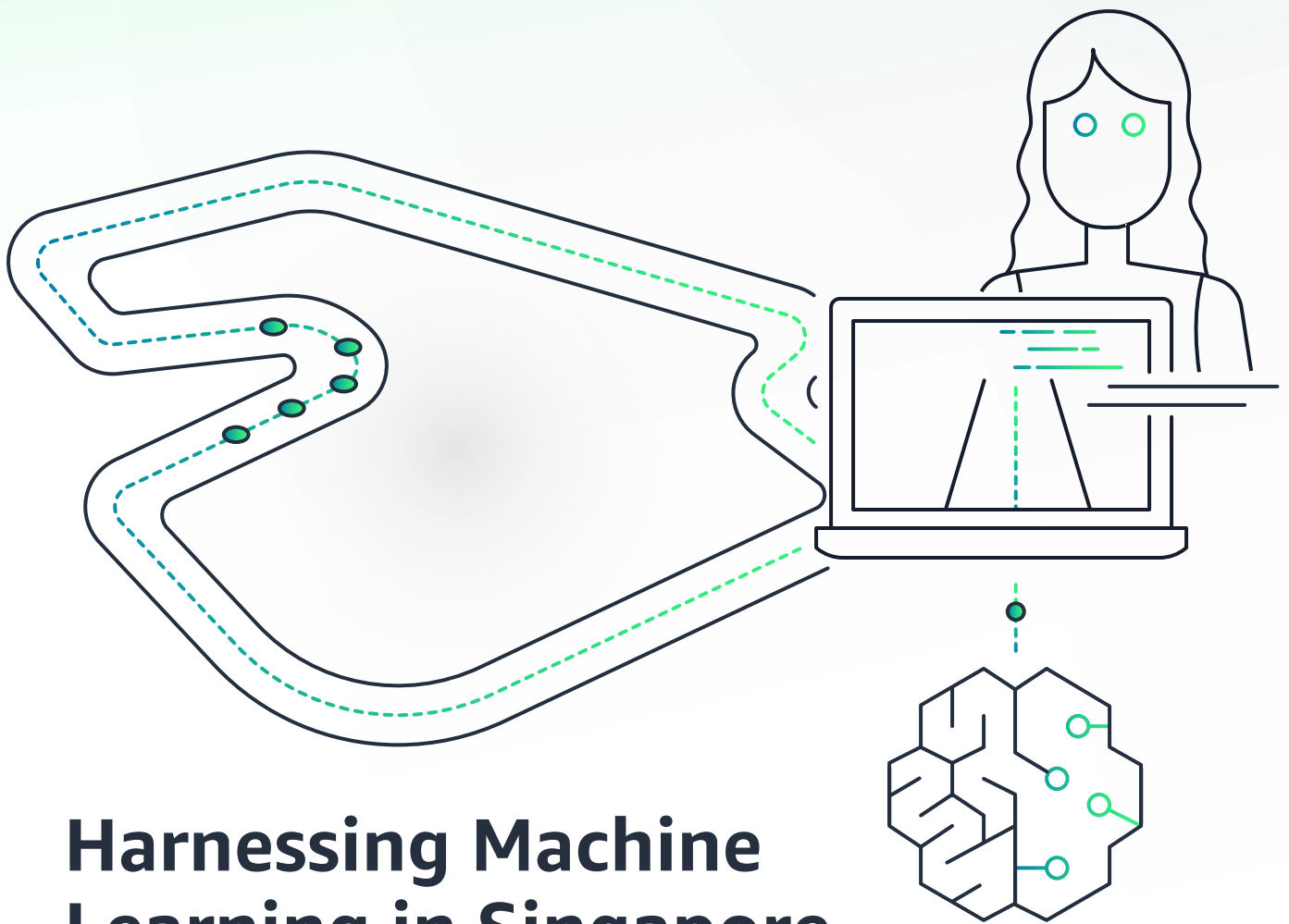
Harnessing Machine Learning in Singapore

AWS is committed to working with businesses, public sector organizations, and education institutions to deepen AI and machine learning skills training. One particularly powerful ML technique is Reinforcement Learning (RL), which has proven effective in solving a wide array of autonomous decision-making problems. However, RL has a steep learning curve because of its extensive technological scope and depth.

