Google

Equiano

Economic Impact Assessment

Nigeria

This assessment was commissioned by Google and delivered by Africa Practice based on economic modelling assistance from Genesis Analytics. It provides an overview of Nigeria's connectivity ecosystem and highlights Equiano's expected key impacts on the economy, job creation and sustainability. This report is accompanied by a technical annex that details the methodology and assumptions adopted in this assessment, as well as the underlying economic modelling and analysis.

Africa Practice
Africa Practice is a strategic advisory firm operating at the nexus of industry and government since 2003. It advises corporations, investors, and foundations across Africa, enabling them to drive sustainable and equitable development.

Genesis Analytics
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Methodological note

This report and the technical annex cite impact figures on connectivity (Equiano's expected impact on internet penetration, speeds and pricing), economic growth (the cable's expected contribution to year-on-year growth, real GDP and total economic output), indirect job creation, and savings in CO_2 emissions.

These impact metrics are modelled based on robust economic and econometric studies, using historical data from Nigeria, South Africa and sub-Saharan Africa, where possible. We have used a study from the APAC region in one instance, given studies from Nigeria or similar African markets are not available.

The aforementioned impact metrics constitute estimates based on historical trends.[1] These should not be construed as a guarantee of any specific outcome.

1. The studies used for the modelling in this economic impact assessment are:
   - Hjort, J. and Poulsen, J., 2019, The Arrival of Fast Internet and Employment in Africa, *American Economic Review*.
   - Analysys Mason, 2020, Economic Impact of Google's Apac Network Infrastructure.
   - Commonwealth Telecommunications Organisation, 2012, The Socio-Economic Impact of Broadband in Sub-Saharan Africa: The Satellite Advantage.
   - RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in South Africa.
   - Scott C., 2012, Does Broadband Internet Access Actually Spur Economic Growth?
   - Qiang C. et al., 2009, Economic Impacts of Broadband. Information and Communications for Development.
   - RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in Nigeria.
   - SQW, 2013, UK Broadband Impact Study, Impact Report.

Executive summary

Equiano - a next-generation subsea internet cable spearheaded by Google - will run from Portugal to South Africa, along Africa's Atlantic Ocean coastline. In 2022, it is expected to land in Lomé (Togo), Lagos (Nigeria), Swakopmund (Namibia) and Cape Town (South Africa), with branching units in place for further phases of the project. Last year, the cable landed in Rupert's Bay (Saint Helena).

Globally, sub-Saharan Africa remains the most underserved region in terms of internet infrastructure. Penetration stands at 29%, while for the entire continent (including North Africa), it is 40%. According to the Broadband Commission for Sustainable Development, USD 100 billion in private and public investment is needed to achieve universal and affordable access to good quality broadband in Africa by 2030.

Nigeria is sub-Saharan Africa's largest economy. Still, the share of people using the internet stands at approximately 35.5% as of 2020 - more than double what it was in 2012. Across much of the country, people lack access that is affordable, reliable and of good quality. Poor connectivity hinders economic growth, poverty reduction, human development and progress towards the Sustainable Development Goals.

Equiano will have a direct impact on connectivity in Nigeria following its landing, resulting in faster internet speeds, improved user experience, and reduced internet prices. Internet speeds in the country are expected to grow almost sixfold from **11 Mbps** in 2021 to **65 Mbps** in 2025, while retail internet prices are forecast to decline by **21%** over the same period. Improved speeds and lower prices are expected to boost penetration by **6 percentage points** over this period.

By increasing international bandwidth, Equiano will indirectly broaden access to the internet in Nigeria, thus contributing to narrowing the digital divide within the country, as well as between it and other regions that currently have more developed connectivity infrastructure.

Africa's digital transformation and its internet economy - projected to grow from USD 115 billion in 2020 to USD 180 billion in 2025 and USD 712 billion by 2050 - depend on well-developed connectivity infrastructure. Strong connectivity and more affordable and reliable internet access can help Nigeria diversify its economy away from oil, unlocking new pathways to collective prosperity. For Nigeria's population, businesses, and government, the digital economy can be a gamechanger and a key lever to accelerate growth, industrialise, innovate and improve people's lives.

Between 2022 and 2025, average year-on-year real growth in Nigeria is expected to increase by **0.52 percentage points** due to Equiano. By 2025, real GDP in the country is forecast to be higher by **USD 10.1 billion** than it otherwise would have been without the cable. Between 2022 and 2025, Equiano is expected to lead to an additional USD 25.3 billion in total economic output in Nigeria.

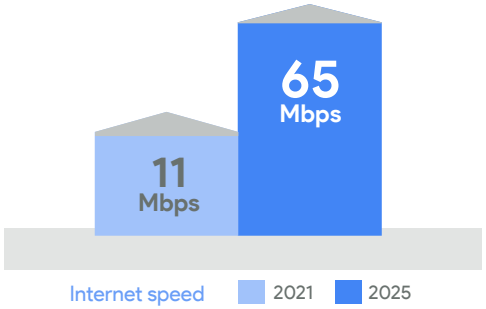
Improved connectivity also accelerates job creation. Between 2022 and 2025, Equiano should **indirectly create 1.6 million new jobs**[2] - equivalent to **330,000 per year** over the assessment period - driven by the expansion of the digital economy and peripheral sectors.

2. It is important to note that Equiano is expected to result in indirect job creation, via the growth of the digital economy, rather than jobs that are directly attributable to the submarine cable.

Equiano's key impacts in Nigeria

A boost for connectivity

Average internet speeds are set to rise following Equiano's landing



Equiano will also result in major price reductions for consumers, improving affordability of access

Decline in internet retail prices (2021 - 2025)

Improved speeds and affordability will result in greater internet penetration

Increase in internet penetration (2021 - 2025, % points)

A catalyst for growth, job creation and sustainability

By 2025, real GDP expected to be higher than it otherwise would have been by:

USD 10.1 billion

Equiano will boost job creation (2022 - 2025)

1.6 million jobs

Tonnes of CO_2 emissions to be saved (2022 - 2025)

1.1 million tonnes

Nigeria's connectivity ecosystem

The case for investing in Nigeria's telecommunications infrastructure

The digital divide

Despite being sub-Saharan Africa's largest economy, a significant share of Nigeria's population lives without internet access that is fast, reliable and of good quality. While entry-level data bundles meet affordability criteria set by the Broadband Commission, Nigeria's 3G and 4G coverage is underdeveloped relative to regional peers such as Ghana or Cameroon. Likewise, Nigeria's mobile data coverage is low when compared to South Africa and Kenya - sub-Saharan Africa's second and third-largest economies. Relatively low mobile broadband coverage hinders internet access and the realisation of Nigeria's digital potential.

Although Nigeria possesses relatively strong first-mile infrastructure with six submarine cables installed, as well as terrestrial links with its neighbours, its middle- and last-mile infrastructure constitute major hurdles to improved nationwide connectivity. Existing networks tend to be concentrated in major urban areas including Lagos, Abuja and Port Harcourt, as well as along inter-city routes. A complex regulatory landscape and high Right of Way (RoW) fees are among the key challenges hindering infrastructural development. According to the Association of Licensed Telecommunications Operators of Nigeria (ALTON), RoW fees represent 70% of the costs related to terrestrial infrastructure deployment.[3]

In addition to these infrastructural constraints, limited digital skills development in the education system hinder the uptake of digital technologies. Likewise, the high costs of internet-enabled devices in relation to local incomes frustrate the development of the digital economy.

A young and growing population

Nigeria is the most populous country in Africa, with an estimated population of 206 million in 2020. It accounts for around half of the entire population of West Africa.[4] The country has a very young population with a median age of 18 years, making it one of the world's youngest economies in terms of demographics. 43% of the population - a total of 89 million people - is between 15 and 44 years of age. This segment typically makes greater use of the internet, for various purposes, including research and education, social networking, and retail and commercial activities.

Meanwhile, 43% of the country's population is below the age of 14. Nigeria's need for improved connectivity is based not only on the current digital divide, but, more importantly, on future gaps. The country's population is set to reach 233 million by 2025, rising to 263 million by 2030. It will reach 401 million by 2050, when Nigeria will become the third most populous country in the world.

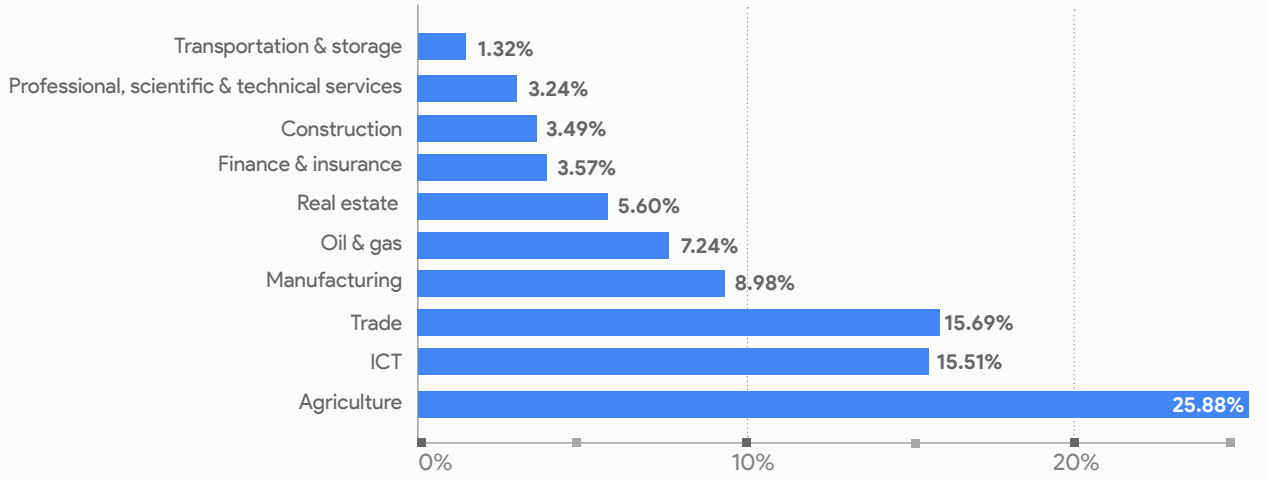
3. The Guardian, 2019, RoW, electricity challenges account for 70% of operators' costs.
4. IMF, 2021, World Economic Outlook Database.

Deepened investments in connectivity infrastructure are central to ensuring future generations have reliable and affordable access to the internet, and can leverage the opportunities access unlocks. Improved connectivity - at all stages of the value chain, ranging from submarine cables to terrestrial fibre networks and data centres - is central to cementing and enhancing Nigeria's position as one of Africa's leading tech hubs. Beyond this, investments in connectivity and the digital economy offer Nigeria an opportunity to reduce its dependence on oil and diversify its economy, thereby becoming less vulnerable to global oil downturns.

An expanding ICT ecosystem that fuels innovation

Nigeria is Africa's largest telecommunications market with over 200 million mobile subscribers and 68 million internet users, accounting for 29% of internet usage on the continent.[5] The ICT sector[6] has increasingly become one of the key drivers of economic growth in Nigeria, contributing 15.5% to GDP in 2021 - more than the oil and gas sector (see Figure 1). Between 2016 and 2021, the sector contributed an average of 13.1% of the country's GDP, as illustrated in Figure 2.

FIGURE 1 : GDP contribution of the ten largest sectors 2021

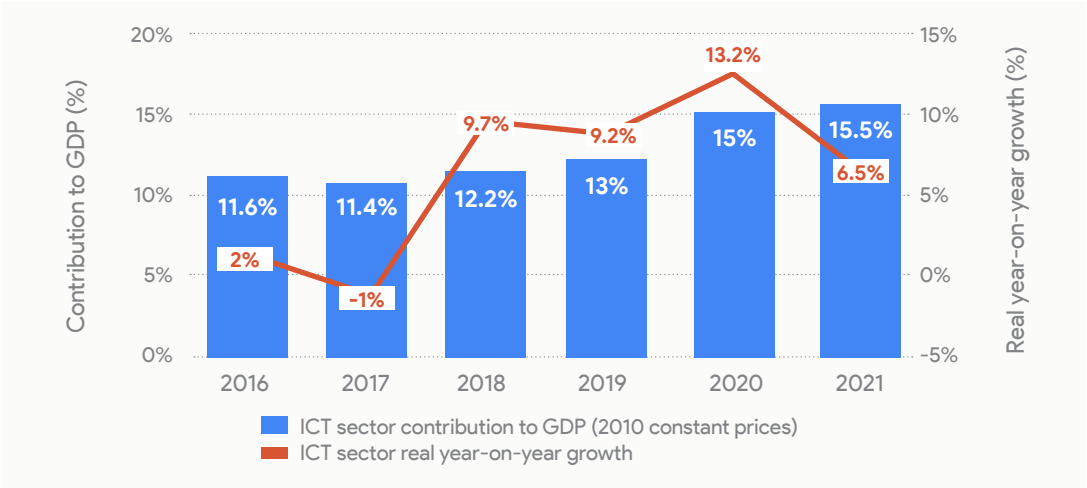


Source: National Bureau of Statistics, 2022, Nigerian GDP Quarterly Report Q4 2021

Nigeria's strong demographic prospects, rapidly increasing internet consumption and ongoing digital divide have spurred a wave of investments in its ICT ecosystem. In August 2021, MTN Nigeria announced it would invest USD 1.5 billion over three years to expand broadband access, connecting an additional 3,000 communities to its network in 2021 and 2022.[7] Meanwhile, international investments are also on the rise: in December 2021, global internet platform Equinix announced the acquisition of MainOne, one of West Africa's leading data centre and connectivity solutions providers.[8]

5. International Trade Administration, 2020, Nigeria - Country Commercial Guide.
6. The ICT sector encompasses telecommunications and information services, publishing, motion picture, sound recording and music production, and broadcasting, according to the National Bureau of Statistics' categorisation.
7. Reuters, 2021, MTN Nigeria to invest $1.5 billion to expand broadband over three years.
8. Techcrunch, 2021, Equinix is acquiring Nigeria's MainOne for $320 million as it expands into Africa.

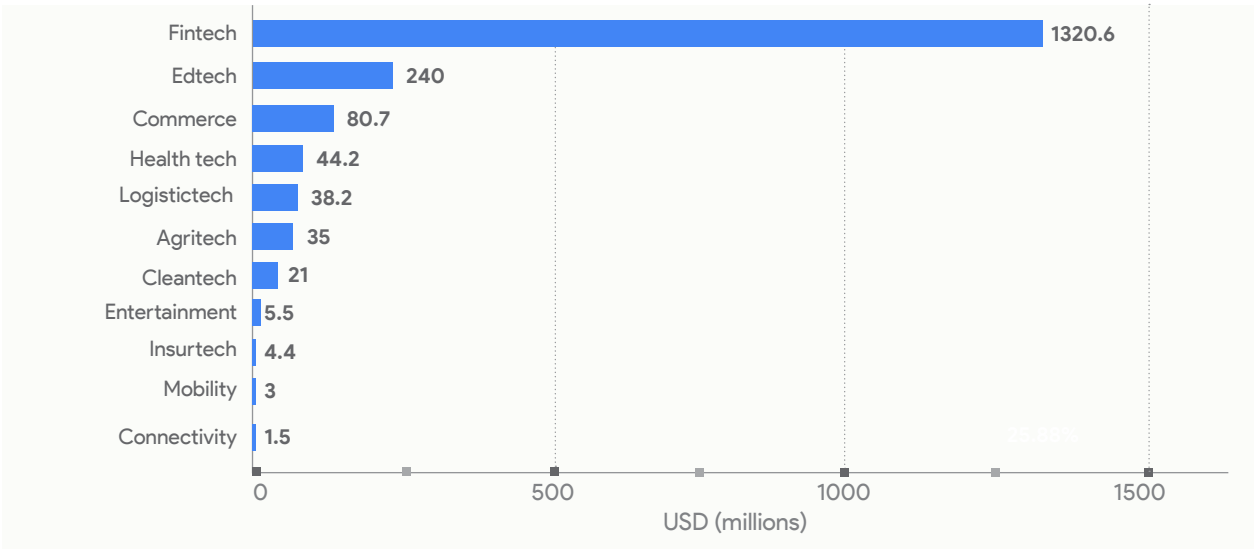
FIGURE 2 : ICT sector growth and GDP contribution 2016 - 2021



Source: National Bureau of Statistics, Nigerian GDP Quarterly Reports, 2016-2021

Lagos is one of the continent's leading digital and innovation hubs. In 2021, start-ups based in Nigeria raised over USD 1.8 billion across 185 equity deals, equivalent to 34% of the continent's equity funding. This is significantly more than in other key markets such as South Africa (USD 832 million), Egypt (USD 652 million) or Kenya (USD 571 million).[9] Figure 3 below breaks down venture capital funding in Nigeria by sector in 2021

FIGURE 3 : Venture capital funding in Nigeria by sector 2021



Source: Partech, 2022, 2021 Africa Tech Venture Capital Report

The convergence of additional bandwidth from Equiano and other next-generation cables, together with deepened investments in terrestrial infrastructure and the rapid growth of local data hosting capacity, is set to benefit Nigeria's innovation ecosystems.

Below, we outline five critical growth pillars within the Nigerian ICT sector:

9. Partech, 2022, 2021 Africa Tech Venture Capital Report.

Data centres. In 2020 and 2021, Nigeria attracted a wave of investments in its data centre ecosystem. This included commitments to new and upgraded facilities by Rack Centre, WIOCC, 21CTL & Konet, and Africa Data Centres. While South Africa remains the preeminent data centre location on the continent, Nigeria is increasingly positioning itself as a key investment market.

The gig economy. Nigeria has the largest number of platform workers on the continent - 2.9 million, according to the most recently available data from 2018.[10,11] As digital industries and the continue to grow, more employment and diverse income-generating opportunities will be created. The ICT sector, digital platform workers, and globally traded services in particular will benefit from this growth.

Fintech. Nigeria has a vibrant fintech sector which has taken advantage of the inefficiencies in and exclusion by the traditional financial services industry. Fintechs have tapped into gaps in the accessibility and service delivery of traditional financial services providers. There are now over 200 standalone fintechs with propositions across the value chain, providing services related to affordable payments, quick loans, and flexible savings and investments, among others.[12] Key success stories include digital payments firms Flutterwave and Interswitch, which are valued at USD 3 billion and over USD 1 billion, respectively. Mobile money firm OPay, which is backed by SoftBank, is now valued at over USD 2 billion.

eCommerce. In 2018, the value of e-commerce expenditure in Nigeria was estimated at USD 12 billion, making it the largest e-commerce market in Africa in terms of revenue.[13] This figure covers all online payments, including online bill payments, and is projected to reach USD 75 billion by 2025.[14] An estimated 6.5 million individuals - equivalent to 6.3% of the adult population - made online purchases and/or paid bills online in 2017.[15] The number of e-commerce users is set to continue growing rapidly as digital platforms become increasingly ubiquitous across the country.

eHailing. Over the last five years, there has been a huge increase in the number of e-hailing companies and applications. In 2019, there were an estimated 3.1 million unique users of digitally enabled ride-hailing services in Nigeria, each generating on average USD 34 annually in net revenues for e-hailing companies.[16] The digitally enabled ride-hailing market therefore had total net revenues worth USD 107 million in 2019, up by 31% from USD 82 million in the previous year.

The creative economy. Nigeria's cultural and creative industries - especially in the areas of visual and performing arts, music, craft, fashion design, film making and video production - have grown steadily over the years, putting the country on the map as a creative powerhouse in Africa.[17] The creative industry in Nigeria has seen a period of rapid growth, fuelled by the emergence of digital technologies that support content creation, distribution and consumption.

In the creative economy, the entertainment and media (E&M) industry is moving into an increasingly digital realm. It was expected that by 2020, more than half of

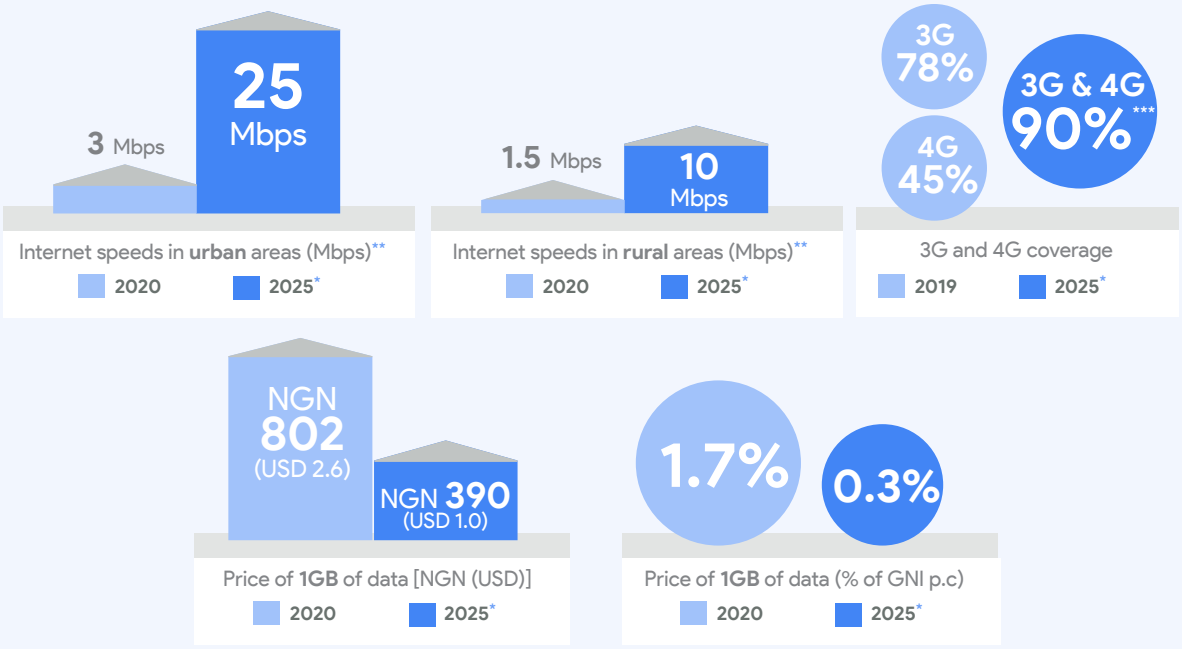
10. Platform workers are defined as individuals who use a mobile application or a website to match themselves with customers, in order to provide a service in return for payment.
11. World Bank, 2018, Nigeria Digital Economy Diagnostic Report.
12. McKinsey & Co, 2020, Harnessing Nigeria's fintech potential.
13. World Bank, 2019, Nigeria Digital Economy Diagnostic.
14. Daily Trust, 2021, Nigerians Spend $13bn On E-Commerce Yearly - Government.
15. World Bank, 2018, Global Findex database.
16. DataReportal, 2020, Digital 2020: Nigeria.
17. UNESCO, 2017, Diversity of Cultural Expressions, Nigeria Report.

the revenue in the sector would come from digital channels. According to PwC, Nigeria will be the world's fastest-growing E&M market over the next few years, with revenue from the industry growing at a 19.3% CAGR to reach USD 10.8 billion in 2023.[18] The E&M market is strongly influenced by surging spending on digitally accessed content. In 2018, for example, 69% of the E&M revenue came from digital channels.[19]

GOVERNMENT POLICY AND CONNECTIVITY TARGETS

In 2013, Nigeria launched its first National Broadband Plan 2013-2018. The plan's objective was to increase broadband access (defined as minimum download speeds of 1.5 Mbps with at least 30% coverage) and achieve 3G coverage for a minimum of 80% of the population.[20] By 2020 this penetration target was close to being achieved. However, the goalposts have shifted – as the developed world pushes ahead with launching 5G technology, Nigeria has yet to reach significant 4G coverage and adoption.

In 2019, the Ministry of Communications' mandate was expanded to include the digital economy, with an emphasis on accelerating growth and social inclusion. This led to the launch of the National Broadband Plan 2020-2025 in 2019. The plan aims to create an enabling environment and improve regulatory frameworks to achieve the targets below:



Note: * Targets set in the Nigeria National Broadband Plan, 2020-2025. ** Average mobile and fixed broadband download and upload speeds.
••• Target internet coverage to enable the targeted speeds to be achieved.

Federal authorities have recommended lower RoW fees to their state-level counterparts. While some states have complied in zero-rating or drastically reducing their prices, in others, revenue generation measures continue to be prioritised at the expense of infrastructure roll-outs.

Despite these challenges, the government has secured major investments in the telecommunications sector. Between 2015 and 2020, telecoms investment grew by USD 32 billion.[21] As part of its National Development Plan 2021-2025, the government expects USD 40 billion in private investments in digital infrastructure.

18. PwC, 2021, Global Entertainment and Media Outlook 2017-2021.
19. PwC, 2019, Insights from the Entertainment & Media Outlook, An African Perspective, 2019-2023.
20. NCC, Nigeria's National Broadband Plan 2013 - 2018.
21. NCC, 2020, Press Statement: Telecoms Sector, others Take Nigeria out of Recession as Sector Boosts GDP by 12.45%.

Sector diagnostic: taking stock of Nigeria's connectivity infrastructure

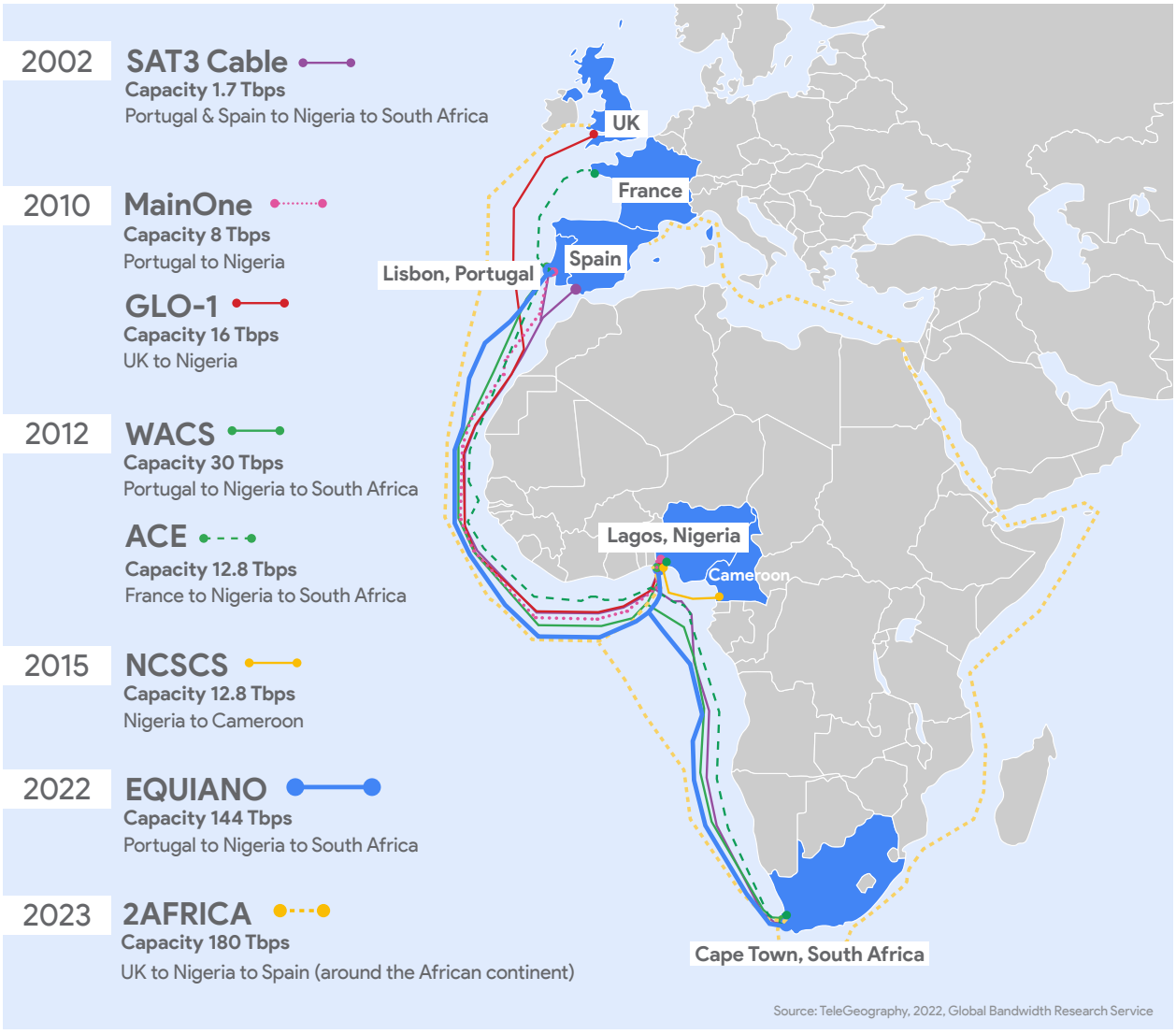
The following section provides an overview of Nigeria's connectivity infrastructure, detailing the country's current and future submarine links, current IP transit pricing, terrestrial infrastructure and internet coverage, as well as speeds and latency.

International connectivity links

Nigeria has six installed subsea cables, with two more - Equiano and 2Africa - set for installation (see Figure 4). While the Glo-1 cable was set for extension along the Nigerian coastline, it has experienced delays and is not included in this analysis.

The new subsea cable installations will lead to increased international bandwidth capacity for Nigeria. The diversity of routes created, together with the increased bandwidth capacity, will likely lead to an improvement in internet speeds and a reduction in IP transit prices. The Equiano cable is designed with substantially larger capacity than the sum of the existing cables (approximately 81 Tbps) and is likely to have a distinct and significant impact on the internet landscape in Nigeria.

FIGURE 4 : Installed and soon-to-be installed subsea cables in Nigeria

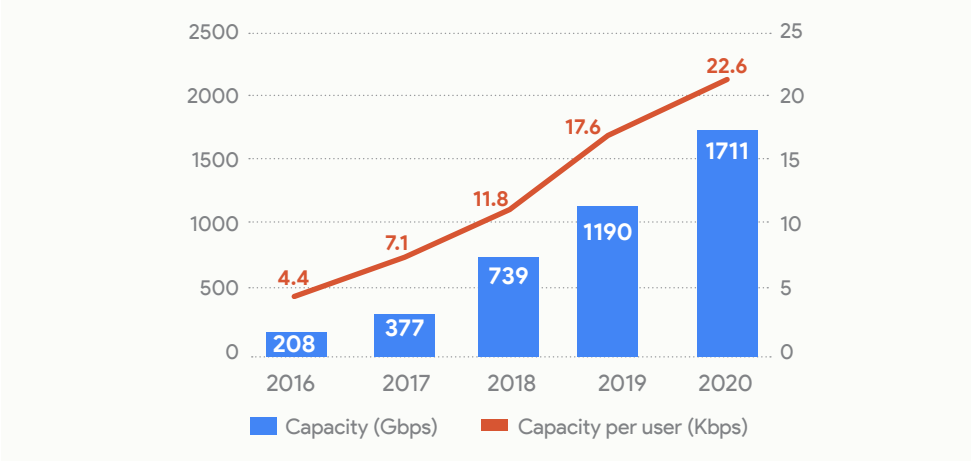


Source: TeleGeography, 2022, Global Bandwidth Research Service

Nigeria experienced tremendous growth in its used international bandwidth between 2016 and 2020, attaining a Compound Annual Growth Rate (CAGR) of 69%. A CAGR of 51% in used bandwidth per user was recorded for the same period.[22,23] This stems from growth in the share of cable capacity that is activated or lit,[24] as well as from an increased deployment of internet capacity by internet backbone providers. The average lit capacity on the Europe-sub-Saharan Africa cable routes grew from 11% to 22% of the cables' total capacities between 2016 and 2020.[25]

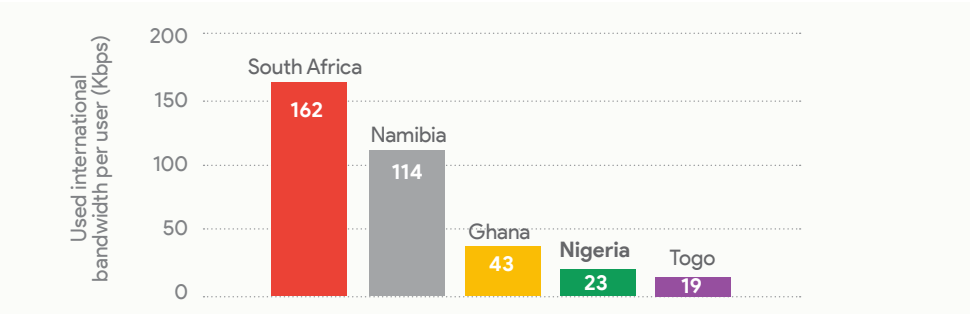
Despite this fast growth, Nigeria's bandwidth capacity relative to the number of users remains low, compared to some peer countries. Bandwidth capacity per internet user in Ghana and South Africa, for example, stood at 43 Kbps and 162 Kbps respectively in 2020, while in Nigeria it was only 23 Kbps (see Figure 6).

FIGURE 5 : Used international bandwidth capacity in Nigeria 2016 - 2020



Source: TeleGeography, 2022, Global Bandwidth Research Service, Regional Analysis | World Bank Open Data, 2021
Note: Bandwidth capacity per user is calculated by dividing total international bandwidth capacity by the number of internet users in the country.

FIGURE 6 : Comparison of used international bandwidth capacity per user in selected African countries 2020



Sources: TeleGeography, 2021, Global Internet Geography, Regional Analysis | Genesis Analytics, 2022, team analysis

22. TeleGeography, 2020, Global Bandwidth Research Service Data.
23. Used international bandwidth also referred to as used capacity is the sum of all capacity deployed by internet backbone providers, content providers, research and education networks and enterprises and other. Used bandwidth does not refer to traffic, but rather to capacity.
24. Fibre optic cable capacity that is in use.
25. TeleGeography, 2022, Global Bandwidth Research Service, Regional Analysis: Africa.

CABLE DAMAGE AND DISRUPTION TO CONNECTIVITY IN NIGERIA

In recent years, several cables connecting to West Africa have experienced physical damage mainly due to weather, other natural conditions and fishing vessels, resulting in major disruptions to services. These incidents have had an impact even to countries which are connected to several cables, such as Nigeria.

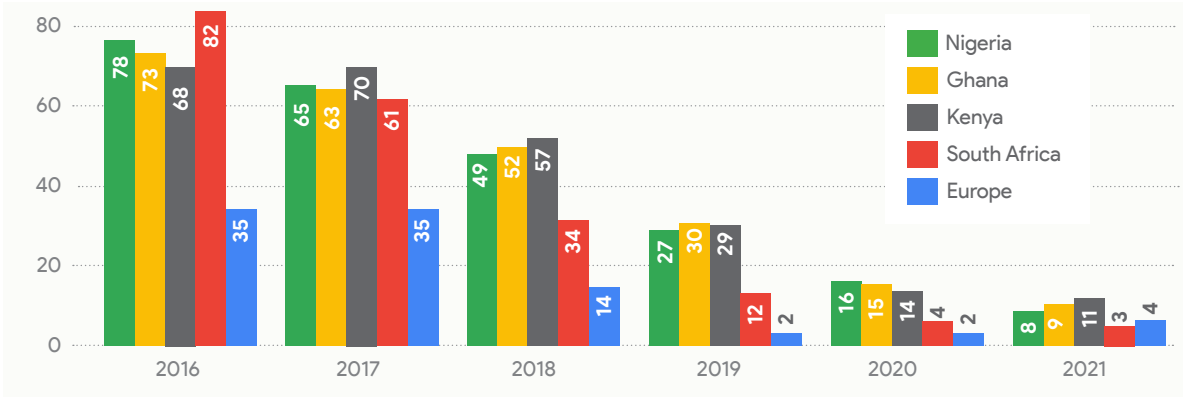
In 2009, damage to the SAT-3/WASC cable - then West Africa's only active submarine link - caused multiple internet blackouts, including in Nigeria, which suffered a 70% reduction in bandwidth for over a week.[26] In January 2020, Nigeria, and the wider region, experienced further significant disruption, following damage to the SAT-3/WASC and WACS systems, which left businesses and users unable to access reliable internet.[27] While the MainOne, ACE and Glo-1 cables were unaffected, a lack of interconnection between operators meant the impact on connectivity was significant, despite redundant international links.

Having a diversity of cable routes and landing stations provides safety in numbers. Equiano's landing in Nigeria will provide the country with additional network redundancy, ensuring better stability of bandwidth connectivity, as well as lower latency and higher speeds in the long-haul transmission of data.

International bandwidth pricing

Nigeria has experienced a sustained and significant decline in IP transit prices - from an average of USD 78 / Month / Mbps in 2016 to USD 8 / Month / Mbps in 2021. This translates to an average decline of 36% year-on-year over this period.[28] Though Nigeria's IP transit prices are similar to those in Kenya and Ghana, they are still over twice as high as in South Africa (see Figure 7). There is, therefore, considerable room for IP transit prices in Nigeria to keep falling. The increase in international bandwidth capacity arising from the installation of new subsea cables such as Equiano will continue to drive the reduction in IP transit prices.

FIGURE 7 : IP transit prices in Nigeria and selected geographies (USD / Mbps / Month) 2016 - 2021



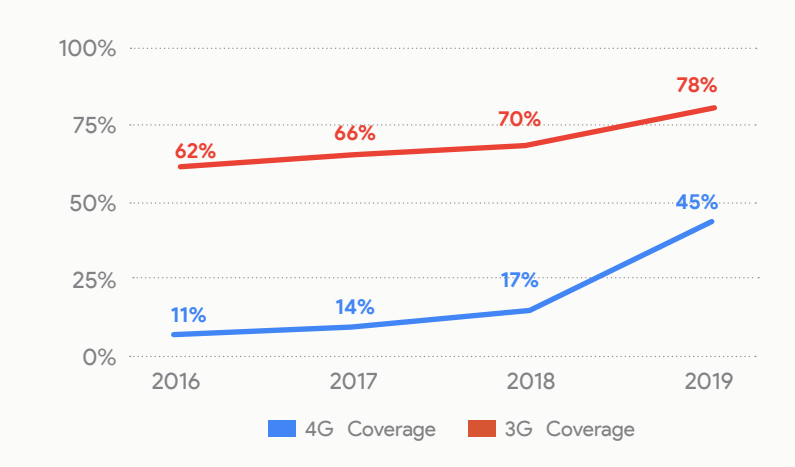
Source: TeleGeography, 2021, Pricing Suite - IP transit prices, database | Genesis Analytics, 2022, team analysis

26. BBC, 2009, Cable fault cuts off West Africa.
27. The Guardian, 2020, Confusion as submarine cable cuts, slows internet.
28. TeleGeography, 2020, Pricing Suite data.

Internet coverage

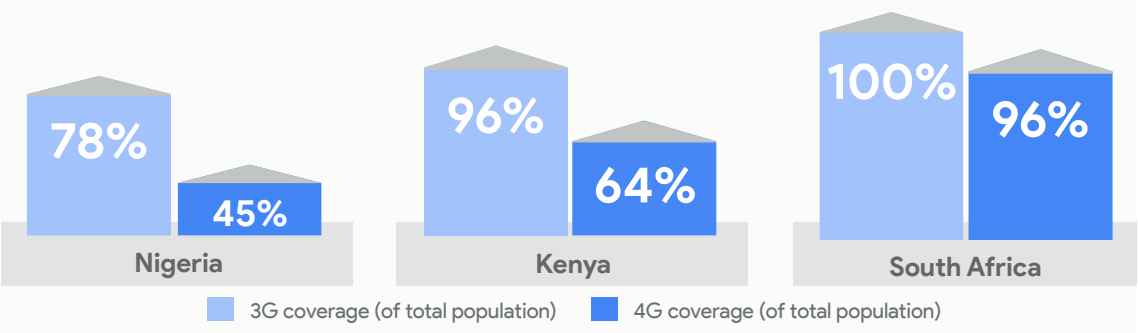
Nigeria has relatively low 3G and 4G network coverage (see Figure 8), which is mainly concentrated in the south and in large, urban settlements across the country. Mobile internet coverage in Nigeria is lower than in peer countries in Africa. Figure 9 provides a comparison with South Africa and Kenya, which represent sub-Saharan Africa's largest economies alongside Nigeria.

FIGURE 8 : 3G and 4G network coverage in Nigeria (% of population) 2016 - 2019



Source: GSMA, 2021, Mobile Connectivity Index

FIGURE 9 : 3G and 4G coverage in Nigeria, Kenya and South Africa 2019



Source: GSMA, 2021, Mobile Connectivity Index

Regionally, Nigeria also fares relatively poorly. In 2019, for example, 3G coverage in Cameroon and Ghana stood at 85% and 89% respectively, with 4G coverage reaching 53% and 68%. The corresponding figures in Nigeria were 78% and 45%, despite the country's comparatively higher population density. Meanwhile, 2G coverage has been flat at 89% between 2016 and 2019.

Internet coverage has expanded steadily in recent years. In particular, 4G coverage experienced a significant boost between 2018 and 2019, jumping from 17% to 45%. This growth was in part driven by large investments made by the country's largest mobile network operator, MTN Nigeria. In 2020, MTN Nigeria announced a further USD 1.6 billion investment to expand its network and operations.[29] Nigeria is set to roll out commercial 5G services in 2022.

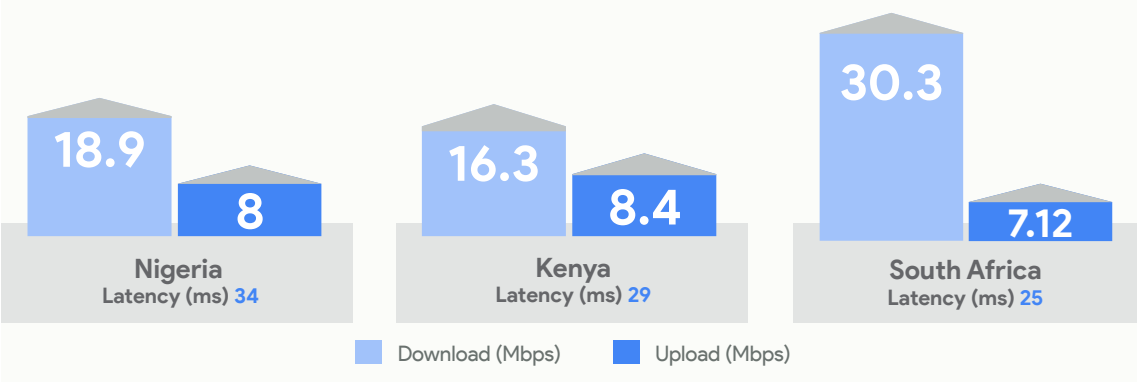
29. MTN Nigeria, 2020, MTN Confirms Further Investments in Nigeria.

On the fixed broadband end, Nigeria has a terrestrial internet fibre network with a length of 54,000km.[30] This equates to roughly a third of South Africa's terrestrial fibre optic network length.[31] More than 75% of the network in Nigeria serves as part of backbone and middle-mile infrastructure, largely backhauling traffic between major cities. The remainder of the total fibre distance is formed of metro fibre networks, which are concentrated in major cities such as Lagos, Abuja and Port Harcourt. Around 39% of the country's population is within 5km of a terrestrial fibre optic cable. Access to the terrestrial internet fibre network is highest in Lagos State, where 85% of the population resides within 5km of the internet fibre network.

Internet speeds and latency

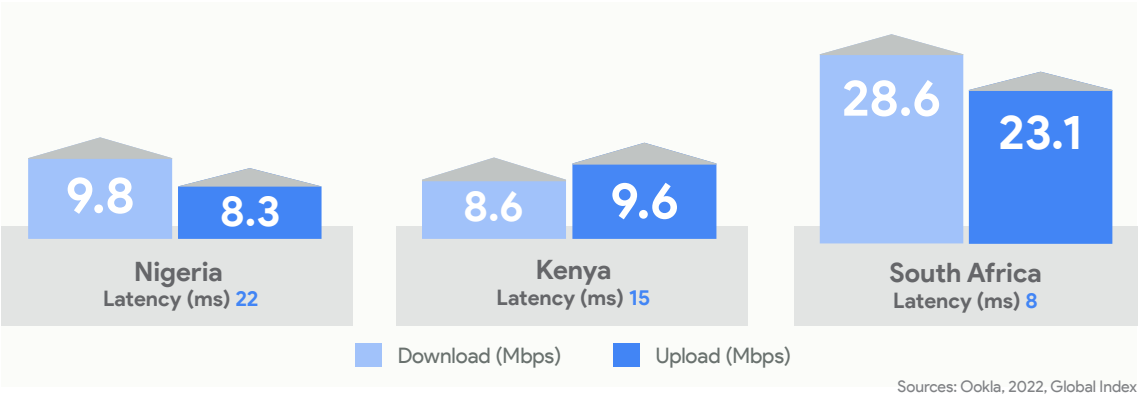
Nigeria has relatively low internet speeds, ranking 94th out of 138 countries for mobile broadband speeds on Ookla's Global Index as of January 2022. The country is ranked 144th out of 178 countries for fixed broadband.