AWS DeepRacer is designed to be an interesting and fun way to get started with RL. AWS DeepRacer is a cloud-based, fully autonomous 1/18th scale race car powered by RL. Learners can get started quickly with hands-on tutorials that help them acquire the basics of ML, start training RL models, and then send them out on the track for a real-world autonomous race.

AWS first launched the global DeepRacer League, the first global, autonomous racing league, in 2018, and held its inaugural event in Singapore in 2019. Since then, AWS has organized DeepRacer Leagues with several leading enterprises, educational institutions, and public sector organizations in Singapore, including DBS Bank, the Home Team Science and Technology Agency, and the Institute of Technical Education. In 2020, AWS organized the first AWS DeepRacer Women's League in Southeast Asia, which aimed to give women more opportunities to develop or fine-tune their ML skills and encourage them to join the tech sector.

An AWS DeepRacer National League competitor following their car around the track.

In 2023, AWS collaborated with the National Library Board (NLB) to launch the first ever Nationwide AWS DeepRacer League. From May to August 2023, AWS and NLB held virtual races for all students and adult learners, attracting more than 600 participants on the virtual race track. The virtual races were complemented by four DeepRacer workshops hosted at libraries. The collaboration between NLB and AWS on the DeepRacer League started with NLB's inaugural ExperienceIT showcase at Punggol Regional Library, where AWS introduced emerging technologies, including AI/ML, to NLB's patrons. "We are excited to collaborate with AWS to make emerging technologies such as machine learning and artificial intelligence more accessible for all to discover and learn about in our libraries. This is very much in line with NLB's LAB25 plans to work with a wide range of partners, including leading tech firms, to create a learning marketplace that offers lifelong learning opportunities for all," said Ng Cher Pong, chief executive, National Library Board.
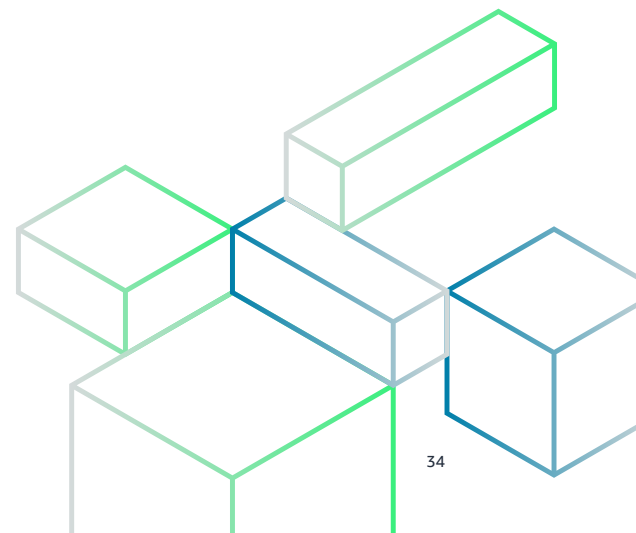
AWS InCommunities in Singapore

Building on the measurable economic impacts of its investment, training, and workforce development programs in Singapore, AWS is also committed to being a good neighbor by creating a positive difference in the communities where it builds and operates data centers through its community engagement initiative, AWS InCommunities.

AWS InCommunities launches long-term, innovative programs that will have a lasting impact in AWS Regions around the world where employees work, live, and raise their families. The efforts of AWS InCommunities are largely focused on four areas to meet the needs of communities: 1) science, technology, engineering, arts, and mathematics (STEAM) education, equity, and access; 2) local skills development; 3) sustainability; and 4) hyperlocal social impact.

Youth STEM empowerment—Science Centre Singapore

Science Centre Singapore (SCS) organizes the Youth STEM Empowerment Programme (YSEP), a programme that guides students to develop innovative products and solutions to solve real-life community problems using science, technology, engineering and mathematics (STEM). In 2022 and 2023, AWS InCommunities sponsored YSEP, through which groups from 21 schools in Singapore created, designed, and built project prototypes to address selected issues related to the United Nations Sustainable Development Goals (SDGs). AWS employees partnered with SCS to mentor the students and conduct workshops in areas such as project and prototype development, communications, and app development, which culminated in a public showcase of the students' products.