FIGURE 10 : Mobile broadband internet speeds and latencies in Nigeria, Kenya and South Africa **January 2022**



Sources: Ookla, 2022, Global Index. Note: Lower latency indicates better user experience

FIGURE 11 : Fixed broadband internet speeds and latencies in Nigeria, Kenya and South Africa **January 2022**



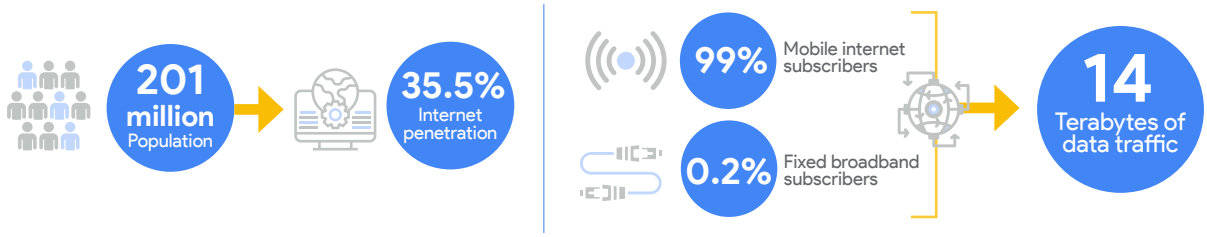
Sources: Ookla, 2022, Global Index

30. NCC, Nigerian National Broadband Plan 2020 – 2025.
31. IOL News, 2011, Telkom Aims to Improve Perceptions.

Using the internet

Improving the adoption of broadband, quality of access and - crucially - affordability has significant potential to accelerate Nigeria's socio-economic development. The subsections below detail the country's connectivity infrastructure, highlighting key trends, progress and challenges.

FIGURE 12 : Internet penetration and usage in Nigeria 2020

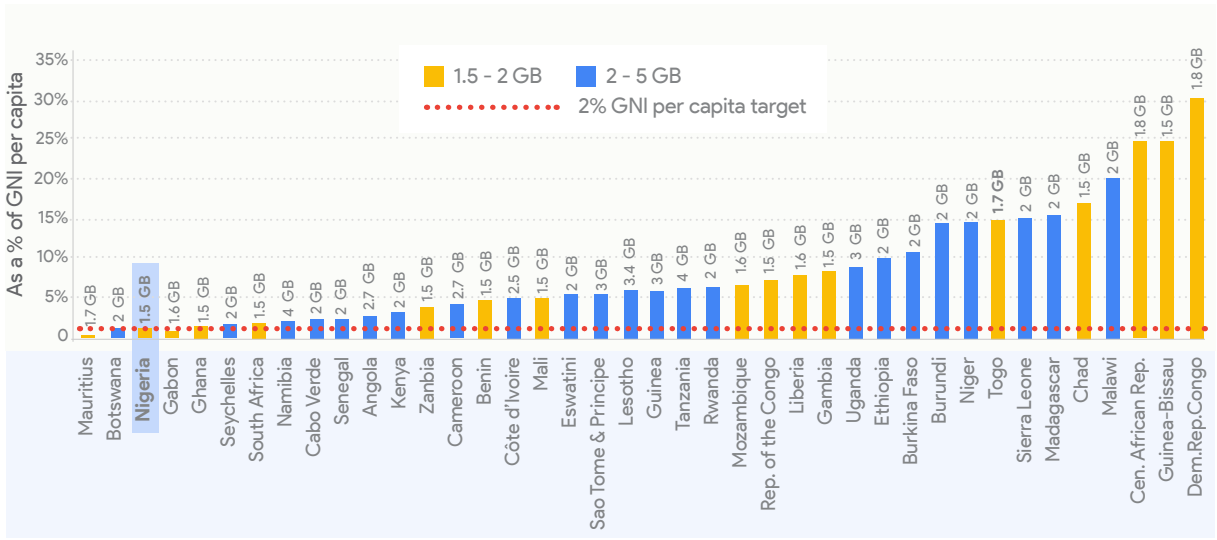


Source: World Bank, Nigerian Communication Commission, ITU

Mobile broadband affordability

Figure 13 highlights mobile data prices as a percentage of Gross National Income (GNI) per capita. In Africa in 2020, only four countries - Mauritius, Botswana, Nigeria and Gabon - had mobile broadband baskets that meet the Broadband Commission's affordability target of 2% of GNI per capita. Nigeria managed to meet the Broadband Commission's target for the first time in 2020 after the average price of entry-level broadband services continued to decline. Between 2016 and 2020, mobile data prices in the country dropped by a year-on-year average of 10%.[32]

FIGURE 13 : Mobile data prices as a percentage of GNI per capita and monthly data allowance in Africa 2020

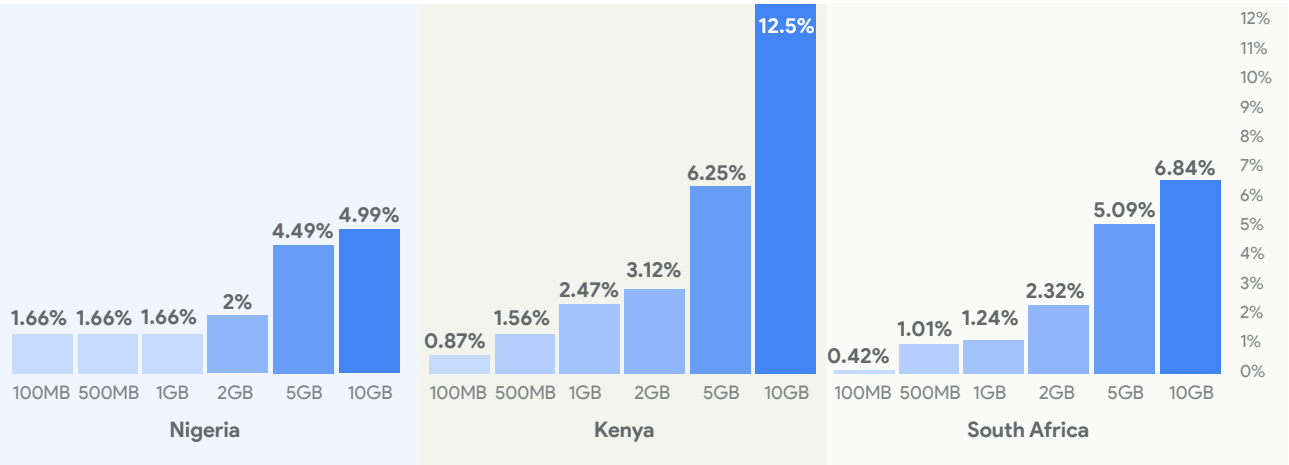


Source: ITU, adapted from *"Measuring Digital Development, ICT Price Trends 2020"*

32. Research ICT Africa, 2021, Mobile Pricing (RAMP).

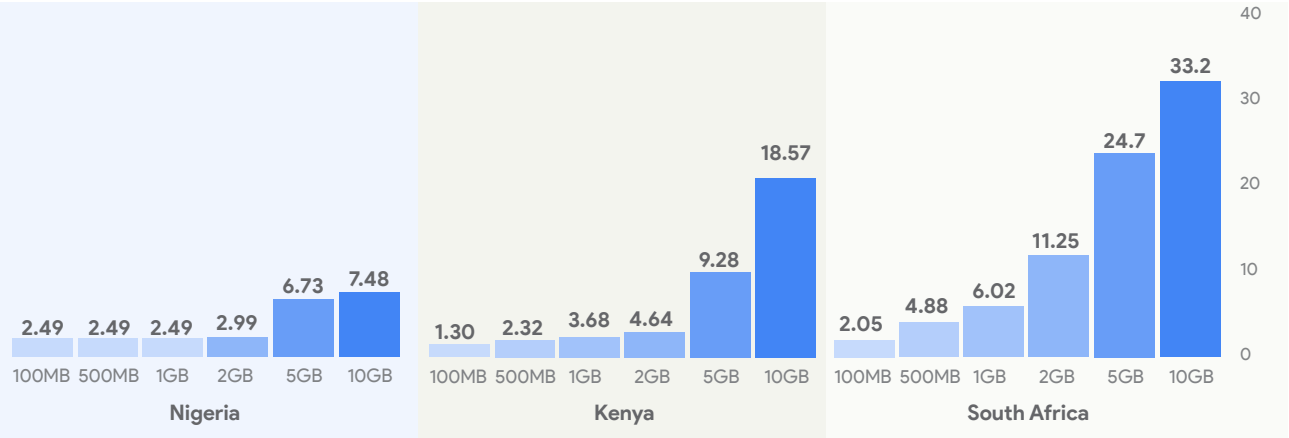
Figures 14 and 15 below illustrate the affordability of mobile broadband in relation to average incomes and in absolute terms (USD) across sub-Saharan Africa's three largest economies. Nigeria performs comparatively well across different mobile broadband bundles.

FIGURE 14 : Affordability of mobile broadband bundles as a percentage of monthly average incomes 2021



Source: Alliance for Affordable Internet, Mobile Broadband Pricing for 2021

FIGURE 15 : Affordability of mobile broadband bundles in USD 2021



Source: Alliance for Affordable Internet, Mobile Broadband Pricing for 2021

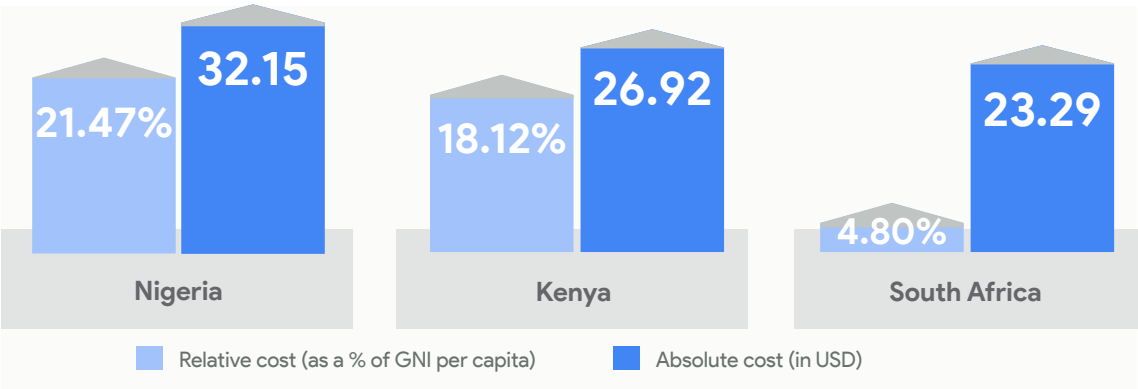
Fixed broadband affordability

Though internet penetration in Nigeria has been growing rapidly, the number of fixed broadband subscriptions has remained very low and is expected to experience limited growth. Fixed broadband subscriptions are currently available solely in high net worth urban areas.

According to the Nigerian Communications Commission (NCC), between 2019 and 2020, the number of active fixed broadband subscriptions decreased by 0.1% - from 107,154 to 107,031.[33] The poor performance of fixed broadband penetration is likely driven by the high cost and large size of fixed broadband subscriptions and packages. The cost of a fixed broadband connection remained above 20% of average income in Nigeria in 2021.

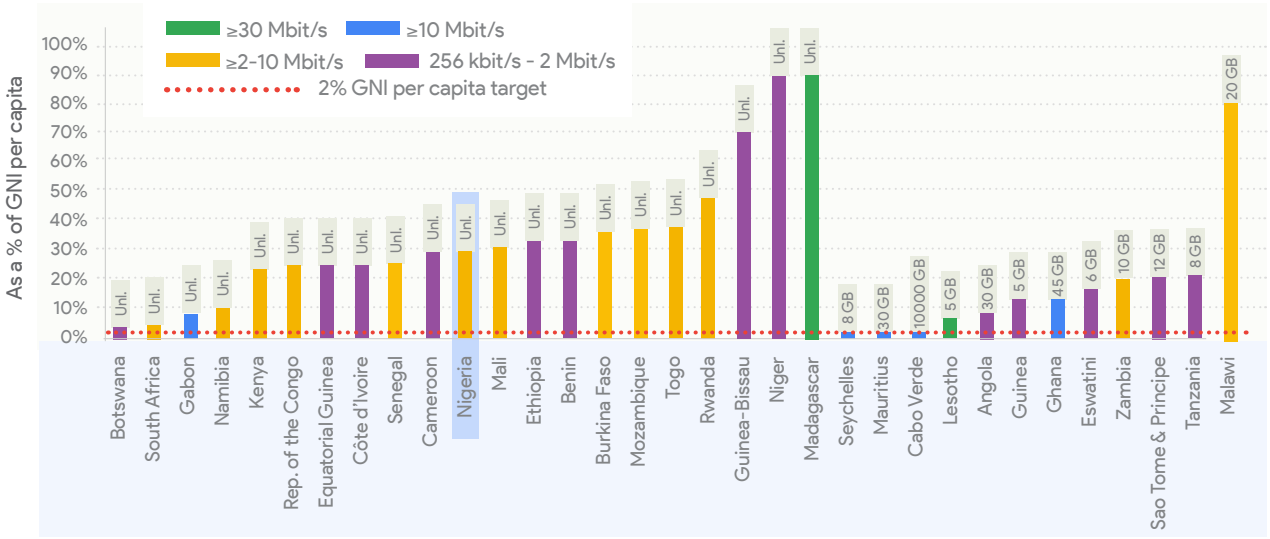
33. NCC, 2021, Subscriber data.

FIGURE 16 : Fixed broadband baskets (5GB, ≥ 256 Kbps) in Nigeria, Kenya and South Africa 2021



Source: Alliance for Affordable Internet, Fixed Broadband Basket Pricing for 2021

FIGURE 17 : Fixed broadband prices as a percentage of GNI per capita, speeds and allowances 2020



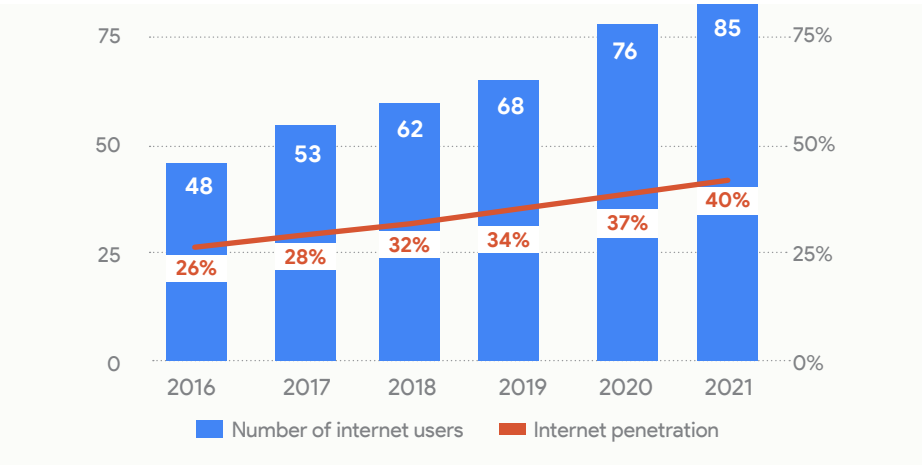
Source: International Telecommunication Union, 2021, Measuring Digital Development, ICT Price Trends

Penetration and usage[34]

The proportion of individuals using the internet in Nigeria increased from 26% in 2016 to 34% in 2019.[35] Between 2012 and 2019, the share of the population going online doubled. This growth is attributed to the significant expansion in 3G and 4G coverage, as well as declines in data prices. In absolute terms, the number of internet users in Nigeria grew at an average rate of 12% year-on-year between 2016 and 2019, reaching a total of 68 million in 2019. The increasing number of users, among other factors, has led to significant growth in data traffic in Nigeria.

34. Internet penetration refers to the share of the population that uses the internet, i.e. individuals who have used the internet from any location using any device in the previous three months. Internet usage refers to the data traffic/activity arising on account of internet users in a country.
35. ITU World Telecommunication / ICT Database, 2020.

FIGURE 18 : Number of internet users and internet penetration Nigeria 2016 - 2021



Source: ITU, World Telecommunication/ICT Indicators Database | Genesis Analytics, 2022, team analysis

Quality of service

Poor quality of service hinders user experience and the adoption of digital services. Nigeria's growing 3G and 4G coverage will help expand access to reliable, high-speed internet, which is key to unlocking the country's digital potential. Meanwhile, the roll-out of 5G in 2022 should also improve user experiences. However, relatively low internet speeds mean that many users are unable to make use of the internet's full potential.

Internet users and their use cases

To better understand the profiles of internet users, as well as their motivations and access requirements, this study segmented Nigerians into five different user profiles, outlining their internet needs and use cases.[36]

FIGURE 19 : Internet user profiles

User profiles	Description of profile	Digital requirements of profile
Large enterprises[37]	While Nigeria has comparatively few large enterprises by global standards, they have an important role in key sectors and create major spillover effects for the wider economy	Access to fast and reliable broadband internet to connect their offices and facilities and be integrated into global value chains
MSMEs[38]	96% of businesses in Nigeria are classified as micro, small or medium enterprises, and they account for 84% of employment	Access digital platforms and tools to manage their business. Access competitive suppliers and markets to sell to customers
Students	Students across all levels of education - from pre-primary to tertiary level - are one of the largest and least-resourced groups requiring devices and learning content	Access online educational and entertainment content to learn from home and leverage digital jobs to earn an income

36. These archetypes have been developed on the basis of employment and demographic statistics and LSM data.
37. Defined as businesses with more than 250 employees.
38. Micro, Small and Medium Enterprises are generally defined as businesses with fewer than 250 employees.

User profiles	Description of profile	Digital requirements of profile
 Medium-to-high skilled workers	Medium-to-high skilled and largely urban-based (remote) workers (including developers) who are either already providing or looking to provide services in the digital economy	Access fast, reliable and affordable broadband internet with professional hardware and software to conduct work (remotely)
 Informal & under-employed workers	82% of the workforce is employed informally, while the unemployment rate reached 33% in Q4 2021	Access digital platforms and tools to engage with potential employers and to network Search for job vacancies online, prepare CVs, work online and upskill using digital training tools
 Gig economy workers	Service providers on platforms like Uber, Gokada and Bolt provide low-skill and temporary services independently	Utilise smartphone apps to connect to sources of income in the gig economy

Equiano

A landmark investment in Africa

Bridging the divides: the critical role of submarine cables

Submarine cables are integral to achieving the above transformational objectives - they are the world's information superhighways and form the cornerstone of the internet. They carry an estimated 99% of global international communications and USD 10 trillion in daily financial transactions.[39] The remainder of international traffic is satellite-based. Highspeed, high-capacity connections - underpinned by submarine infrastructure - are central to today's hyperconnected global economy. Cables enable high-quality video streaming and conferencing, international phone calls, and support the growth of cloud computing.

A next-generation project

In June 2019, Google announced the subsea internet cable, Equiano, that would ultimately run from Portugal to South Africa along the Atlantic Coast of Africa. The initial configuration of the cable system will include landings in Lomé (Togo), Lagos (Nigeria), Swakopmund (Namibia), Rupert's Bay (St. Helena), and Cape Town (South Africa) with branching units in place for further phases of the project. The first phase is expected to be completed in 2022.

39. Reuters, 2022, U.S. recommends approving Google, Meta undersea cable to Asia.

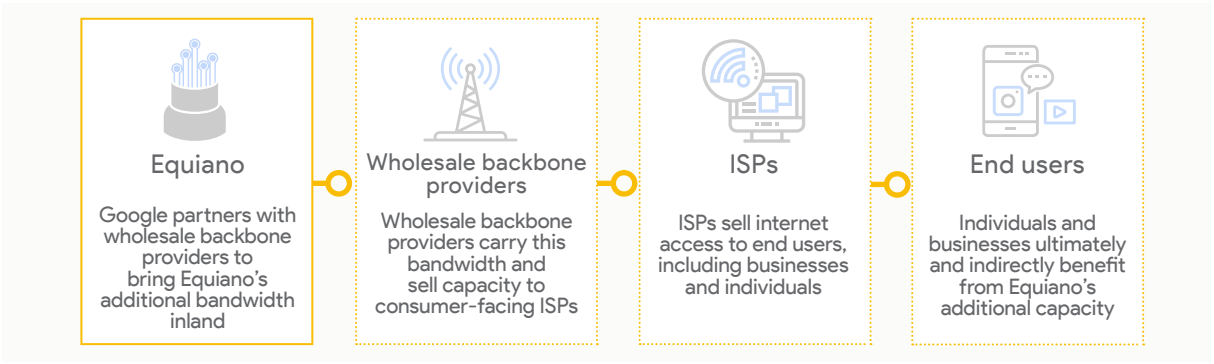
The next-generation Equiano cable will be the first subsea cable to incorporate optical switching at the fibre-pair level, rather than the traditional approach of wavelength-level switching. Equiano will also be the first spatial-division multiplexed (SDM) cable deployed along this route, allowing for a greater design capacity of 144 Tbps. The relative cost of deploying the Equiano cable with respect to its capacity will therefore be lower than the other cables built to date.

A cable system that serves the wider ecosystem's needs

While Google is spearheading the construction of the Equiano cable, other partners - namely wholesale network providers - will be able to use and benefit from the cable's additional capacity. Google does not directly provide broadband or mobile access to end users but instead partners with multiple key telecom players - such as telcos or infrastructure operators - where Equiano lands to ensure that the cable's additional capacity benefits the most end users and businesses across the continent (see Figure 20 below).