Augmented reality/virtual reality coding—Junior Achievement Singapore

AWS InCommunities collaborated with Junior Achievement (JA) Singapore to launch the "Fun with AR/VR Coding" course for four secondary schools in Singapore, reaching nearly 800 students. Through this course, AWS offers a bespoke learning journey for students in Singapore to create augmented reality and virtual reality (AR/VR) games and stories, focused on addressing the SDGs.

The Fun with AR/VR Coding course starts with research and design and covers basic and advanced level AR/VR creation tools. Students use a coding platform that helps them to build and animate their own 3D creations and explore them in virtual or augmented reality.

Biodiversity and conservation—Mandai Wildlife Reserve

AWS has proudly sponsored the Jurong Bird Park since 2019. In 2023, it further broadened this commitment to avian conservation by expanding the collaboration with the Mandai Wildlife Reserve to support the aviary conservation program at The Winged Sanctuary at Singapore's new bird park, The Bird Paradise. Through this collaboration, AWS has supported the Mandai Wildlife Reserve to provide world-class animal care for more than 970 species of birds, as well as admitting nearly 1,400 rescued native animals for medical attention, of which 61% were successfully released back into the wild.

"I joined the AWS team in 2017 as a data center facility manager, so I've seen first-hand how our infrastructure contributes to our customers, partners, and cloud users. Now as the clean energy strategy lead for the Region, I work with a talented team to drive AWS to net zero, and help our customers become more sustainable."

— **Amba Rethinam**
APJC Clean Energy Strategy Lead, AWS

Community volunteering

Giving back is an important part of Amazon's culture and an example of how Amazon uses its scale for good. Around the world, thousands of Amazon employees participate in initiatives like Amazon's Global Month of Volunteering to build stronger communities in the cities and towns where our employees live and work.

In Singapore, AWS InCommunities and local AWS employees regularly volunteer with community and voluntary welfare organizations. These initiatives include collaborating with the Halogen Foundation to deliver entrepreneurship education to secondary school students, raising funds and awareness for children with cancer with Hair for Hope, and combating food insecurity with Willing Hearts and The Food Bank Singapore.

Sustainability
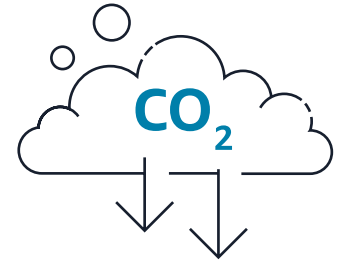
The Climate Pledge to achieve net-zero emissions

Amazon is committed to becoming a more sustainable business and reaching net-zero carbon across its operations by 2040, 10 years ahead of the Paris Agreement, as part of The Climate Pledge. Amazon co-founded The Climate Pledge and became its first signatory in 2019. Today, more than 400 organizations globally have signed the Pledge, including Neuron Mobility, SAITECH Limited, and Terrascope in Singapore. As part of its Pledge commitment, Amazon is on a path to power its operations with 100% renewable energy by 2025, five years ahead of the original 2030 target.

Amazon is the world's largest corporate purchaser of renewable energy, and as of 2022, it reached 90% renewable energy across its business. To date, Amazon has announced more than 500 renewable energy projects globally, which are expected to generate more than 77,000 gigawatt-hours (GWh) of clean energy each year. Organizations that migrate to or build on AWS can benefit from the net effect of Amazon's sustainability efforts to reduce their carbon footprint.

AWS renewable energy initiatives in Singapore

Amazon is committed to leaving the world a better place than it found it. The company achieves this through strengthening its commitment to clean energy in the areas where it invests in infrastructure. In 2021, Amazon announced its first renewable energy project in Singapore with Sunseap. The 62MW Sunseap project is composed of a series of solar panels mounted on a ground system that has the ability to optimally position the system to capture sun exposure as weather conditions change. In 2022, Amazon signed an additional corporate power purchase agreement (PPA) with Sembcorp for a solar project in Singapore. The 17.6 MW Sembcorp project has 33,580 solar panels installed across two sites with an integrated rainwater harvesting system that collects and treats up to 170,000 cubic meters of rainwater annually, equivalent to the amount required to fill 68 Olympic-sized swimming pools.

Amazon's solar projects in Singapore have a combined renewable energy generating capacity of an estimated 79.6 megawatts (MW), which is enough to power almost 20,000 Singapore homes each year.

Achieving emissions reductions

AWS contributes toward The Climate Pledge goals by constantly improving the energy efficiency of its computing resources and by increasing the share of renewable energy in total consumption by its data centers. As a result, the carbon footprint of cloud computing with AWS is lower than that of on-premises and most other data center providers. A report by 451 Research, part of S&P Global Market Intelligence, found that computing in the cloud is five times more energy efficient than on-premises data centers in the Asia Pacific region. By adopting AWS's cloud infrastructure, private and public sector organizations can align with AWS's energy efficiency and clean energy goals, while meeting their own computing needs.

In Singapore, enterprises and public sector organizations moving to the cloud experience an average workload energy reduction of up to 76%, which amounts to 1,542 metric tons of carbon per megawatt of data center capacity per year. Greater access to renewable energy resources for cloud providers would result in additional emissions removal of up to 434 metric tons per year, compared with the grid baseline. Powering cloud services with 100% renewable energy would bring total workload energy-related carbon reductions to 1,976 metric tons per megawatt per year. This advantage is attributable to the combination of more energy-efficient servers, higher server usage, and excellence in sustainable design achieved by AWS infrastructure.

AWS is committed to minimizing the environmental impact of its business. In addition to helping increase agility and reduce costs, moving to AWS is also significantly more sustainable, as customers no longer must provision for peaks, and AWS's infrastructure is designed to operate efficiently at scale. Organizations will need to make energy-efficient computing an even higher priority as they seek to minimize their environmental impact and their compute demand grows.

AWS's global infrastructure is built on custom hardware, which is optimized for one set of requirements—workloads run by AWS customers. This results in efficiency advantages at both the server and facility levels in its cloud infrastructure, and it translates into dramatically less energy used to perform the same unit of work.

AWS designs server systems with great attention to power optimization, using the latest technology components. It runs servers at higher usage levels than enterprise data centers, leveraging the ability to share and dynamically allocate resources in the cloud.
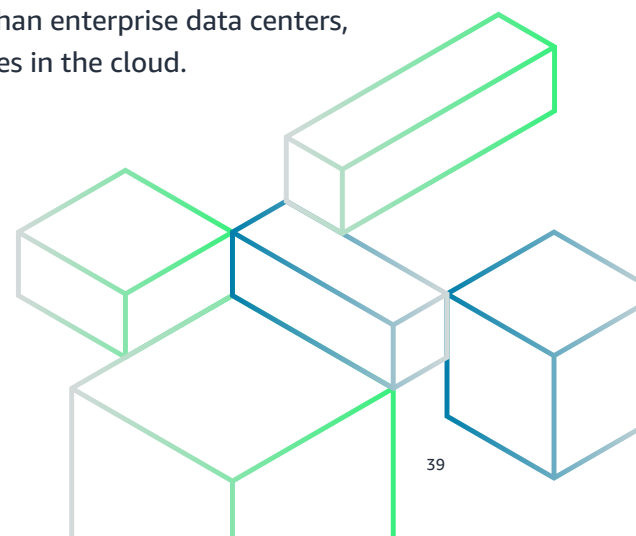
One of the most visible ways AWS is using innovation to improve power efficiency is its investment in AWS chips, like the AWS Graviton family of processors. AWS Graviton-based instances use up to 60% less energy than comparable EC2 instances. The latest Graviton4 provides up to 30% better compute performance, 50% more cores, and 75% more memory bandwidth than current generation Graviton3 processors, delivering the best price performance and energy efficiency for a broad range of workloads running on Amazon EC2.
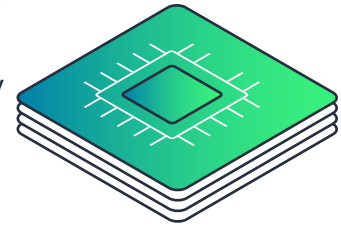
Machine learning requires enormous amounts of computing power. With the increasing adoption of machine learning, AI, and now generative AI by so many customers, Amazon observed the need for chips that were both powerful and cost-efficient while using less energy. Trainium is a purpose-built chip for training deep learning models, while the Inferentia chip enables models to generate inferences more quickly and at lower cost. The Trainium and Inferentia chips help customers meet their sustainability goals when training and deploying ultra-large models. For example, the latest AWS Inferentia2 instances use advanced silicon processes and hardware and software optimizations to deliver high-energy efficiency when running deep learning models at scale, delivering up to 50% better performance per watt relative to other comparable Amazon EC2 instances.