This is achieved when key telecom players acquire capacity from the Equiano cable on an indefeasible right of use (IRU) basis. This allows Google's partners to benefit from Equiano's additional capacity over a pre-agreed, long-term time frame for their own use or to lease to third parties. Terrestrial infrastructure players may also avail their fibre routes to Google in exchange for a portion of Equiano's capacity.

FIGURE 20 : How Equiano indirectly benefits end users



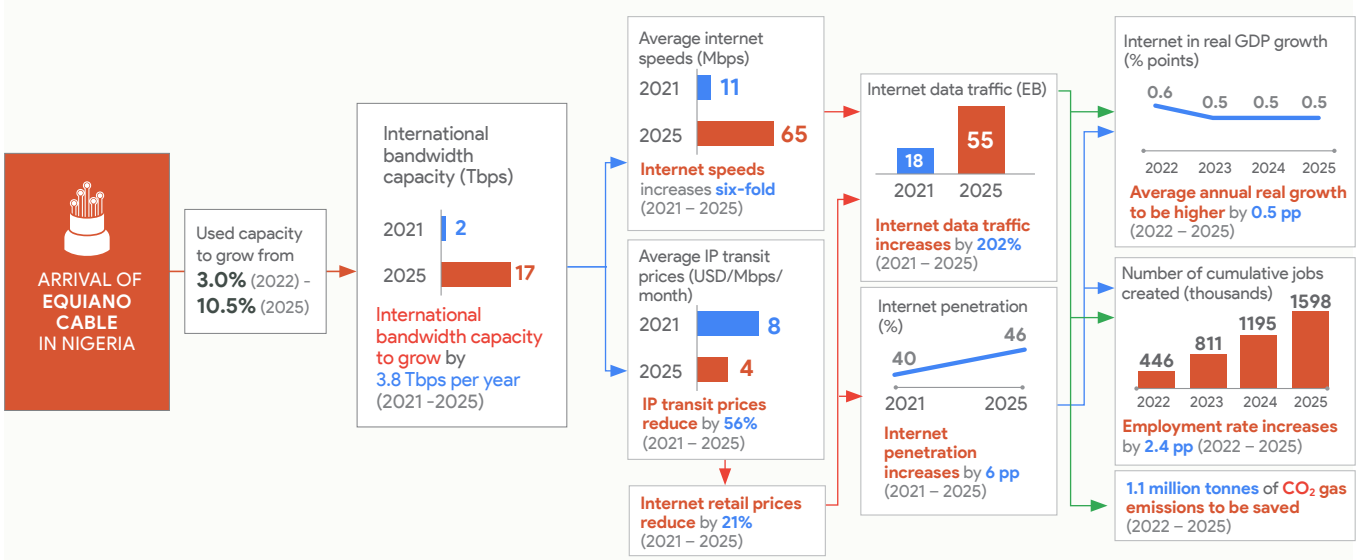
Source: Genesis Analytics, 2022

Equiano's cable landing stations will operate on an open-access and non-discriminatory model where all terrestrial players can interconnect with them if they wish to do so. By guaranteeing open access, Equiano aims to encourage more efficient and cost-effective equipment, ultimately resulting in better outcomes for consumers, businesses and the economy more broadly.

Equiano
A catalyst for connectivity

Equiano will have a direct impact on internet connectivity in Nigeria, resulting in faster internet speeds, lower latency, and lower wholesale and retail internet prices. The cable system will also spur higher economic growth and accelerate digital transformation, and is expected to contribute to a decline in greenhouse gas emissions. Figure 21 below provides a high-level overview of Equiano's expected impacts and their related pathways. The impact assessment model, assumptions and economic analysis are detailed in the technical annex.

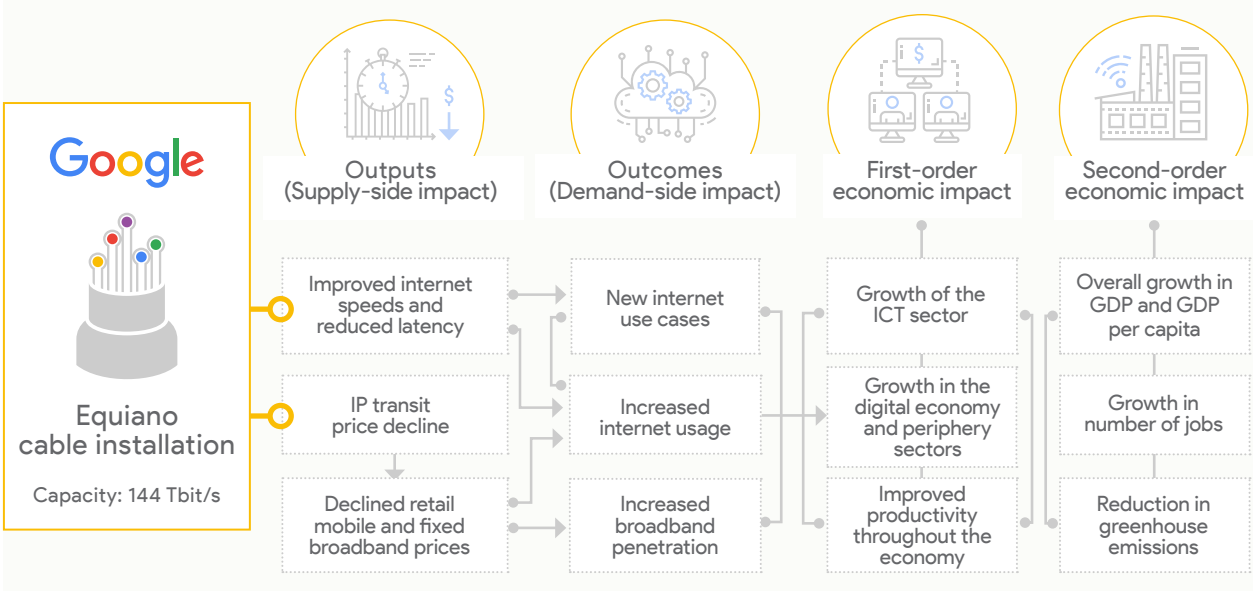
FIGURE 21 : Overview of Equiano's impacts 2021 - 2025



Source: Genesis Analytics 2022, team analysis | Note: pp – percentage points; 2021 figures are forecast based on the 2017 - 2020 trends and the impact assessment model specifications. 2025 figures are results of the impact assessment model

These impact pathways are illustrated in Figure 22 and detailed in the following subsections. In-depth economic modelling and analysis is provided in a separate annex, along with a comprehensive literature review. The pathways show the successive impact of Equiano on the supply- and demand-side components of the internet market, the ICT sector, and the economy as a whole. This framework is based on existing literature concerning the impact of subsea cables on the supply and demand for internet broadband, as well as on literature on the impact of broadband on economic performance.

FIGURE 22 : Equiano's economic impact pathways



Source: Genesis Analytics, 2022

Changes in the supply-side metrics following Equiano's landing are expected to boost demand for, and uptake of, the internet by government, businesses and individuals. In turn, this will contribute to specific sectors benefiting directly from greater internet use, as well as boosting productivity in other sectors of the economy. These sectoral and productivity effects are the first-order economic impacts of the cable. Ultimately, they will lead to higher economic growth, greater job creation and a reduction in greenhouse emissions - the second-order economic impacts. Table 1 below expounds on these impact pathways, which are driven by:

- Faster internet speeds and reduced latency **(pathway 1)**
- More affordable internet access **(pathway 2)**

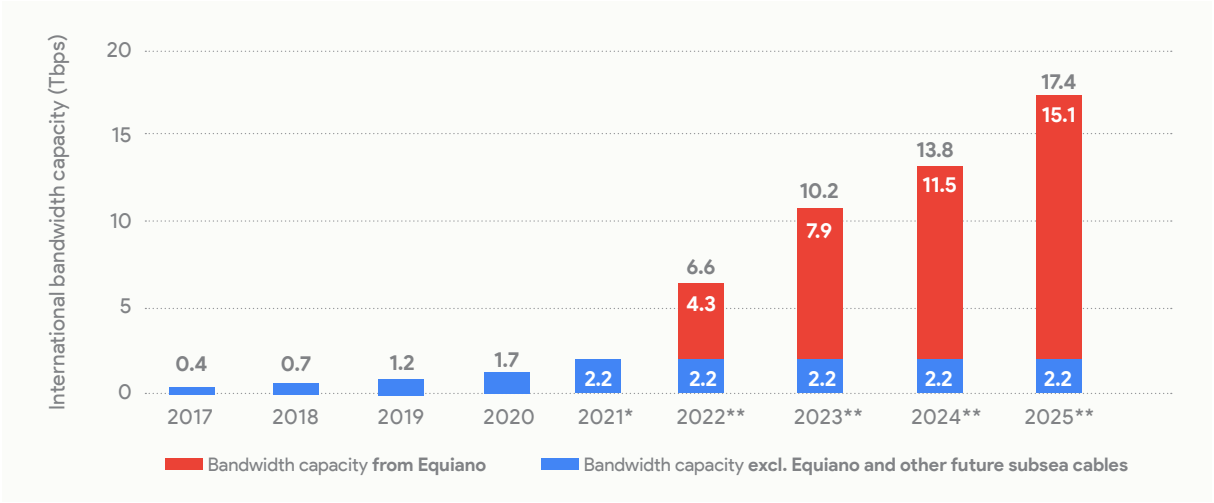
Table 1: Equiano's impact pathways and effects on the economy

	Supply-side impact	Demand-side impact	First-order economic impact	Second-order economic impact
Pathway 1	**Internet speeds and latency** The increased international bandwidth capacity from the Equiano cable means that more data can be transmitted within a given time frame. This will translate into faster internet speeds and lower latency, especially for non-cacheable content, and in areas with an established connection to the internet infrastructure backbone of the country.	Faster internet speeds and lower latencies are likely to enable new internet use cases, such as online learning and virtual conferencing, which have greater broadband requirements. Improved internet speed and latency will also result in greater internet usage demonstrated by greater data traffic.	Increased demand for and usage of the internet arising from increased penetration, growing adoption of new use cases and an overall increase in data traffic have the following immediate economic effects: • Growth of the ICT sector: greater demand and usage of the internet increases ISPs' revenues, induces the expansion of their networks and causes them to hire more labour, creating more jobs within the sector. • Growth of the digital economy and peripheral sectors: as more people increasingly provide and/or access services online and make transactions, internet penetration and usage increases, as does adoption of new use cases. Peripheral sectors such as transport and storage also experience growth as a result. • Improved productivity: increased adoption and usage of the internet will boost economic output with fewer resources. Examples of this are efficiencies in communication, payments and the various operational activities of businesses in a wide range of sectors. Such efficiencies lead to increased economic output within a shorter time frame.	Growth in the ICT sector, the digital economy and its peripheral sectors - as well as productivity improvements in the wider economy - enable: • Faster growth of GDP and GDP per capita. • Growth in the number of jobs in the economy. • Diversification of the economy away from agriculture. • Reduction in greenhouse emissions.
Pathway 2	**IP transit prices** The cost of long-haul transmission of data is a major determinant of local IP transit prices. The creation of an alternative long-haul transport route through the Equiano cable, together with the greater capacity of the cable, will directly (through a lower installation cost relative to design capacity) and indirectly (through increased competition for long-haul transmission of data) lower transmission and IP transit costs. The benefits of lower IP transit costs could in turn be directly passed on to consumers by ISPs through decreases in internet prices, or indirectly, through the provision of more data, uncapped data limits or higher speeds at the same price. Lower IP transit prices could improve ISPs' bottom lines, enabling them to invest in the expansion of their networks, thereby increasing coverage.	A reduction in retail fixed and mobile broadband prices will boost adoption and usage of internet through: • New internet subscribers (especially for fixed broadband) who previously could not afford the cost of a subscription. • Increased internet usage by subscribers who will be able to use more data at the same price or access higher internet speeds at a lower price. • Increased adoption of new internet use cases with high data requirements that had previously been too costly.		

Connectivity impact of Equiano

The increase in international bandwidth capacity following Equiano's landing (see Figure 23) is expected to have an immediate impact on average IP transit prices, speeds and latency. For end users in Nigeria, this will translate to cheaper and more reliable internet access, leading to a substantial growth in traffic and internet penetration.

FIGURE 23 : International bandwidth capacity in Nigeria **2017 - 2025**



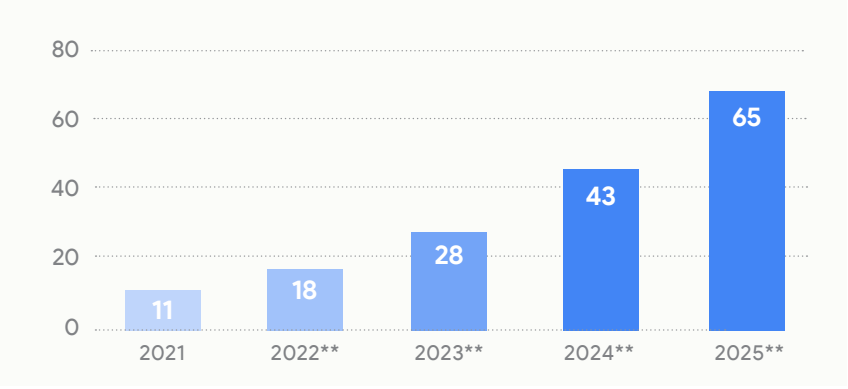
Sources: Telegeography, 2021, Global Bandwidth Research Service Data
Note: * Forecasts | ** Equiano impact analysis period

Accelerating internet speeds

Investments in submarine cables boost internet speeds

The increased international bandwidth capacity from the Equiano cable means that more data can be transmitted to Togo within a particular time frame. This will translate into faster internet speeds and lower latency, particularly with regard to non-cacheable content, and in areas in close proximity to a terrestrial fibre optic cable.

FIGURE 24 : Equiano's impact on internet speeds (Mbps) **2021 - 2025**



Sources: Ookla, 2022, Speedtest Global Index | Genesis Analytics, 2021, Team Analysis
Note: **Equiano impact analysis period

Making the internet more affordable

While internet access in Nigeria is comparatively affordable and prices for entry-level services meet the affordability target of 2% of monthly GNI per capita set by the Broadband Commission, there is still scope for prices to drop further. The cost of long-haul transmission of data is a major determinant of local IP transit prices. Equiano's landing in Nigeria will create a new, high-capacity route for international data transmission.

The cable's lower installation cost relative to design capacity, as well as increased competition for the long-haul transmission of data, will lead to lower IP transit prices. In turn, lower IP transit prices could be passed on to customers through decreases in internet prices, or indirectly - through the provision of more data, uncapped data limits or higher speeds at the same price.

Methodological note: MODELLING EQUIANO'S EXPECTED IMPACT ON INTERNET PRICES

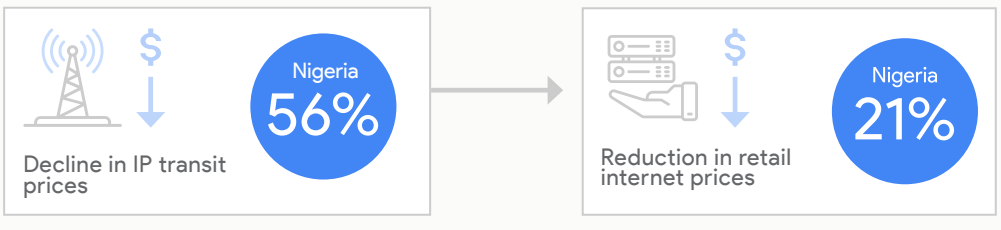
The modelling of Equiano's expected impact on internet prices is based on a 2020 study by Analysys Mason,[40] which quantifies the impact of Google's investments in network infrastructure in the Asia-Pacific (APAC) region. While the dynamics of APAC's internet market are different to those of Nigeria, the study's results can be applied here, as the state of the APAC internet market during the period covered by the study (2010-2019) is comparable to the current and predicted near-future state of connectivity in Nigeria.

The study finds that IP transit prices declined by 74% between 2010 and 2019 in countries with a strong connection to the network of subsea cables - a result of internet network infrastructure installed during this period. The study implies an additional 1 Tbps in international bandwidth capacity results in wholesale IP transit prices declining by 4.9%.

This coefficient is then applied to Nigeria's IP transit pricing. The expected decline in retail internet prices in Nigeria due to Equiano is then calculated, based on the assumption that 30% of the reduction in IP transit prices is passed on to customers. Please see section 4.3 of the technical annex for a more detailed explanation.

It is important to note that Equiano's expected impact on retail internet prices constitutes an estimate based on historical trends. This should not be construed as a guarantee of any specific outcome.

FIGURE 25 : Equiano's impact on internet prices **2021 - 2025**

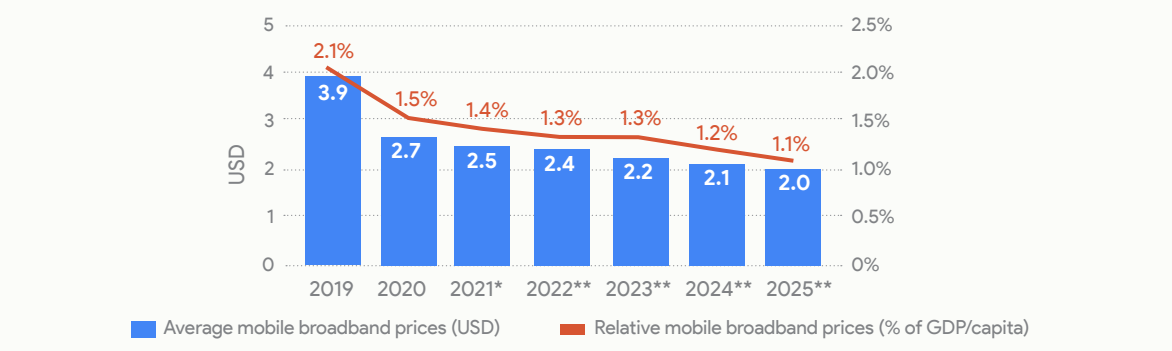


Source: Genesis Analytics, 2022, team analysis

40. Analysys Mason, 2020, Economic Impact of Google's APAC Network Infrastructure.

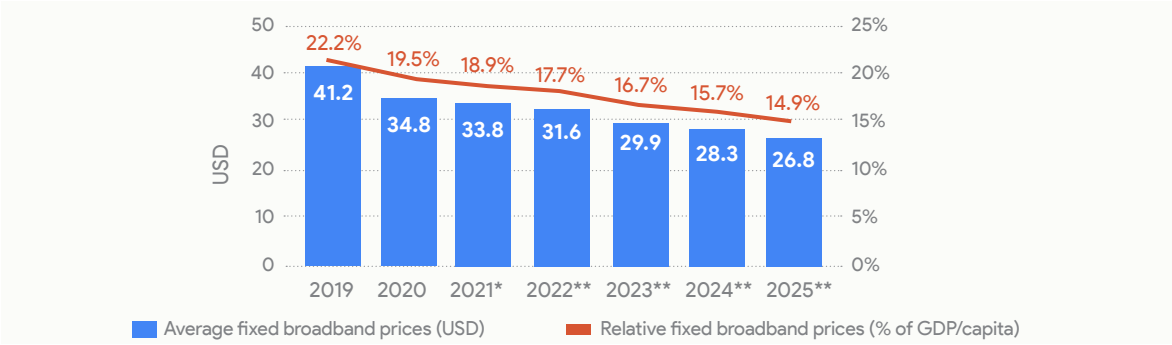
Figures 26 and 27 below illustrate the expected decline in average mobile and fixed broadband retail prices, immediately prior to and during the Equiano impact assessment period (2022-2025).

FIGURE 26 : Average mobile data retail prices[41] 2019 - 2025



Sources: International Telecommunication Union, 2019-2020, Measuring Digital Development, ICT Price Trends | Genesis Analytics, 2022, team analysis.
Note: *Forecast | **Equiano impact analysis period

FIGURE 27 : Average fixed broadband retail prices 2019 - 2025



Sources: International Telecommunication Union, 2019-2020, Measuring Digital Development, ICT Price Trends | Genesis Analytics, 2022, team analysis.
Note: *Forecast | **Equiano impact analysis period

Equiano's impact on internet penetration and traffic

Lower prices, combined with improved speeds and latency, are expected to increase internet penetration in Nigeria by 6 percentage points between 2021 and 2025. Figure 28 below illustrates the two pathways which lead to this increase, while Figure 29 highlights the anticipated growth in the number of internet users and penetration following Equiano's landing.

41. While internet affordability is typically defined in relation to GNI per capita, GDP is a metric that can be used to forecast growth figures with greater confidence. We have therefore selected the GDP per capita metric to highlight Equiano's expected impact on internet prices up to 2025.