AWS is focused on advancing facility-level improvements in efficiency, including data center designs that use lower energy methods and a leaner electrical infrastructure, resulting in lower energy losses to power distribution. As Singapore customers move their workloads from enterprise data centers to AWS, the carbon footprint of these workloads is reduced due to much lower energy consumption.

Reducing water usage and returning water to communities

In addition to a commitment to energy efficiency and renewable energy, AWS is dedicated to conserving and reusing water in its operations. AWS collaborates with both the private sector and public entities to support water availability in communities where it operates data centers. On the hottest days when AWS needs water for cooling, it has optimized systems to use minimal water. Outside air is cooled through an evaporative process and pushed into the server rooms to keep hardware at stable operating temperatures. During cooler months, where possible, outside air is supplied directly to the data center without needing to be cooled. AWS is constantly innovating the design of its cooling systems, and it uses real-time sensor data to adapt to changing weather conditions to further reduce water use.

AWS also evaluates the opportunity to reduce its consumption of potable water and is actively expanding the company's use of non-potable and recycled water for cooling purposes. In certain regions, the company works directly with utilities and regulators to obtain approval for the use of recycled water in direct evaporative cooling technology. AWS is continuing to work with water utilities in various regions to expand this recycled water infrastructure. Through these actions, it is actively contributing to sustainable water solutions by reducing its impact on the local potable water supply for the communities where it operates. AWS also uses on-site, modular water-treatment systems in multiple regions, which allow the company to remove scale-forming minerals and reuse water for more cycles. Increasing its "cycles of concentration" contributes to reducing the water intake needed to cool its data centers. Along with reducing water usage, AWS also actively looks for opportunities to return water to the communities where it operates.

For AWS, running our operations sustainably means reducing the amount of water we use to cool our data centers. Our holistic approach minimizes both energy and water consumption in our data center operations and guides the development of our water use strategy for each AWS Region. It starts with evaluating climate patterns, local water management and availability, and opportunities to use sustainable water sources.

AWS will be water positive by 2030, returning more water to communities than it uses in its direct operations. AWS's global water use efficiency metric of 0.19 liters of water per kilowatt-hour (kWh) demonstrates AWS's leadership in water efficiency among cloud providers. AWS is already well on the path to becoming water positive through innovative programs to lower water use across facilities by using cloud technologies to continually improve water efficiency and investing in projects that deliver water back to communities. This initiative adds to Amazon's $10 million commitment to Water.org to support the launch of the Water & Climate Fund, which will deliver climate-resilient water and sanitation solutions to 100 million people across Africa, Asia, and Latin America. This donation will directly empower 1 million people with water access by 2025, providing 3 billion liters of water each year to people in water-scarce areas.

In Singapore, AWS's leased data centers are using recycled wastewater (NEWater) instead of potable water, making higher-quality water available for the community. With innovation at its core, AWS also piloted and deployed a water recycling system in Singapore, which it codeveloped with a local startup, Hydroleap, and has plans to scale it across the Asia Pacific region. Hydroleap developed a unique electrooxidation technology, which was customized to improve the efficiency of AWS cooling towers, helping AWS meet its water efficiency goals.