FIGURE 28 : Lower prices and improved speeds increase internet penetration and improve user experiences

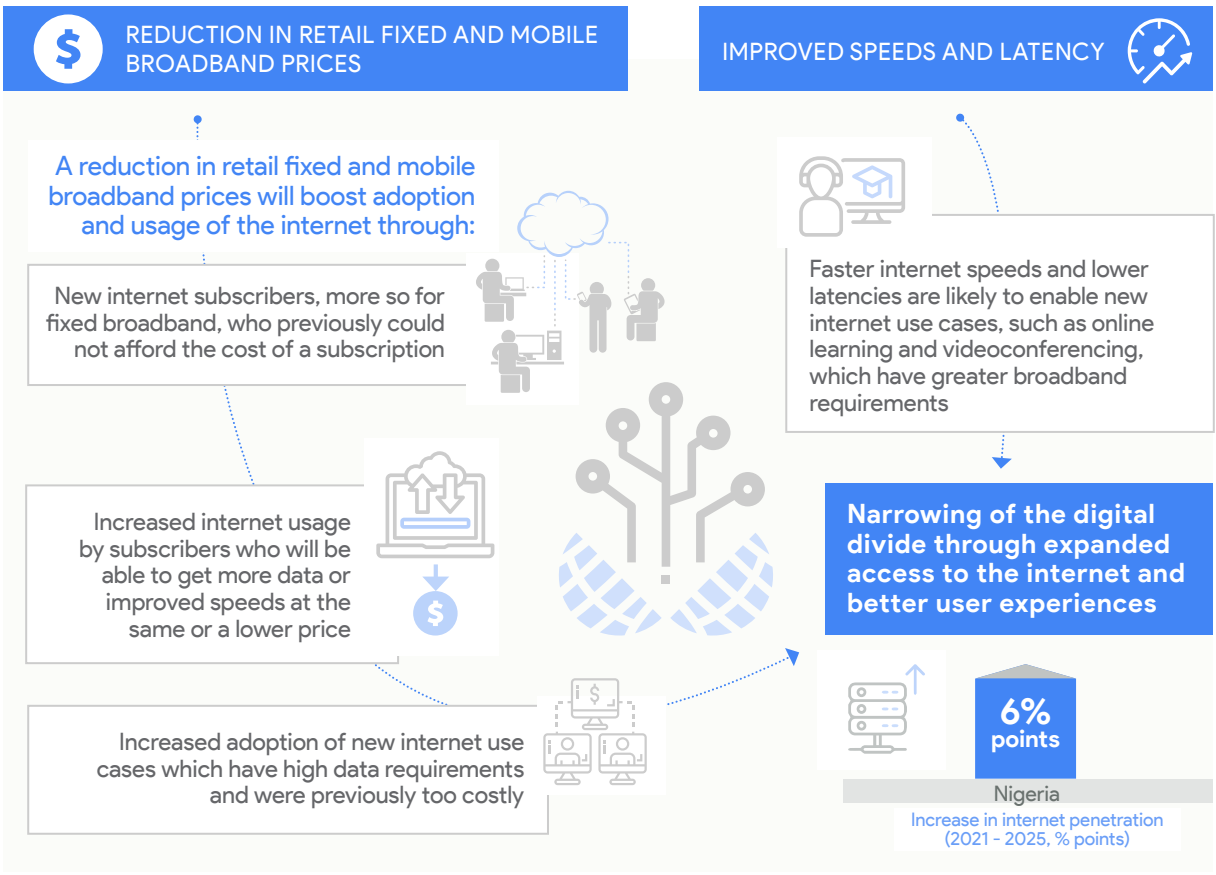
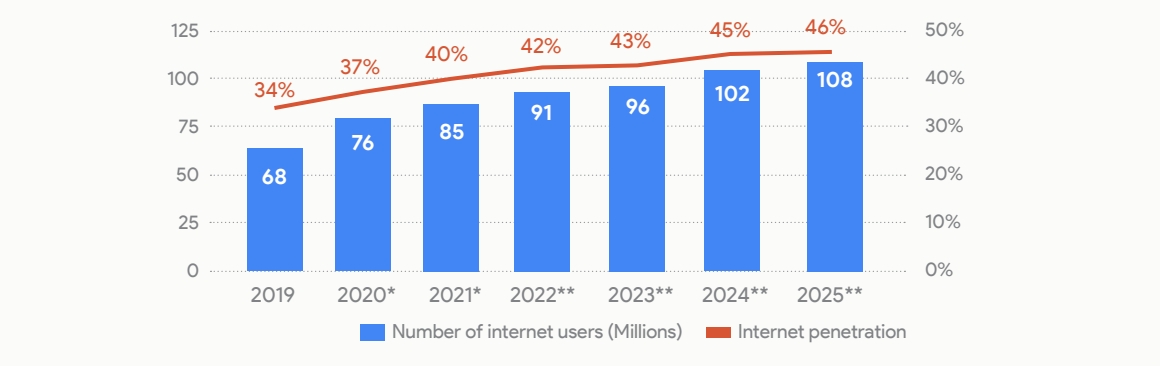


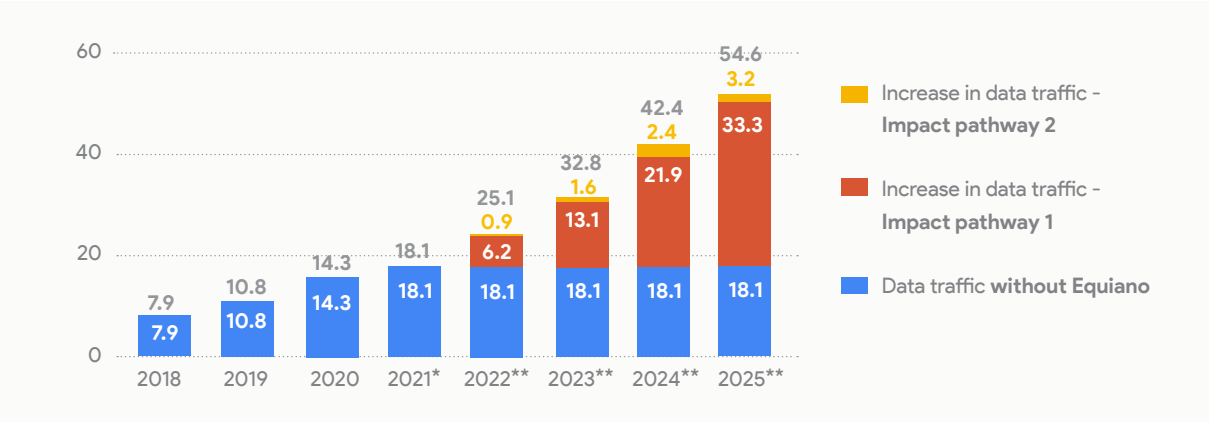
FIGURE 29 : Number of internet users and internet penetration in Nigeria 2019 - 2025



Source: ITU, World Telecommunication/ICT Indicators Database | Genesis Analytics, 2022, Team analysis
Note: *Forecast | **Equiano impact analysis period

Faster internet speeds will lead to a higher demand for data traffic. In parallel, lower internet retail prices will increase internet usage both extensively (by enabling new users to get online for the first time, as well as new ways of using the internet for existing users) and intensively (by enabling existing users to consume more data). The growth in total data traffic in Nigeria following Equiano's landing estimated from faster internet and more affordable access is illustrated in Figure 30 below.

FIGURE 30 : Total data traffic in Nigeria (EB) 2018 - 2025



Source: Genesis Analytics, 2022, team analysis | Analysys Mason, 2017, Wireless Network Data Traffic in sub-Saharan Africa: Trends and Forecasts 2016–2021
Note: Exabyte (EB) = 10^{12} MB | *Forecast | **Equiano impact analysis period

Catalysing network expansion and attracting hyperscalers

Submarine cables' impact on speeds and prices described above can catalyse investments by ISPs and infrastructure operators, thereby expanding terrestrial networks. Specifically, lower IP transit prices following the landing of cables such as Equiano improve ISPs' bottom lines, enabling them to invest in the expansion of their networks to reach new customers. In parallel, greater demand and usage of the internet following Equiano's landing is also expected to increase ISPs' revenues, inducing the expansion of their networks.

High Right of Way (RoW) fees, however, remain a major impediment to investments in terrestrial infrastructure across Nigeria. While the federal government has sought to slash RoW fees to stimulate infrastructure development and has removed them for telcos laying fibre optic cables along federal highways until December 2022, some state governments have resisted federal appeals in order to preserve existing revenue streams. Under Nigeria's political system, the federal government cannot force state governments to lower RoW fees.

Very few states have implemented a 2020 agreement by state governors to adopt a reduced and uniform RoW fee structure. Addressing this critical bottleneck is vital to expanding terrestrial infrastructure across the country.

Well developed digital infrastructure - including submarine cables - is an essential prerequisite for investments in large-scale data centres. Nigeria has already attracted sizeable investments in large-scale data centres, such as Africa Data Centres' facility in Lagos, which opened in November 2021 and will ultimately have 10MW of IT load.[42] Similarly, Rack Centre doubled the capacity of its Lagos facility to 1.5MW in July 2021 and aims to add a further 13MW of capacity, which is expected to come on stream in 2022. Enhanced connectivity provided by Equiano and other next-generation submarine cables will underpin growing investments in hyperscalers in Nigeria, contributing to the growth of the broader digital economy.

Cheaper and quicker internet underpins better user experiences

Improved speeds, lower latencies and more affordable internet bundles and subscriptions following Equiano's landing will support the types of users outlined in the table below. More reliable connectivity will improve the quality of their experience using latency-sensitive products and applications.

42. Africa Data Centres is taking a phased approach to the construction of its data centre campus in Lagos.

Table 2 : Internet use cases, minimum digital requirements and Equiano's impact

USE CASE	MINIMUM DIGITAL REQUIREMENTS	EQUIANO CABLE IMPACT
Online learning Some educational institutions in Nigeria have transitioned to virtual learning as a result of the pandemic. **User profile:** Students, remote workers, job seekers, gig economy workers and migrant families.	1. A 1.5 Mbps Internet speed as a minimum requirement (both upload and download speed). 2. Institution platform, EDX, Coursera, Google Classroom, Google Meet, Zoom etc. Google Meet requires that outbound signals from a participant in all situations must meet a 3.2 Mbps bandwidth requirement for HQ video calls. The minimum requirement for SD video calls is 1 Mbps. 3. Educational materials require ~20 GB per month.	Internet speeds are set to increase from 11 Mbps in 2021 to 65 Mbps in 2025, while retail internet prices are set to decrease by 21% within the same time frame. Through the value chain illustrated in Figure 20, Equiano will improve the ability of businesses and individuals to meet the minimum digital requirements for various use cases by: • **Delivering** more than the required speed and latency to enable good connectivity for all use cases. • **Improving** the bandwidth available to users in order to seamlessly access the digital tools for each of the use cases. • **Enabling** the acquisition of monthly data requirements for various use cases, more so for those requiring 20 GB per month or less. • **Boosting** the adoption of the outlined use cases, giving more businesses and individuals access to an internet connection which meets the minimum digital requirements. • **Increasing** the intensive and extensive usage of the internet for these use cases.
Entertainment and gaming As individuals remain at home due to the COVID-19 pandemic, users are now increasingly using the internet for entertainment and live gaming. **User profile:** Students, remote workers, job seekers, gig economy workers and migrant families.	1. Netflix requires 3 Mbps for SD (standard definition) quality. YouTube videos can be streamed in standard definition for just 500 Kbps, with live events requiring at least 1 Mbps. Live gaming requires 10Mbps. 2. YouTube, Netflix, Showmax, NollyLand, IrokoTV, FilmHouse. 3. Videos, audio and games require ~100 GB per month.	
Job search and application A growing share of job recruitment processes are now conducted online from application to interview. **User profile:** Job seekers.	1. To search and complete job applications requires 500 kbps. Google Meet requirements as stated above. 2. Jobberman, Hot Nigerian Jobs, My Job Mag, NG careers, Joblist, Grow with Google, Google Meet, and Zoom. 3. Job forms and remote interviews require ~5 GB per month.	
Remote work Remote workers require high internet bandwidth and reliable internet connectivity. **User profile:** Students, remote workers, job seekers.	1. Google meet has a minimum 3.2 Mbps bandwidth requirement. 2. Google Workspace, Meet, Firebase, Slack, Adobe, call centre applications, Upwork etc. 3. Documents, coding, video and audio require ~100 GB per month.	
Gig economy work Gig economy workers include workers who provide a temporary service on digital platforms such as Gozem. **User profile:** Gig economy workers.	1. Internet bandwidth of ~500 Kbps to ~2 Mbps. 2. Uber, Bolt, Google Maps, Oga Taxi, Jumia, OFood etc. 3. GPS, audio, text, and voice call require ~20 GB per month.	
E-commerce and online business management Businesses require the internet to offer online retail services and manage operations. **User profile:** Businesses.	1. WhatsApp Business required 64 Kbps and 500 Kbps for other business applications. 2. Jumia, Google Cloud, Google My Business, WhatsApp Business, Shopify, Sage. 3. GPS, audio, video, text, and voice call require ~20 GB per month.	
Remittances Remittances include local and cross-border payment to peers and merchants. **User profile:** Students, remote workers, businesses, job seekers, gig economy workers and migrant families.	1. A minimum of 500 Kbps. 2. WorldRemit, TransferWise etc. 3. Payment rails (P2P, P2B, P2G, B2P, and G2P) require < 1 GB per month.	

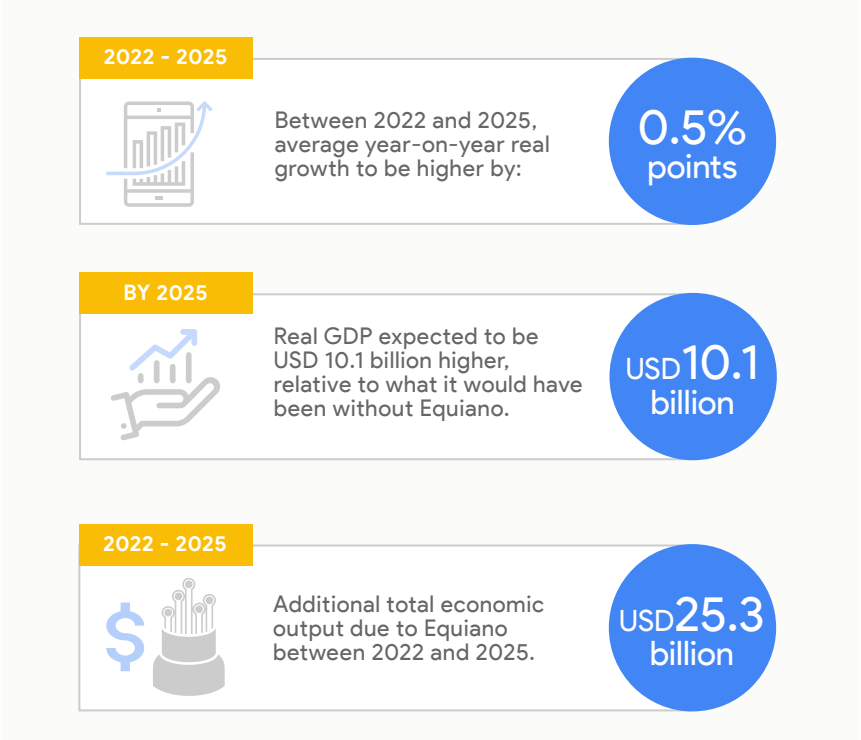
Macroeconomic impact of Equiano

Internet connectivity unlocks significant economic opportunities - more so in developing countries than in their developed counterparts. A landmark study by the International Telecommunications Union in 2019 found that in Africa, a 10% increase in mobile internet penetration increases GDP per capita by 2.5%.[43] According to a separate study by the World Bank, achieving universal and affordable access to the internet across the continent would increase GDP growth by 2 percentage points per year and would boost employment opportunities by up to 13%.[44]

Boosting economic growth

More affordable and reliable internet access - following the landing of submarine cables such as Equiano - accelerates digital transformation and stimulates the digital economy, boosting GDP and growth rates.

FIGURE 31 : Equiano's impact on the economy



Source: Genesis Analytics, 2022, team analysis

Underpinned by reliable connectivity, the digital economy can be a game-changer for Nigeria's economy and society: it represents an opportunity to accelerate growth, industrialise, diversify away from oil, innovate, improve service delivery, and enhance people's lives. This takes place through a wide range of mutually reinforcing and overlapping pathways, classified below by three key stakeholder categories:

43. International Telecommunication Union (ITU), 2019, Economic Contribution of Broadband, Digitization, and ICT Regulation: Econometric Modelling for Africa.
44. World Bank, 2020, Togo: Could more digitalization be the solution?

At the individual level, broadband access plays a crucial role in developing human capital, which is essential for economic growth and competitiveness. It helps people acquire new skills and knowledge that are key to identifying and unlocking new employment opportunities. Improved connectivity also means better access to public services, as well as more affordable products and services from the private sector.

For businesses, broadband access lowers costs, raises productivity, drives innovation, introduces new processes and extends commercial links. Broadband also lowers the cost of international communications, thereby benefiting export-oriented firms. For information-intensive companies in the service sector (the knowledge economy), broadband is an integral part of business models. A wide range of sectors - such as fintech, e-commerce, healthtech, media and entertainment, local transportation, food delivery and business-to-business (B2B) e-logistics - are leveraging internet access and adoption to innovate and lead the way in the continent's digital transformation.

For governments, digital transformation can fundamentally improve the way the public sector operates - leading to more efficient service delivery in areas such as health, education or public administration. This, in turn, contributes to a more productive and efficient economy.

For Nigeria, attracting investments that boost connectivity and pivoting towards a digital-first economy offers an opportunity to diversify the economy away from oil, which accounted for over 80% of total export revenues in 2019 and half of government revenues. Diversifying Nigeria's economy will reduce its vulnerability to movements in international oil prices, which have historically fluctuated significantly, limiting the country's ability to implement long-term poverty reduction and growth strategies. Leveraging ICT can unlock new pathways to collective prosperity, increasing government revenues and creating much-needed economic opportunities.

Accelerating job creation

Methodological note:
MODELLING EQUIANO'S EXPECTED IMPACT ON JOB CREATION

The increase in data traffic and internet penetration (outlined in section 6.1.3) following Equiano's landing is expected to create new opportunities for first-time users. It will also enable existing users to find new ways of using the internet, leading to greater employment within the digital economy and the ICT sector. To quantify Equiano's impact on the employment rate in Nigeria, we incorporate the findings of the **RTI study on the economic impacts of submarine fibre optic cables and broadband connectivity in Nigeria.**[45]

45. RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in Nigeria.

The study found that between 2008 and 2013, in areas connected to Nigeria's terrestrial fibre infrastructure (within 500m of a terrestrial fibre optic cable), **the arrival of a new submarine cable increased the likelihood of being employed by 7.8%.** The modelling of Equiano's impact is detailed in section 4.6.2 of the technical annex.

It is important to note that Equiano's expected impact on job creation constitutes an estimate based on historical trends. This should not be construed as a guarantee of any specific outcome.

Between 2022 and 2025, Equiano is expected to indirectly create **1.6 million new jobs** in Nigeria following the cable's landing. By 2025, the employment rate is expected to be **2.4 percentage points higher** as a result of Equiano, driven by two main pathways, outlined below. **It is important to note that Equiano is expected to result in indirect job creation, via the growth of the digital economy, rather than jobs that are directly attributable to the submarine cable.**

Growth of the digital economy and peripheral sectors.

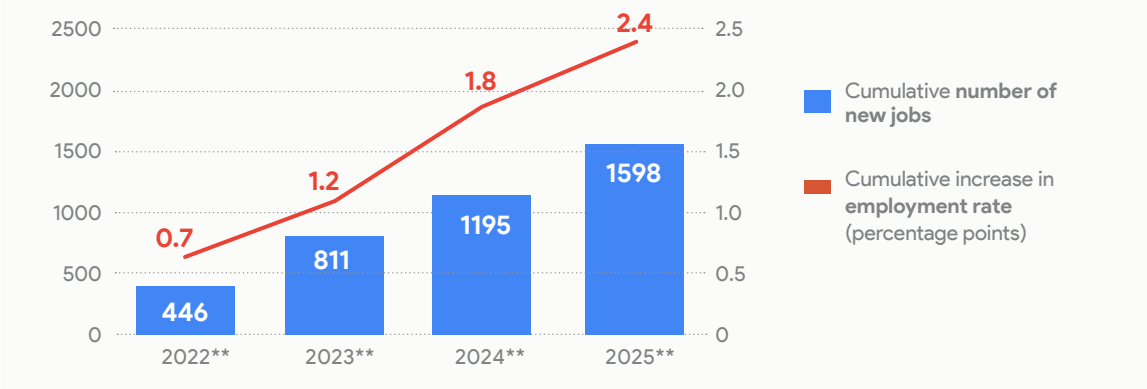
The decline in internet retail prices and improved speeds lead to growing adoption by new users, and more intensive usage by existing ones. In turn, this facilitates the entry of new firms, particularly so in sectors that rely heavily on ICT such as finance and services. Peripheral sectors such as transport and storage also experience growth as a result of the development of e-commerce.

Growth of the telecoms sector.

Rising internet access boosts ISPs' and telcos' revenues, inducing the expansion of their networks, prompting them to hire more.

Figure 32 below illustrates expected job creation following the cable's landing and the associated increase in the employment rate. Equino's expected job creation is a significant impact against the backdrop of Nigeria's high and rising unemployment rate, which reached 33% in Q4 2020, up from 27% in Q2 2020.[46]

FIGURE 32 : Increase in employment due to Equiano **2022 - 2025**



Source: Genesis Analytics, 2022, team analysis | Note: **Equiano impact analysis period

46. Bloomberg, 2021, Nigeria Unemployment Rate Rises to 33%, Second Highest on Global List.

Sustainability impact of Equiano

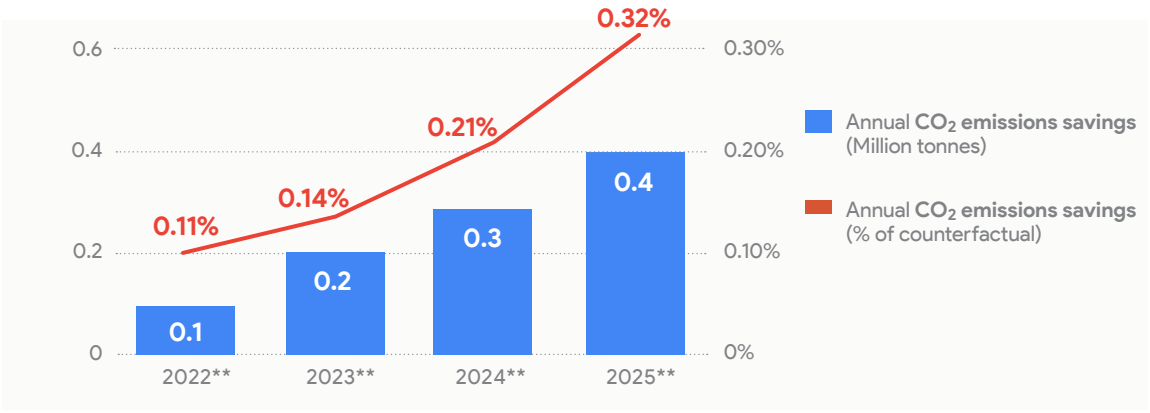
Savings in CO_2 emissions and contribution to the SDGs

The expected increase in broadband penetration and adoption by consumers, businesses, government institutions and educational establishments is expected to lead to savings of CO_2 emissions, as a result of three main impact pathways:

1	2	3
Adoption of more sustainable and efficient electronic communications and a reduction in the consumption of paper	Adoption of teleconferencing and telecommuting, leading to savings in the consumption of petrol	Growth of the e-commerce sector, leading to reduced energy demand for the construction and maintenance of retail and other commercial real estate spaces

Figure 33 below illustrates the cumulative savings in CO_2 gas emissions from Equiano, which amount to 1.1 million tonnes between 2022 and 2025. This averages to 264 kilotons of CO_2 emissions per year, equivalent to 0.2% of Nigeria's CO_2 emissions in 2020.