> "This ongoing collaboration between Hydroleap and AWS, which started nearly two years ago, has helped us to improve and fine-tune our patented electrooxidation technology to be an effective tool for meeting AWS's water efficiency goals. Now, with the available data from the existing projects, we can unleash the potential impacts we can make together across the Asia-Pacific region and even globally."
>
> **— Mohammad Sherafatmand**
> PhD, founder and chief executive officer of Hydroleap

In 2024, Amazon was a recipient of the Singapore Watermark Award, the nation's highest accolade, that honors organizations for their exemplary leadership and outstanding achievements in advancing the water sustainability agenda in Singapore. The award is given only to the top organizations in Singapore that demonstrate a strong commitment to their water stewardship, sustained efforts in water use, innovation in water conservation, and active engagement of the community to advocate and catalyze action and support for the water cause.

Helping customers become sustainable cloud users

The Sustainability Pillar in the AWS Well-Architected Framework helps customers improve their cloud architectures. The framework consists of design principles, questions, and best practices across six pillars—Operational Excellence, Security, Reliability, Performance Efficiency, Cost Optimization, and Sustainability. The Sustainability Pillar supports AWS customers in their efforts to structure their cloud architecture to reduce energy consumption and improve efficiency. The framework helps customers reduce their carbon footprint by integrating sustainability goals, impact measurements, maximized workloads, managed services, and actions to reduce downstream energy usage.

AWS also offers the customer carbon footprint tool to help customers calculate the environmental impact of their AWS workloads. The tool uses easy-to-understand data visualizations to provide customers with their historical carbon emissions and helps them to evaluate emission trends as their AWS use evolves, estimate the tonnage of carbon emissions avoided by using AWS instead of an on-premises data center, and review forecasted emissions based on current use. The forecasted emissions show how a customer's carbon footprint will change as Amazon stays on path to powering its operations with 100% renewable energy by 2025 and drives toward net-zero carbon by 2040 as part of The Climate Pledge.

The Amazon Sustainability Data Initiative (ASDI) seeks to accelerate sustainability research and innovation by helping customers minimize the cost and time required to acquire and analyze large sustainability datasets. ASDI supports innovators and researchers with the data, tools, and technical expertise they need to move sustainability to the next level.

International Blue Carbon Institute

In 2022, Amazon and Conservation International established the International Blue Carbon Institute in Singapore, an organization that will help mitigate climate change and protect coastal communities by supporting the restoration and protection of coastal blue carbon ecosystems in Southeast Asia and beyond.

The International Blue Carbon Institute, which will be housed in Singapore, will focus on supporting Southeast Asia and the Pacific Islands in realizing their immense blue carbon potential. While Southeast Asia holds more than one-third of the world's mangrove forests, an important source of blue carbon, the greatest loss of mangrove forest has also occurred in this region.

In Asia through to the Pacific Islands, coastal communities are increasingly vulnerable to sea-level rise and stronger storms. Blue carbon ecosystems fortify communities against climate effects while providing fresh water and supporting biodiversity, as well as other natural benefits. The International Blue Carbon Institute, with support from the Singapore Economic Development Board, will serve as a knowledge hub to build capacity, expertise, standards, and methodology to develop and scale urgently needed blue carbon projects.

As part of its ongoing commitment to nature-based solutions, Amazon will provide a grant of up to $3 million to establish and fund IBCI's operations for the first three years to help the region build and scale credible blue carbon projects. Beyond the funding, Amazon plans to work hand-in-hand with Conservation International to set high standards for blue carbon and engage key stakeholders in the region, enabling a policy and business pathway for blue carbon in Southeast Asia and the Pacific.
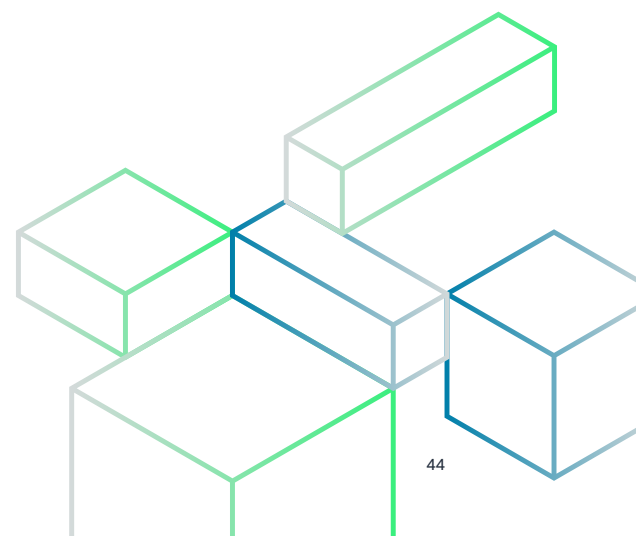
Appendix

EIS methodology

To measure the economic impact of data center investments, AWS uses a Nobel Prize–winning model developed by Harvard economist Wassily Leontief, the input-output (I-O) model. In processing the model, AWS uses a conservative framework to define investment and calculate economic multipliers, which represents the "as built" world. AWS Economic Impact Studies can be directly correlated with what it took, or what AWS is actively planning to do, to construct, connect, operate, and maintain the data centers in a given AWS Region.

I-O 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. In the I-O model, "local" is typically a country, but could also be a smaller geographic area (e.g., a county in the U.S.), or a region in the EU (e.g., Lombardy in Italy). The method uses historical data from the country, and in this report, data maintained by the OECD and the Singapore Ministry of Manpower (MOM). The data shows the impact of each Singapore dollar spent in one industry on all other industries. AWS uses standard procedures for calculating multipliers from the I-O data supplied by the OECD. See, for example, Ronald Miller and Peter Blair, Input-Output Analysis: Foundations and Extensions, 2009, Cambridge University Press.

The estimated economic impacts are the cumulative effects of:

- **Direct effect,** which is the change in employment, earnings, and GDP created by AWS's direct suppliers in a country as a result of the AWS investment, such as construction firms, colocation providers, or power companies.

- **Indirect effect**, which is the change in employment, earnings, and GDP created by the indirect suppliers, who supply to AWS's direct suppliers as a result of the AWS investment, such as construction labor and materials.

- **Induced effect**, which is the change in employment, earnings, and GDP created by the firms that supply household goods to workers at Amazon companies and AWS's direct and indirect suppliers.

Glossary

- **Amazon CloudFront:** Amazon CloudFront provides businesses and web application developers with a secure and cost-effective solution for distributing content with low latency and high data transfer speeds. By using the AWS backbone network, CloudFront accelerates content distribution by routing each user request to the most optimal edge location that can best serve that content. Customers can enhance security with traffic encryption and access controls, and benefit from AWS Shield Standard, which defends against distributed denial of service (DDoS) attacks at no additional cost. Notably, Hulu relies on Amazon CloudFront to consistently provide high-quality video streaming services to millions of people.

- **AWS Local Zones:** AWS Local Zones place select AWS capabilities, including compute, storage, and databases, closer to end users. With AWS Local Zones, customers can easily run highly demanding applications for their users, such as media and entertainment content creation, real-time gaming, simulations, and machine learning. For example, Epic Games uses AWS Local Zones to deliver enhanced player experiences for its popular Fortnite game.

- **gross domestic product (GDP):** Gross domestic product quantifies the economic impact of AWS investment. Following the value-added approach, GDP represents the final value of goods and services produced by an economic activity in terms of the sales value (gross output) less any related investment (intermediate inputs) required to produce the output.

- **gross investment:** Gross investment includes the total costs paid by AWS to construct, connect, operate, and maintain AWS infrastructure across its full life cycle. These costs include the full value of capital expenditures and operational expenditures necessary to realize the project, such as imports of servers and employment of marketing professionals.

- **jobs supported:** The jobs supported by AWS investment quantifies the number of full-time equivalent (FTE) jobs created and retained at businesses that supply AWS and its suppliers. FTE is a concept used to normalize full-time and part-time jobs, where two employees working 50% of the time add up to one FTE. The input-output model measures the number of jobs supported by AWS investment as a function of the ratio of total compensation and average compensation for workers in sectors required to produce the output supporting AWS purchases. This measures the total compensation and jobs supporting AWS investment. Jobs at a given firm may support existing production demand and be retained by AWS investment or may also be created as a result of new demand.