FIGURE 33 : Savings in CO_2 gas emissions from Equiano **2022 - 2025**



Source: Genesis Analytics, 2022, team analysis | Note: **Equiano impact analysis period

More broadly, investments in connectivity can significantly accelerate progress towards achieving the UN's SDGs by 2030. The SDGs are a blueprint for a better and more sustainable future for all. SDG 17 - Partnerships for the Goals - emphasises that technology is a cross-cutting theme that underpins the attainment of all other SDGs, including economic development, health and education.

Concluding remarks

As outlined in the preceding sections, boosting connectivity can play an important role in realising Nigeria's economic potential. Attracting domestic and international investments in internet infrastructure - at all stages of the value chain, ranging from submarine cables to terrestrial fibre networks that bring access to end users - is central to reducing the digital divide within Nigeria. The development of connectivity infrastructure will also reduce the access gap between Nigeria and other countries with more mature digital ecosystems.

The digital economy can unlock new pathways for inclusive growth and has the transformative potential to spur innovation, create jobs, improve service delivery and reduce poverty in Nigeria. Nigeria is one of Africa's leading digital economy and innovation hubs. Equiano's landing in the country in 2022 is expected to cement this position by boosting internet speeds and broadening access, resulting in faster economic growth and job creation. A total of 1.6 million jobs are expected to be indirectly created between 2022 and 2025 due to Equiano. By 2025, the cable will boost the employment rate by 2.4 percentage points - a significant impact in the context of Nigeria's high and rising unemployment rate.

Boosting internet penetration, adoption and usage among individuals and businesses should be a top priority for governments across sub-Saharan Africa. To accelerate the growth of digital ecosystems and the wider economy, governments should create enabling environments that are conducive to attracting investments in submarine cables such as Equiano.

In particular, enacting transparent policies and procedures with clear timelines to obtain licences and permits for laying and landing submarine cables will stimulate private sector investment. Having a single agency facilitate licence and permit applications will further streamline the process and attract investment. Similarly, improved coordination between government institutions at both the federal and state levels could also simplify these processes. An open model can be adopted for cable landing stations, providing non-discriminatory and cost-oriented access to landing parties to accelerate connectivity.

In parallel, governments should implement best regulatory practices to enable the protection and maintenance of existing submarine cables. Applications for the inspection and repair of submarine cables should be fast-tracked and works exempted from existing cabotage laws, while cable protection laws should be fully implemented and effectively enforced.

Government efforts to increase and broaden internet penetration should not be limited to promoting investment in and maintenance of submarine cables - they should also facilitate the expansion of the country's internet backbone and last-mile connectivity through deliberate policymaking. These measures will ultimately ensure the transfer of the benefits of the newly landed submarine cables to more households and businesses across the country. Different technologies can be leveraged to achieve greater last-mile connectivity. Encouraging investments in these technologies to improve last-mile connectivity requires specific government policies:

Fibre optic terrestrial networks. Governments should establish policies and undertake public infrastructure investments that mitigate the high cost of civil works for fibre deployment so as to make fibre affordable even for developing localities.

Mobile wireless networks. Governments should encourage infrastructure-sharing arrangements among mobile network operators to reduce the cost of extending and improving the density of their mobile wireless networks.

Satellites. Governments should implement supportive regulation, such as lower licence fees for satellite services, and lower import duties on equipment that enables satellite connectivity. Satellite technology has an important role to play in bringing connectivity to remote and underserved communities in rural areas.

Establishing such enabling policy and regulatory frameworks will boost investor confidence and stimulate investment, leading to better infrastructure, higher internet speeds and lower prices. Ultimately, this will increase internet penetration and use, accelerate economic growth, create jobs, reduce greenhouse gas emissions, and lead to an overall improvement in Nigerians' economic opportunities and quality of life.

NIGERIA ECONOMIC IMPACT ASSESSMENT: Technical Annex

Table of contents

Introduction and methodology

This study provides technical background to the Nigeria Economic Impact Assessment, which features an overview of Nigeria's connectivity ecosystem, the national policy environment, background on Equiano and insights into the role of submarine cables in the global economy. The Nigeria Economic Impact Assessment highlights the cable's key impacts on connectivity, the economy, and sustainability, which are elaborated upon in the below sections.

This study is based on a theory of change framework that outlines the mechanisms through which the arrival of the Equiano cable will impact Nigeria's economy. The pathways show the successive impact of Equiano on the supply- and demand-side components of the internet market, the ICT sector, and the economy as a whole. This framework draws on existing literature concerning the impact of subsea cables on the supply and demand for internet broadband, as well as on literature on the impact of broadband on economic performance.

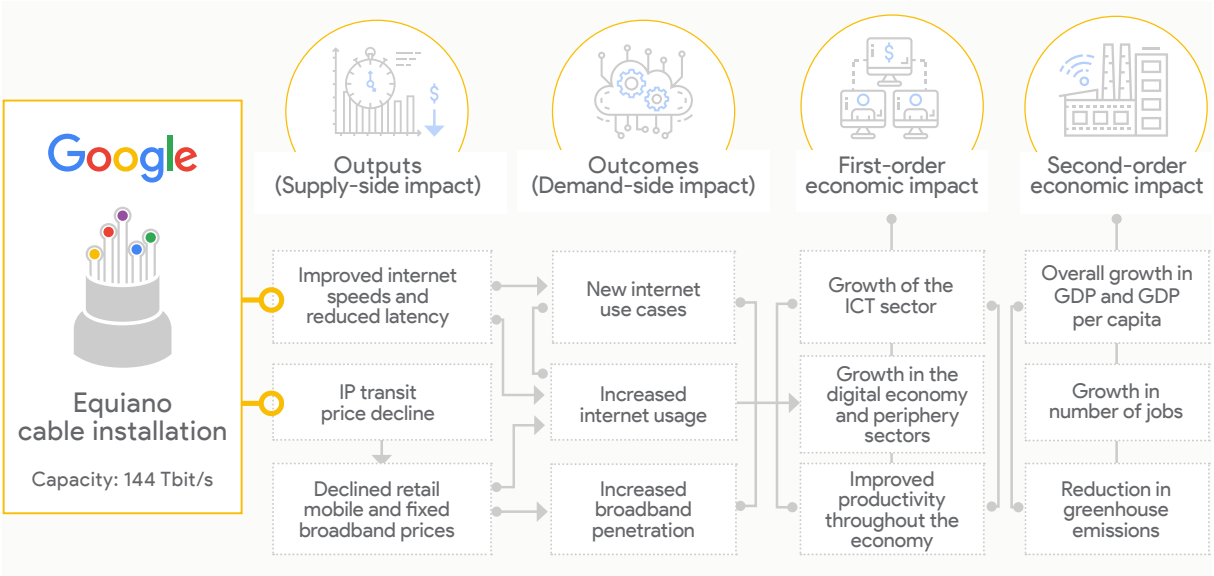
In order to estimate the impact of the Equiano cable on Nigeria's economy, we establish the relationship between the different variables within the impact pathways. The change coefficients quantifying these relationships are obtained from the results of several studies which have run empirical models with multiple data sets. These studies and their results are outlined in the literature review in the annex. Based on the change coefficients, the change in each variable within the impact pathway framework is then modelled. These calculations serve as the basis for estimating the macroeconomic impacts of the Equiano cable.

Equiano cable assessment

Equiano cable impact pathways

Based on a review of the relevant literature, the Equiano cable is expected to impact Nigeria's economy through the impact pathways shown in Figure 1 below. Increased bandwidth capacity resulting from the installed cable will have an immediate effect on the supply-side metrics, i.e. the quality, accessibility, and cost of internet in the country.

FIGURE 1 : Equiano's economic impact pathways



Changes in the supply-side metrics following Equiano's landing are expected to boost demand for, and uptake of, the internet by government, businesses and individuals. In turn, this will contribute to specific sectors benefiting directly from greater internet use, as well as boosting productivity in other sectors of the economy. These sectoral and productivity effects are the first-order economic impacts of the cable. Ultimately, they will lead to higher economic growth, greater job creation and a reduction in greenhouse emissions - the second-order economic impacts. Table 1 below expounds on these impact pathways, which are driven by:

- Faster internet speeds and reduced latency (pathway 1)
- More affordable internet access (pathway 2)

Table 1: Equiano's impact pathways and effects on the economy

	Supply-side impact	Demand-side impact	First-order economic impact	Second-order economic impact
Pathway 1	**Internet speeds and latency** The increased international bandwidth capacity from the Equiano cable means that more data can be transmitted within a given time frame. This will translate into faster internet speeds and lower latency, especially for non-cacheable content, and in areas with an established connection to the internet infrastructure backbone of the country.	Faster internet speeds and lower latencies are likely to enable new internet use cases, such as online learning and virtual conferencing, which have greater broadband requirements. Improved internet speed and latency will also result in greater internet usage demonstrated by greater data traffic.	Increased demand for and usage of the internet arising from increased penetration, growing adoption of new use cases and an overall increase in data traffic have the following immediate economic effects: • Growth of the ICT sector: greater demand and usage of the internet increases ISPs' revenues, induces the expansion of their networks and causes them to hire more labour, creating more jobs within the sector. • Growth of the digital economy and peripheral sectors: as more people increasingly provide and/or access services online and make transactions, internet penetration and usage increases, as does adoption of new use cases. Peripheral sectors such as transport and storage also experience growth as a result. • Improved productivity: increased adoption and usage of the internet will boost economic output with fewer resources. Examples of this are efficiencies in communication, payments and the various operational activities of businesses in a wide range of sectors. Such efficiencies lead to increased economic output within a shorter time frame.	Growth in the ICT sector, the digital economy and its peripheral sectors - as well as productivity improvements in the wider economy - enable: • Faster growth of GDP and GDP per capita. • Growth in the number of jobs in the economy. • Diversification of the economy away from agriculture. • Reduction in greenhouse emissions.
Pathway 2	**IP transit prices** The cost of long-haul transmission of data is a major determinant of local IP transit prices. The creation of an alternative long-haul transport route through the Equiano cable, together with the greater capacity of the cable, will directly (through a lower installation cost relative to design capacity) and indirectly (through increased competition for long-haul transmission of data) lower transmission and IP transit costs. The benefits of lower IP transit costs could in turn be directly passed on to consumers by ISPs through decreases in internet prices, or indirectly, through the provision of more data, uncapped data limits or higher speeds at the same price. Lower IP transit prices could improve ISPs' bottom lines, enabling them to invest in the expansion of their networks, thereby increasing coverage.	A reduction in retail fixed and mobile broadband prices will boost adoption and usage of internet through: • New internet subscribers (especially for fixed broadband) who previously could not afford the cost of a subscription. • Increased internet usage by subscribers who will be able to use more data at the same price or access higher internet speeds at a lower price. • Increased adoption of new internet use cases with high data requirements that had previously been too costly.		

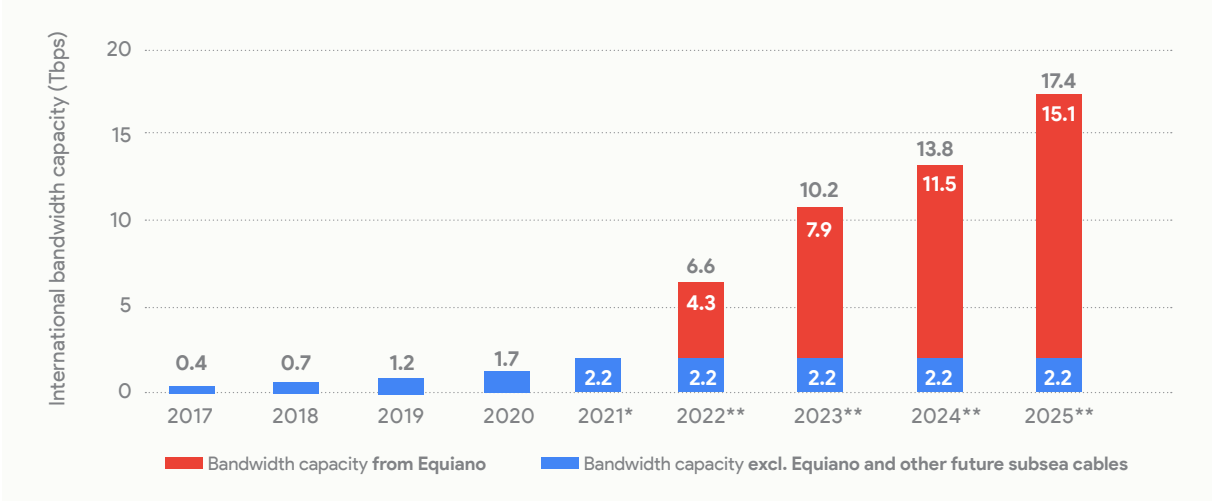
Equiano cable impact analysis

Based on the impact pathways shown in Figure 1, this section presents the results of the Equiano cable impact assessment in Nigeria, quantifying the changes in terms of connectivity, economic growth, employment and greenhouse gas emissions.

The Equiano cable has a design capacity of 144 Tbps. As with other subsea cables globally, only a portion of this capacity will be utilised and translated into additional international bandwidth capacity for Nigeria.[1] Africa's Atlantic coastline is expected to see a number of new cable installations, thereby increasing the region's total potential bandwidth capacity. Equiano's lit capacity is therefore likely to start off very low in order to match the lower demand for bandwidth.

Lit capacity of the cable is therefore modelled to start at 3% of potential capacity in 2022. As demand for bandwidth increases in response to steady and affordable supply, the lit capacity, relative to the potential capacity, is expected to rise by 2.5 percentage points every year, reaching 10.5% by 2025. This additional lit capacity will then translate, one-for-one, into higher international bandwidth capacity for Nigeria, as shown in Figure 2. It is this increase in bandwidth capacity that consequently affects the domestic internet market's supply-side metrics.

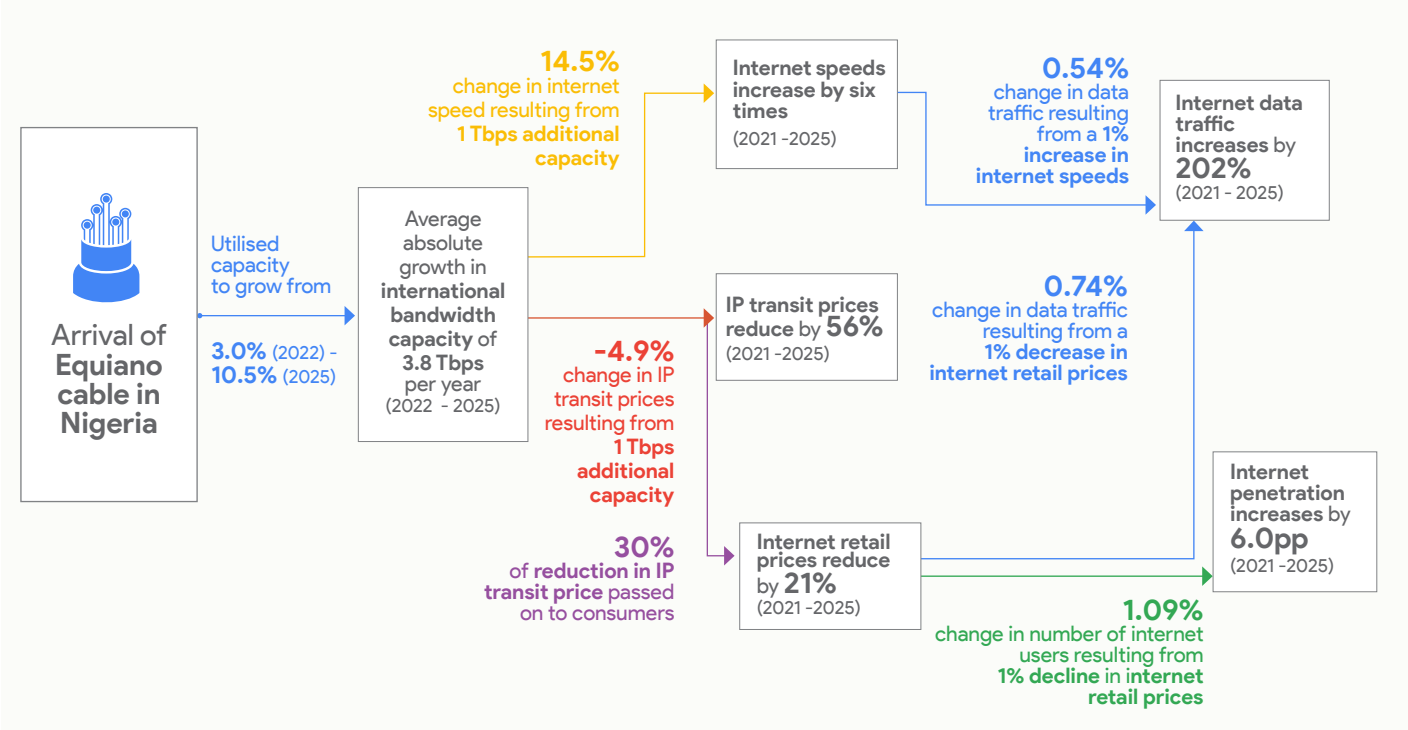
FIGURE 2 : International bandwidth capacity in Nigeria **2017 - 2025**



Sources: Telegeography, 2021, Global Bandwidth Research Service Data, 2021
Note: * Forecasts | ** Equiano impact analysis period

1. The average lit capacity of undersea cables globally remains below 30%. Across the cables from Europe to sub-Saharan Africa, the average lit capacity stood at 17% in 2017, having risen from 5% in 2013 (TeleGeography Blog, 2018). The average lit capacity for the existing cables in Nigeria now stands at 10% (TeleGeography, Global Bandwidth Research Service data).

Overview of the supply-side and demand-side impacts of Equiano



Source: Genesis Analytics, 2022, team analysis. Note: pp - percentage points

Supply-side impacts

The expanded international bandwidth capacity modelled in the previous section is expected to have an immediate effect on average internet speeds, latency, and IP transit prices. In a 2019 study by Hjort and Poulsen,[2] performed across 12 sub-Saharan African markets (including Nigeria) between 2007 and 2014, average internet speeds increased by 35% after the arrival of a subsea internet cable. Within this period, the subsea internet cables that arrived in the region were ACE, WACS, EASSy and SEACOM, with respective design capacities of 12.8 Tbps, 5.1 Tbps, 4.7 Tbps and 1.5 Tbps. These cables therefore had an average design capacity of 6.0 Tbps. Assuming an average lit capacity of 10% across the cables at the time of installation, the average increase in international bandwidth capacity from the arrival of a subsea cable was 0.6 Tbps.

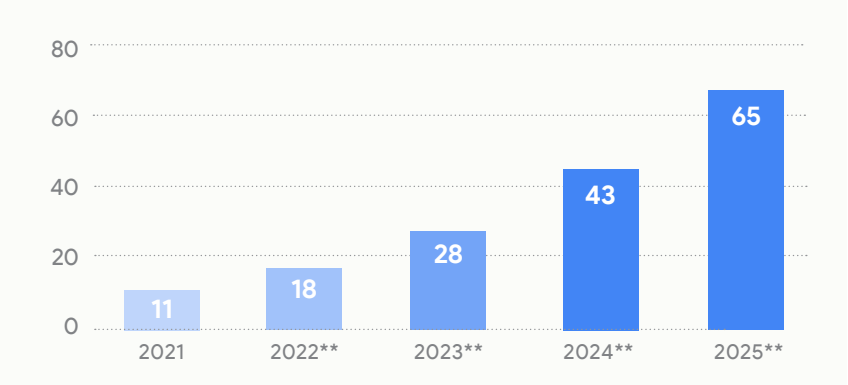
An average increase of 0.6 Tbps in international bandwidth capacity improved internet speeds by 35% on average. Accordingly, we calculate that an increase of 1 Tbps in international bandwidth capacity leads to an increase in internet speeds of 58%.

Given that average internet speeds today are much higher than they were between 2007 and 2014, we apply a 25% discount to the implied coefficient of change from Hjort and Poulsen's study. The applied percentage change in internet speeds for every 1 Tbps increase in bandwidth capacity is 14.5%.

Applying the above coefficient results in a near sixfold increase in internet speeds between 2022 and 2025. As such, average internet speeds[3] are expected to rise from 11 Mbps in 2021 to 65 Mbps in 2025 as a result of Equiano's arrival (see Figure 3).

2. Hjort, J. and Poulsen, J., 2019, The Arrival of Fast Internet and Employment in Africa, *American Economic Review*.
3. Based on median speeds reported by Ookla's Global Index.

FIGURE 3 : Average internet speeds (Mbps) 2021 - 2025

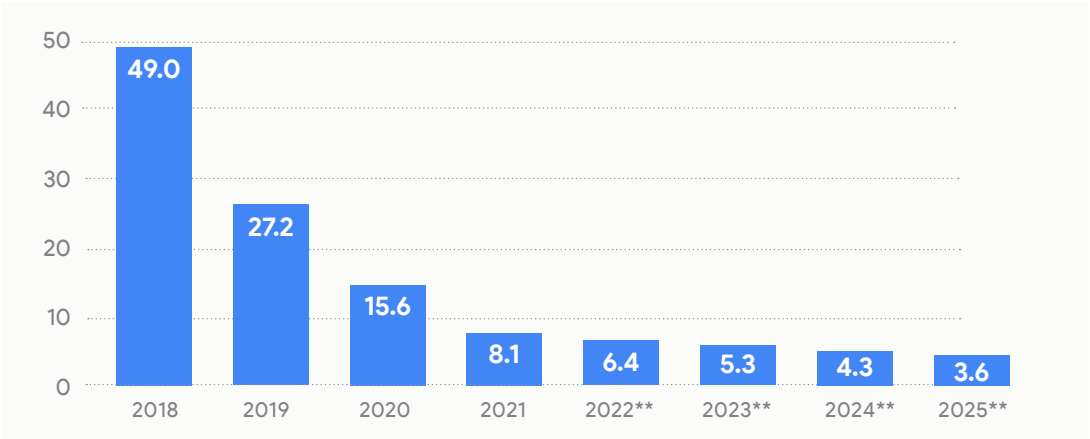


Sources: Ookla, 2022, Speedtest Global Index | Genesis Analytics, 2021, Team Analysis
Note: **Equiano impact analysis period

The change in IP transit prices due to increased international bandwidth capacity is derived from the results of a 2020 Analysys Mason study,[4] which quantifies the impact of Google's investment in internet network infrastructure within the Asia-Pacific (APAC) region. The dynamics of the internet market in APAC are different from those in sub-Saharan Africa; however, the results from the APAC study can be applied here, as the state of the APAC internet market during the period covered by the study (2010-2019) is comparable to the current and predicted near-future state of connectivity in sub-Saharan Africa.

The Analysys Mason study finds that IP transit prices declined by 74% between 2010 and 2019 in countries with a strong connection to the network of subsea cables - a result of internet network infrastructure installed during this time. The subsea cables Google invested in within this region are SJC, Indigo and JGA, which have design capacities of 28 Tbps, 36 Tbps and 36 Tbps respectively. Assuming an average lit capacity of 15% by the end of the period, we can project an additional bandwidth capacity of 15 Tbps from the three cables, inducing a 74% reduction in IP transit prices. This implies that an additional 1 Tbps of international bandwidth capacity results in a decline in IP transit prices of 4.9%. **By this coefficient of change, IP transit prices are expected to fall by 56.2% between 2021 and 2025 - from an average of USD 8.1 per Mbps per month across all circuit networks, to an average of USD 3.6 per Mbps per month** (see Figure 4).

FIGURE 4 : IP Transit prices in Nigeria (USD / Mbps / month) 2018 - 2025



Source: TeleGeography, 2021, Pricing Suite | Genesis Analytics, 2022, team analysis
Note: **Equiano impact analysis period

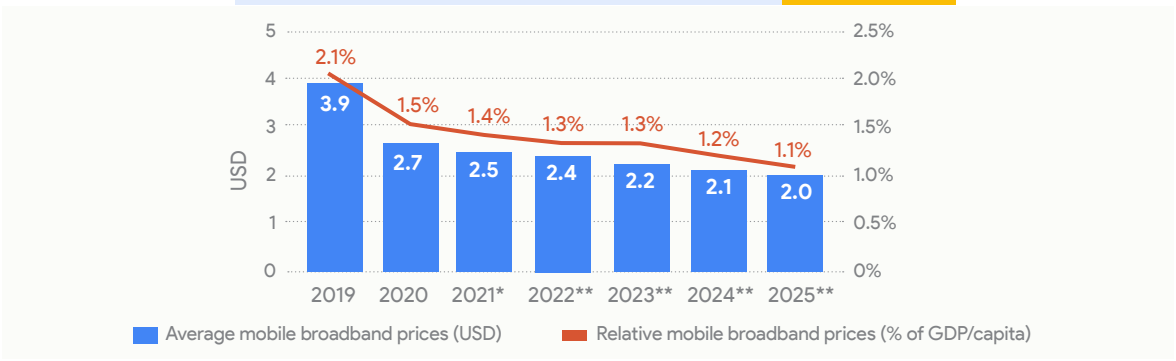
4. Analysys Mason, 2020, Economic Impact of Google's APAC Network Infrastructure.

In the absence of sufficient data or extensive literature on the relationship between IP transit prices and internet retail prices, it is assumed that only 30% of the reduction in IP transit prices is passed on to consumers. This figure is based on the assumption that ISPs will seek to increase the capital available to them through retained earnings for the purpose of investing in last-mile infrastructure. Moreover, last-mile infrastructure investments are more likely to be made in rural areas, where last-mile connectivity is low due to limited infrastructure networks and challenging topographies.

Accordingly, the reduction in internet retail prices year-on-year is 30% of the decline rate of IP transit prices. Cumulatively, internet retail prices are therefore expected to decline by 21% between 2021 and 2025.

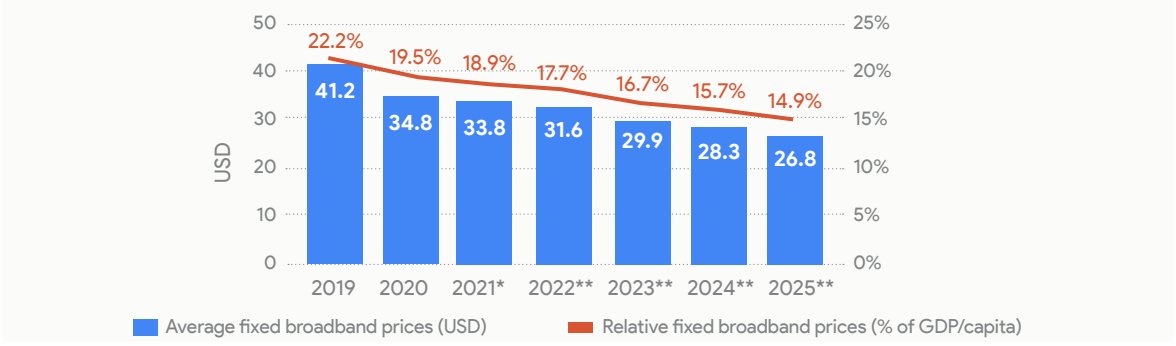
Figures 5 and 6 illustrate the reduction in average mobile data and fixed broadband retail prices.

FIGURE 5 : Average mobile data retail prices (1.5GB) 2019 - 2025



Sources: International Telecommunication Union, 2019-2020, Measuring Digital Development, ICT Price Trends | Genesis Analytics, 2022, team analysis.
Note: *Forecast | **Equiano impact analysis period

FIGURE 6 : Average fixed broadband retail prices 2019 - 2025



Sources: International Telecommunication Union, 2019-2020, Measuring Digital Development, ICT Price Trends | Genesis Analytics, 2022, team analysis.
Note: *Forecast | **Equiano impact analysis period

Demand-side impacts

As illustrated in Figure 1, Equiano is expected to impact the demand-side of the broadband economy - with faster speeds and cheaper broadband access, consumer demand for connectivity is expected to increase.

Faster speeds (impact pathway 1)

Equiano is expected to improve the speed of connectivity across Nigeria, leading to better user experience and a higher demand in data traffic.

Hjort and Poulsen found that, as a result of a new subsea internet cable's arrival, the probability that an individual will use the internet daily rises by 8.2%, while the probability of weekly usage rises by 12.3%. To translate the increase in frequency of using the internet into the equivalent increase in data consumption, we estimate the increase in per capita data consumption by individuals who started using the internet daily or weekly. In both cases, we estimate that, on average, new daily or weekly internet users would have doubled their data consumption.[5]

According to the Digital 2015: Nigeria report by DataReportal, 7% of Nigerians were active social media users in 2015.[6] Using this as a proxy for the share of individuals using the internet daily, we can say that approximately 93% of Nigerians at the time of Hjort and Poulsen's study used the internet less than once a day. Therefore, a total of 20.5% of individuals who did not use the internet daily (93% of the total population) would have doubled their data consumption, translating into an increase in aggregate data traffic of 38.1%. This change, however, arises from faster internet speeds and lower retail prices, both of which follow from the arrival of a subsea cable.

As there is no robust data on the respective faster speeds and lower prices to data traffic, we assume these two factors drive growth in traffic equally. The rise in internet data traffic resulting from faster speeds is therefore 19.1%, owed to the 35% increase in internet speeds reported by Hjort and Poulsen. This results in an implied change coefficient of 54.5% - a 100% increase in internet speeds leads to a 54.5% rise in data traffic. **Applying this coefficient, the total increase in data traffic between 2021 and 2025 due to improved speeds following Equiano's landing in Nigeria is expected to be 184%.**

Lower retail prices (impact pathway 2)

The decline in internet retail prices is expected to drive up both penetration rates and the number of subscribers, while allowing existing users to consume more data and broaden the ways in which they use the internet.

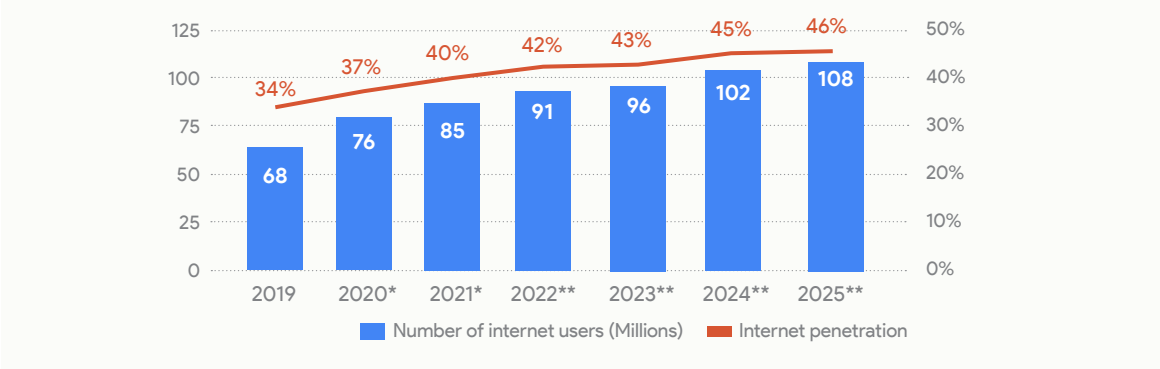
The increase in the number of internet subscribers following a decrease in prices reflects the price elasticity of demand for the internet, an estimate for which can be derived from data on the price elasticity of demand for cable TV. Since the average pricing of cable TV across

5. The rationale behind this estimate is that most of the new daily internet users would have previously been using the internet weekly – perhaps once, twice or thrice a week. In switching to daily use of the internet, they are increasing their frequency of using the internet by two to seven times. Their daily data consumption would however likely reduce with the higher frequency of using the internet. In light of this, we have made the conservative assumption that the data consumption of new daily internet users increases twice on average. Similarly, a majority of the new weekly internet users will likely have previously been using the internet monthly – perhaps once or twice. Their internet usage frequency will therefore increase by two to four times, and along with it their data consumption. However, daily data consumption will likely reduce. We there fore assume that on average the data consumption of new weekly internet users increases by two times.
6. DataReportal, 2015, Digital 2015: Nigeria.

different plans and packages is similar to the average pricing of various internet subscription packages, demand for cable TV is used as a proxy for the measurement of the price elasticity of demand for internet subscriptions/usage. Moreover, cable TV and broadband internet have seen similar rates of subscription across households in Nigeria.

A 2012 study by the Commonwealth Telecommunications Organisation[7] graphs out the number of subscribers of cable TV as a function of price. From this, we estimate the elasticities at different price points. Taking the average price elasticity of -1.09 - the average price elasticity between the USD 100 and USD 60 price points - we apply this to the internet market in Nigeria and find that the overall decline in retail prices of 20.6% between 2021 and 2025 increases the number of internet users by 26.7%. **This translates to an increase in internet penetration of 6 percentage points over the same timeframe, as shown in Figure 7 below.**

FIGURE 7 : Number of internet users and internet penetration in Nigeria **2019 - 2025**



Source: ITU, World Telecommunication/ICT Indicators Database | Genesis Analytics, 2022, Team analysis
Note: *Forecast | **Equiano impact analysis period

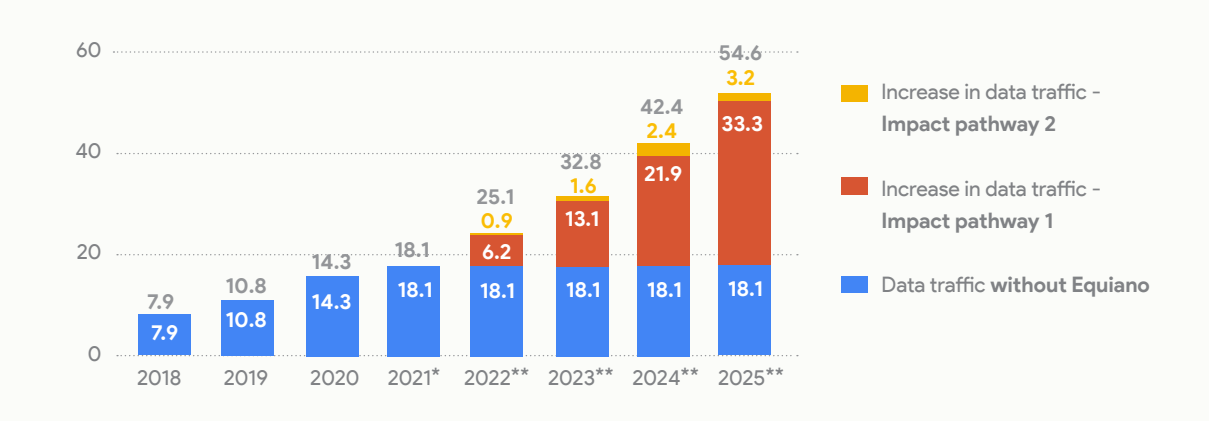
As mentioned in the above section, the total change in internet usage that would have been observed in Hjort and Poulsen's (2019) study is estimated at 38.1%. Half of this increase is attributable to improved internet speeds, while the other half is attributable to lower internet retail prices. This translates into an increase in internet usage of 19.1%, attributable to a 20.6% decline in internet retail prices, yielding a change coefficient of 74.1%. By this metric, the total change in data traffic between 2021 and 2025 attributable to lower internet retail prices is 17.6%.

It is worthwhile to note that the Equiano impact pathway distinguishes increased data traffic caused by intensive internet usage from that caused by extensive internet usage. Greater intensive internet usage arises from existing subscribers using the internet more actively for existing use cases. More extensive internet usage is a result of new subscribers and new internet use cases. Though this distinction exists in the theory of change (Equiano impact pathway), quantifying it credibly is a challenge. The modelled increase in data traffic - 201.7% in total between 2021 and 2025 - therefore encapsulates both intensive and extensive increases in internet usage.

Figure 8 illustrates the increases in data traffic attributable to the two impact pathways (increased speeds and reduced retail prices) discussed above.

7. Commonwealth Telecommunications Organisation, 2012, The Socio-Economic Impact of Broadband in Sub-Saharan Africa: The Satellite Advantage.

FIGURE 8 : Total data traffic in Nigeria (EB) 2018 - 2025



Source: Genesis Analytics, 2022, team analysis | Analysys Mason, 2017, Wireless Network Data Traffic in sub-Saharan Africa: Trends and Forecasts 2016–2021
Note: Exabyte (EB) = 10^{12} MB | *Forecast | **Equiano impact analysis period

First-order economic impact

Examining the first-order economic impact of Equiano[8] is critical to assessing the cable's overall contribution to Nigeria's economy. The increased data traffic and growing number of internet subscribers will likely boost revenues for ISPs, enabling them to expand as well as invest in improving their fixed and wireless broadband reach. In addition to increasing economic output, this will create a multiplier effect, whereby improved fixed and wireless broadband connectivity spurs a further increase in internet demand, ultimately leading to notable growth in the ICT sector.

Increased adoption of the internet by more people and for more uses will lead to additional growth in the digital economy and peripheral sectors. Although it will cause a shift in business and service delivery models, this will not necessarily entail the demise of traditional businesses. Retailers in countries with large e-commerce industries have reported that some verticals have experienced growth in revenues from their physical stores concurrently with growth in their online sales.

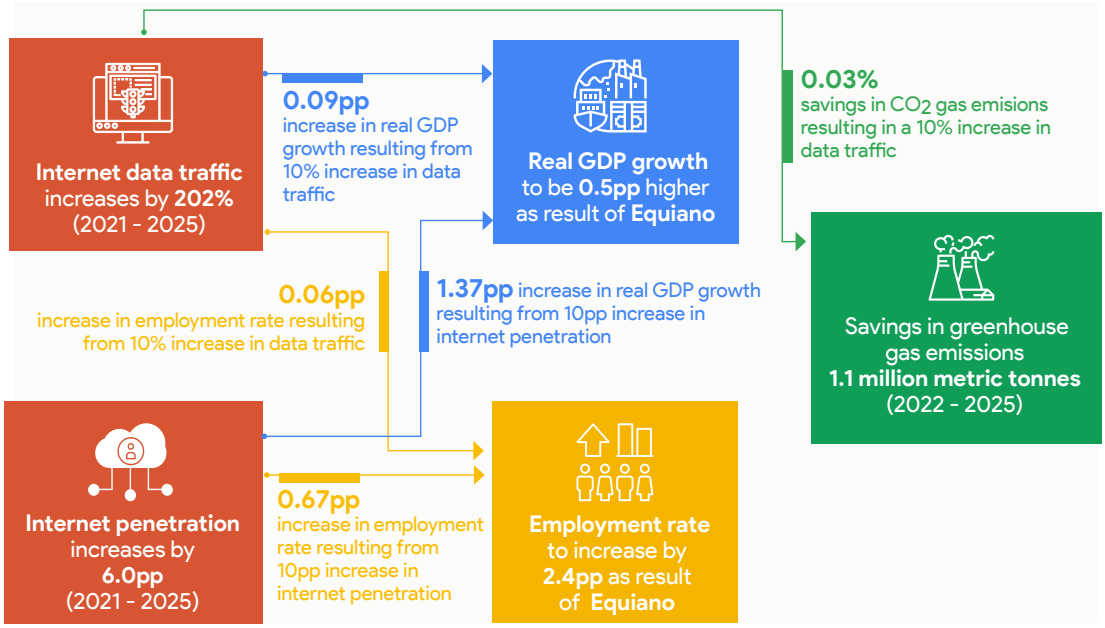
Growth of the digital economy will also spill over into peripheral sectors, such as transport and storage due to the growth of e-commerce. A greater share of business operations being undertaken online will enable improved coordination, collaboration and automation. This in turn will boost the productivity of labour and capital, resulting in greater economic output.

Second-order economic impact

Figure 9 summarises Equiano's second order economic impacts on real GDP growth, employment and savings in greenhouse gas emissions.

8. Though not quantified, the economic growth that should result from the installation of the Equiano cable will manifest primarily through first-order economic impacts. The modelling and quantification of the first-order economic impact requires rich sectoral data, business micro data and data on the digital economy, none of which are readily available. Since the relationship between the outcome variables and the second-order economic impact variables can be established through the results of other empirical studies on this topic, modelling and quantifying the first-order economic impact is not necessary to quantify the ultimate economic impact of the Equiano cable.

FIGURE 9 : Macroeconomic impact of Equiano



Source: Genesis Analytics, 2022, team analysis | Note: pp - percentage points

Real GDP growth

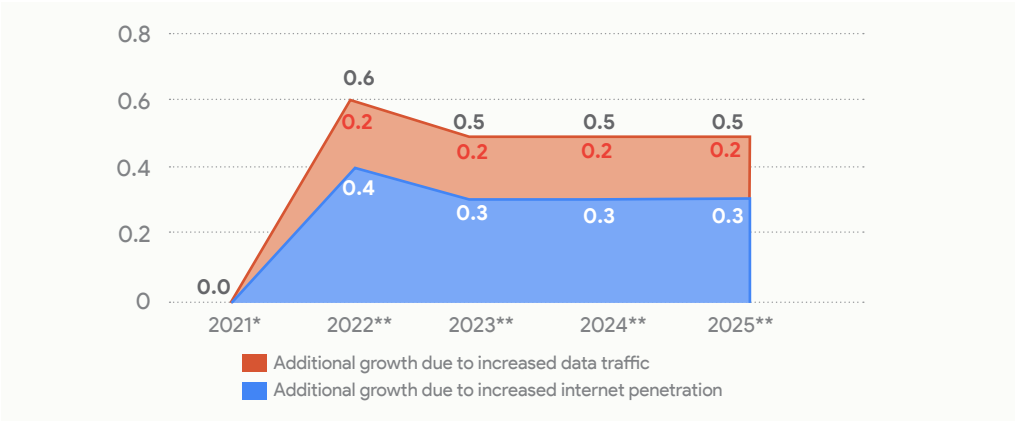
Based on the literature review, increased internet usage and broadband penetration are expected to yield higher real economic growth. A 2020 RTI study[9] found that a 10% increase in international bandwidth consumption per user in South Africa results in a 0.15% increase in GDP per capita.[10] By reconstructing the total international bandwidth consumption (data traffic) in the context of the RTI study (2005-2017) - as well as the resultant increase in GDP based on the observed increase per capita - we found a change coefficient of 0.92%. This means a 100% increase in data traffic leads to a 0.92% increase in real GDP, or an increase in the real growth rate of 0.92 percentage points. The resultant increase in real GDP by 2025 - due to the 202% predicted increase in data traffic by the same year - is thus 1.26%.

Two separate studies - by Scott[11] and Qiang et al.[12] - found that an increase in broadband penetration of ten percentage points in developing countries leads to a rise in the real economic growth rate, observing increases of 1.35 and 1.38 percentage points respectively. Taking the average of the two coefficients and applying the result to this model, we find that the increased internet penetration in Nigeria of 6 percentage points between 2021 and 2025 will lead to a rise in real GDP of 0.8% within the same time period.

Accordingly, Nigeria's real GDP is expected to be USD 10.1 billion more than it otherwise would have been in 2025, reflecting an increase in the average year-on-year real economic growth rate of 0.52 percentage points between 2022 and 2025. The Equiano cable will have led to an additional USD 25.3 billion in total economic output between 2022 and 2025. With an average population growth rate of 2.5%, the additional overall economic growth will result in a faster average year-on-year growth rate of 0.50 percentage points per capita GDP.

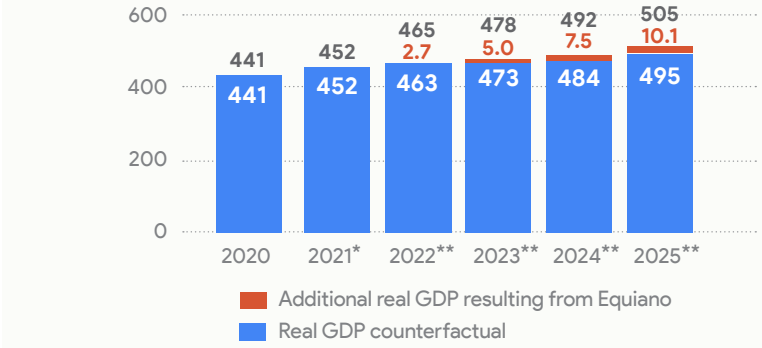
9. RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in South Africa.
10. Though the RTI series on the economic impacts of submarine fibre optic cables covers Nigeria, the study on Nigeria does not analyse the impact of the installation of a new subsea cable on bandwidth consumption nor economic output.
11. Scott C., 2012, Does Broadband Internet Access Actually Spur Economic Growth?
12. Qiang C. et al., 2009, Economic Impacts of Broadband. *Information and Communications for Development.*

FIGURE 10 : Increase in real GDP growth due to installation of Equiano (percentage points) 2021 - 2025



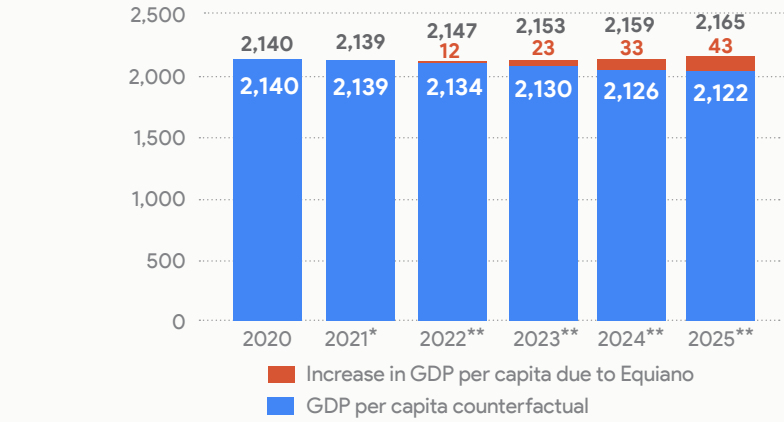
Source: Genesis Analytics, 2022, team analysis
Note: *Forecast | **Equiano impact analysis period

FIGURE 11 : Increase in real GDP due to installation of Equiano (USD billions) 2020 - 2025



Source: IMF, 2021, World Economic Outlook | Genesis Analytics, 2022, team analysis
Note: *Forecast | **Equiano impact analysis period

FIGURE 12 : Increase in real GDP per capita due to installation of Equiano (USD) 2020 - 2025



Source: IMF, 2021, World Economic Outlook | Genesis Analytics, 2022, team analysis
Note: *Forecast | **Equiano impact analysis period

Employment

The increase in data traffic and internet penetration is expected to create new opportunities for first-time users. It will also enable existing users to find new ways of positively using the internet, leading to greater employment within the digital economy and the ICT sector. To quantify Equiano's impact on the employment rate in Nigeria, we incorporate the findings of the RTI study on the economic impacts of submarine fibre optic cables and broadband connectivity in Nigeria.[13]

The study found that between 2008 and 2013, in areas connected to Nigeria's terrestrial fibre infrastructure (within 500m of a terrestrial fibre optic cable), the arrival of a new submarine cable increased the likelihood of being employed by 7.8%. Between 2008 and 2013, three cables were landed in Nigeria - MainOne, Glo-1 and WACS - with an average design capacity of 7.32 Tbps. Assuming an initial lit capacity of 10% for these cables, and applying the existing change coefficients established by this assessment so far, we calculate the arrival of a subsea cable in Nigeria translates, on average, into an increase in data traffic of 10.8%, as well as an increase in internet users of 0.9 percentage points. We assume that the increase in data traffic and the increase in the number of internet users contribute equally to the 7.8% rise in the likelihood of being employed in connected areas.

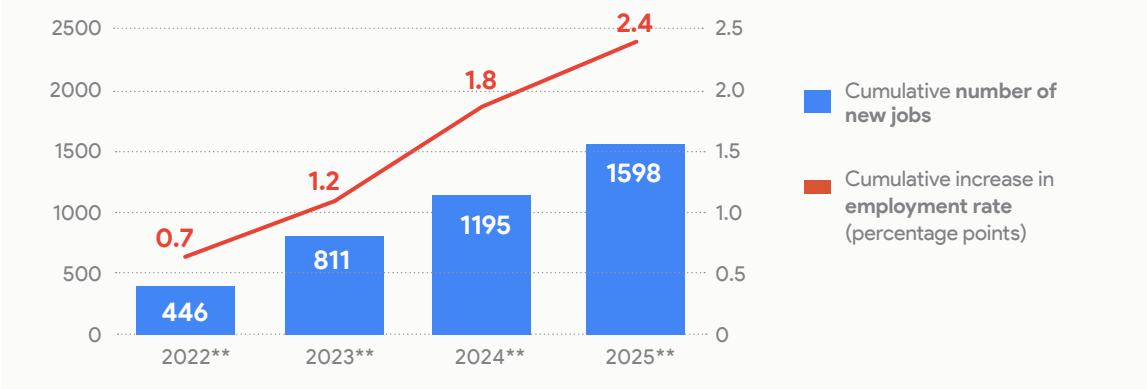
To quantify the number of new jobs created as a result of the arrival of a subsea cable (in the context of the RTI study), we estimate the proportion of the population living in connected areas. In 2013, the metropolitan area network that forms the last-mile fibre optic network covered about 10% of Nigeria by land mass. The metropolitan area fibre optic network was limited to major cities and state capitals like Lagos, Abuja and Port Harcourt. The population of the ten largest cities in 2013 accounted for 15.1% of the total population. It is likely that this is approximately the share of the population that lived within 5km of the last-mile fibre optic network at the time.

Assuming a uniform distribution of individuals within a 5km radius of the terrestrial fibre optic network would mean that 10% of individuals lived within the connected areas i.e. a 500m radius. This means that around 1.5% of Nigerians lived in connected areas over the period covered by the study. As such, the arrival of a subsea cable would have resulted in an increase in the national employment rate of 0.12%, arising equally from increases in data traffic and internet penetration.

By this metric, a 10% increase in data traffic results in a 0.06 percentage point increase in the national employment rate, while a 10% increase in the number of individuals using the internet internet penetration leads to a 0.7 percentage point increase in the national employment rate. The average data traffic increase of 32% year-on-year between 2021 and 2025 is thus expected to increase the employment rate by 0.76 percentage points. An average annual increase in the number of individuals using the internet of 6.1% between 2021 and 2025 should result in an employment rate in 2025 that is 1.6 percentage points higher than that of 2021. **The employment rate in Nigeria should therefore be 2.4 percentage points higher by 2025, representing a total of approximately 1.6 million jobs created between 2022 and 2025 as a result of Equiano's landing. This equates to an average of 330,000 jobs annually over the same time frame.**

13. RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in Nigeria.

FIGURE 13 : Increase in employment due to Equiano 2022 - 2025

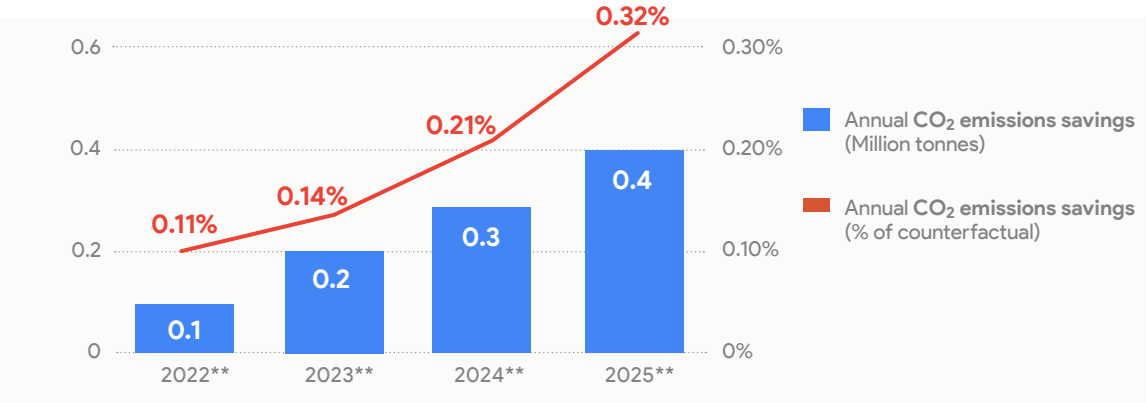


Source: Genesis Analytics, 2022, team analysis | Note: **Equiano impact analysis period

Greenhouse gas emissions

According to a 2013 SQW study[14] in the UK, an average increase in internet speeds of 48% in 2012 yielded an average saving in CO_2 gas emissions of 0.7 million tonnes, equivalent to 0.14% of the counterfactual CO_2 emissions for that year. Given that internet speeds only affect data traffic within the framework of this study, the results of the SQW study imply that a 100% increase in data traffic would yield a savings in CO_2 gas emissions equivalent to 0.29% of the counterfactual. Applying this coefficient to this study, while allowing for a 50% increase in the impact of data traffic on CO_2 gas emissions year-on-year as a result of new internet use cases, yields a cumulative savings in CO_2 emissions of 1.1 million tonnes over the period 2022 to 2025. This averages out to an annual CO_2 emissions savings of 264 kilotons or approximately 0.2% of annual emissions in 2020.

FIGURE 14 : Savings in CO_2 gas emissions from Equiano 2022 - 2025



Source: Genesis Analytics, 2022, team analysis | Note: **Equiano impact analysis period

14. SQW, 2013, UK Broadband Impact Study, Impact Report.

Literature review

A number of studies have been conducted analysing the effect that improvements in various elements of internet provision have on the economies of different countries and regions. The following variables have previously been analysed in these studies: the landing of a subsea cable, broadband penetration, broadband consumption, digitisation, and ICT regulation.

Impact of a subsea cable on the internet market and wider economy

RRTI analysed the impact of the landing of subsea fibre optic cables and improved broadband connectivity on several sub-Saharan African countries - including South Africa and Nigeria – between 2009 and 2014.[15] The studies focused on the cables that landed during this period – SEACOM, EASSy and WACS. The hypothesis is that the arrival of a subsea cable stimulates network expansion by ISPs, which leads to increased data traffic competition and therefore to decreased internet retail prices, as well as increased speeds. As a result, consumers increase their consumption of digital content, products and services, while some become first-time internet subscribers. The ease of doing business also improves with higher internet speeds, quality and reliability; more businesses use the cloud and e-commerce for the first time. This results in the emergence of new firms and startups, as well as growth in productivity, efficiency and revenue for businesses.

The RTI South Africa study finds that the arrival of the aforementioned subsea cables led to an increase in the employment rate by 2.2 percentage points between 2009 and 2014, though only in areas that are in close proximity to a terrestrial fibre optic cable. At a national level, no impact was observed on employment. Firms in areas that are close to terrestrial fibre optic cables were found to have a 23% increase in net firm entry[16] on a quarterly basis, on account of recently installed subsea cables. The arrival of subsea cables is also seen to increase growth in GDP per capita by 1.21 percentage points, leading to per capita income being 6.1% higher after five years as compared to the counterfactual. In the long run, the RTI study finds that increased international bandwidth consumption and broadband penetration have an impact on GDP per capita. A 10% increase in international bandwidth consumption leads to a 0.15% increase in GDP per capita, while a 10% increase in broadband penetration leads to a 0.27% increase in GDP per capita.

The RTI Nigeria[17] study evaluates the impact of the arrival of submarine fibre optic cables on the economy between 2008 and 2013. During this period, there were three subsea cables that landed in Nigeria - Glo-1 (2.5 Tbps), MainOne (5.0 Tbps) and WACS (14.5 Tbps) - with an average design capacity of 7.3 Tbps. The study specifically looks at the impact of the new subsea cables on the likelihood of being employed and the productivity of firms. It finds that in areas with last mile connectivity (within 500m of the terrestrial fibre optic network) the likelihood of employment increases by 7.8%. However, beyond these areas, there was no evidence to suggest the arrival of new subsea cables resulted in job creation.

15. RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in South Africa. RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in Nigeria
16. Net firm entry refers to the number of new firms entering a market minus the number of firms
17. RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in Nigeria

The study also found that firms in connected areas experienced higher productivity and increased input by leveraging improved connectivity. This was especially the case for ICT-intensive sectors such as financial services. This sector was found to have experienced an increase in its exports of 1,100% by 2017 as a result of the arrival of the new subsea cables.

Hjort and Poulsen measured the effect of the arrival of subsea cables on employment and wages in 12 African countries, including South Africa, between 2007 and 2014.[18] They found that employment increases by 2.2 to 3.1 percentage points in areas that are connected (within 500m) to the internet backbone network - the terrestrial fibre optic cable network - in South Africa. The increase in the employment rate in the connected areas does not result from a shift in jobs from the unconnected areas (through migration of employees or businesses) as the impact of the arrival of subsea cables in unconnected areas is near zero and statistically insignificant.

Hjort and Poulsen also found that the increase in overall employment is driven specifically by more employment in skilled occupations. The increase in employment in the connected areas was found to be accompanied by 2.4% to 3.3% increase in average incomes, as proxied by light density at night.

Hjort and Poulsen also identified the mechanism through which the increase in employment is achieved. The arrival of a subsea cable boosts internet speeds and decreases retail prices, which in turn increases internet usage both intensively (greater and more diverse internet usage by existing users) and extensively (the emergence of new users). This leads to the entry of new firms, particularly in sectors that rely heavily on ICT such as finance and services.

Internet speeds in areas connected to the internet backbone were found to have increased by up to 35% after the arrival of a subsea cable. Fixed broadband subscription prices decreased by 25% to 35% annually in the first four years following the installation of a subsea cable, as shown in Figure 15 below. In the connected areas, the probability that an individual uses the internet daily increased by 8.2% to 12.4%, while the probability that an individual uses the internet weekly increased by 12.3% to 14.2% after the landing of a new subsea cable.

Analysys Mason measured the impact of Google's USD 2 billion investments in network infrastructure - six subsea cables, edge infrastructure and Google Global Cache - in the APAC region between 2010 and 2019.[19] These investments enabled the acceleration of the supply of international bandwidth capacity and increased the diversity of routes, not only benefiting Google's services, but also the broader connectivity ecosystem in the region.

Specifically, 367 Tbps of additional capacity was achieved through the installed submarine cables. This resulted in download speeds four times faster, a 12% to 49% reduction in end-user latency, and a 74% decrease in IP transit prices in the countries that had strong subsea cable connectivity. From this improvement in the connectivity ecosystem, three new internet use cases could be supported - video conferencing, commerce and transactions, and cloud services. Ultimately, between 2010 and 2019, the improvement in the connectivity ecosystem led to the creation of 1.1 million jobs and USD 430 billion in additional GDP within the APAC region.

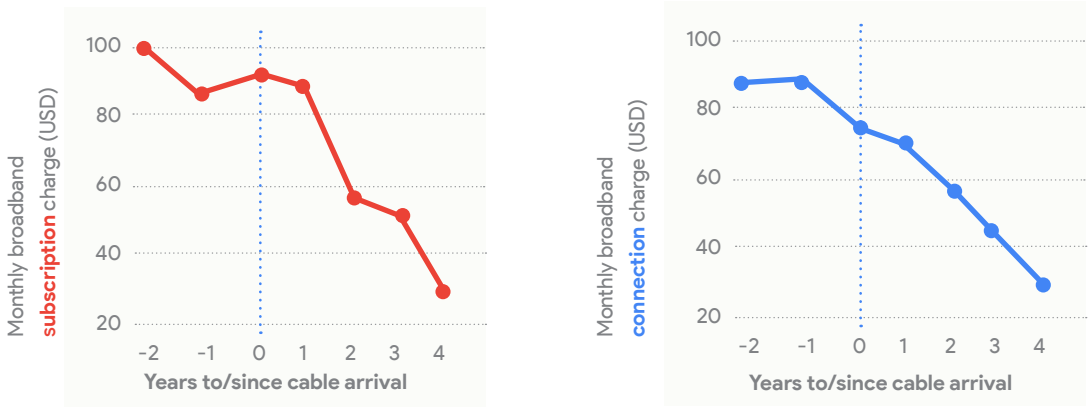
18. Hjort J. and Poulsen J., 2019, The Arrival of Fast Internet and Employment in Africa, *American Economic Review*.
19. Analysys Mason, 2020, Economic Impact of Google's Apac Network Infrastructure.

Impact of increased broadband penetration on economic output

A number of studies have specifically looked at the impact of increased broadband penetration on economic output. In 2016, Minges published an extensive literature review on this subject, outlining the results of various studies that have sought to establish a relationship between these two variables. Katz and Callorda's 2018 study[20] examined the economic contribution of fixed and mobile broadband. Table 2 below shows the results of these studies. All the coefficients were statistically significant with a significance level of at least 10%.

The results from the studies all show a positive relationship between broadband penetration and economic growth, including in emerging economies such as Nigeria. The higher income levels are not only at a national, but also a household and per capita level. Qiang et al.[21] and Scott[22] modelled the impact of an increase in fixed broadband penetration on developing countries' real growth rate. The average between the two authors' findings for this change coefficient is an increase of 1.37 percentage points in real economic growth, following an increase in fixed broadband penetration of ten percentage points. Mobile broadband penetration was found to have a greater economic impact than fixed broadband penetration: a one percentage point increase in the former induced a 0.18% increase in GDP per capita, compared with 0.06% for fixed broadband penetration.

FIGURE 15 : Broadband subscription and connection charges before and after subsea cable arrival[23]



20. Katz R., Callorda F., 2018, The Economic Contribution of Broadband, Digitization and ICT Regulation. *ITU Publications.*
21. Qiang C. et al., 2009, Economic Impacts of Broadband. *Information and Communications for Development.*
22. Scott C., 2012, Does Broadband Internet Access Actually Spur Economic Growth?
23. Hjort J. and Poulsen J., 2019, The Arrival of Fast Internet and Employment in Africa, American Economic Review, pg 1032 - 1079.

Table 2: Impact of broadband penetration on economic output – meta analysis

Author(s)	Focus country(s)/ region	Study time frame	Key explanatory variable	Change in explanatory variable	Dependent variable	Change in dependent variable
Czernich, Falck, Kretschmer and Woessmann (2009)	OECD countries - 25	1996 - 2007	Broadband penetration (% of population)	10 percentage points increase	GDP growth rate	0.65 percentage points
Koutroumpis (2009)	EU countries - 15	2003 - 2006	Broadband penetration (% of population)	10 percentage points increase	GDP growth rate	0.26 - 0.85 percentage points
Zaballos and Lopez-Rivas (2012)	LAC countries - 26	2003 - 2009	Broadband penetration (% of population)	10 percentage points increase	GDP per capita	3.19%
Qiang, Rossotto & Kimura (2009)	Developed countries - 120*	1986 - 2006	Fixed broadband penetration (% of population)	10 percentage points increase	GDP growth rate	1.21 percentage points
Qiang, Rossotto & Kimura (2009)	Developing countries - 120*	1986 - 2006	Fixed broadband penetration (% of population)	10 percentage points increase	GDP growth rate	1.38 percentage points
Scott (2012)	Developed countries - 86*	1980 - 2011	Fixed broadband penetration (% of population)	10 percentage points increase	GDP growth rate	1.19 percentage points
Scott (2012)	Developing countries - 86*	1980 - 2011	Fixed broadband penetration (% of population)	10 percentage points increase	GDP growth rate	1.35 percentage points
Thompson and Garbacz (2011)	Developed countries	2005 - 2009	Fixed broadband penetration (% of households)	10 percentage points increase	GDP per household	0.77 percentage points
Katz and Callorda (2012a)	Panama	2000 - 2010	Fixed broadband penetration (% of households)	10 percentage points increase	Real GDP	0.44%
Katz and Callorda (2018)	Global - 139 countries	2010 - 2017	Fixed broadband penetration (% of population)	1 percentage points increase	GDP per capita	0.08%
Katz and Callorda (2018)	High income countries	2010 - 2017	Fixed broadband penetration (% of population)	1 percentage points increase	GDP per capita	0.14%
Katz and Callorda (2018)	Middle income countries	2010 - 2017	Fixed broadband penetration (% of population)	1 percentage points increase	GDP per capita	0.06%
Thompson and Garbacz (2011)	Developed countries	2005 - 2009	Mobile broadband penetration (% of households)	10 percentage points increase	GDP per household	0.52%
Katz and Callorda (2012b)	Philippines	2000 - 2010	Mobile broadband penetration (% of households)	10 percentage points increase	Real GDP	0.32%
Katz and Callorda (2018)	Global - 139 countries	2010 - 2017	Mobile broadband penetration (% of population)	1 percentage points increase	GDP per capita	0.15%
Katz and Callorda (2018)	Middle income countries	2010 - 2017	Mobile broadband penetration (% of population)	1 percentage points increase	GDP per capita	0.18%
Katz and Callorda (2018)	Low income countries	2010 - 2017	Mobile broadband penetration (% of population)	1 percentage points increase	GDP per capita	0.20%
Czernich, Falck, Kretschmer and Woessmann (2009)	OECD countries - 25	1996 - 2007	Introduction of broadband	-	GDP per capita growth rate	2.7 - 3.9 percentage points
Katz and Callorda (2013)	Ecuador	2009 - 2011	Household having broadband	-	Average annual household income	3.67%
Deloitte (2012)	Global - 96 countries	2008 - 2011	Substitution from 2G to 3G penetration	10 percentage points increase in 3G penetration	GDP per capita growth rate	0.15 percentage points

* Total number of countries included in the study, inclusive of developing and developed countries

Impact of broadband penetration and internet usage on greenhouse gas emissions

The potential of increased broadband penetration and adoption in commercial and social activities to positively contribute to the reduction of greenhouse gas emissions has long been recognised. Several impact pathways lead to this outcome, including: reductions in the use of paper arising from electronic communication and publications; savings in the consumption of petroleum products due to teleconferencing and telecommuting; and reduced energy demand for the construction and maintenance of retail and other commercial real estate spaces due to the proliferation of e-commerce.

In 2007, Fuhr and Pociask[24] estimated the savings in greenhouse gas emissions arising from wide adoption and use of broadband-based applications between 2007 and 2017 in the US. By reviewing scientific literature, they estimated that the potential impact of changes from the delivery of broadband is an incremental reduction in greenhouse gas emissions of more than 1 billion tonnes over the ten-year period. E-commerce would contribute about 21% to the estimated savings in greenhouse gas emissions, teleconferencing 20%, increased electronic publication and communication 7%, while 52% of the savings would be attributable to telecommuting.

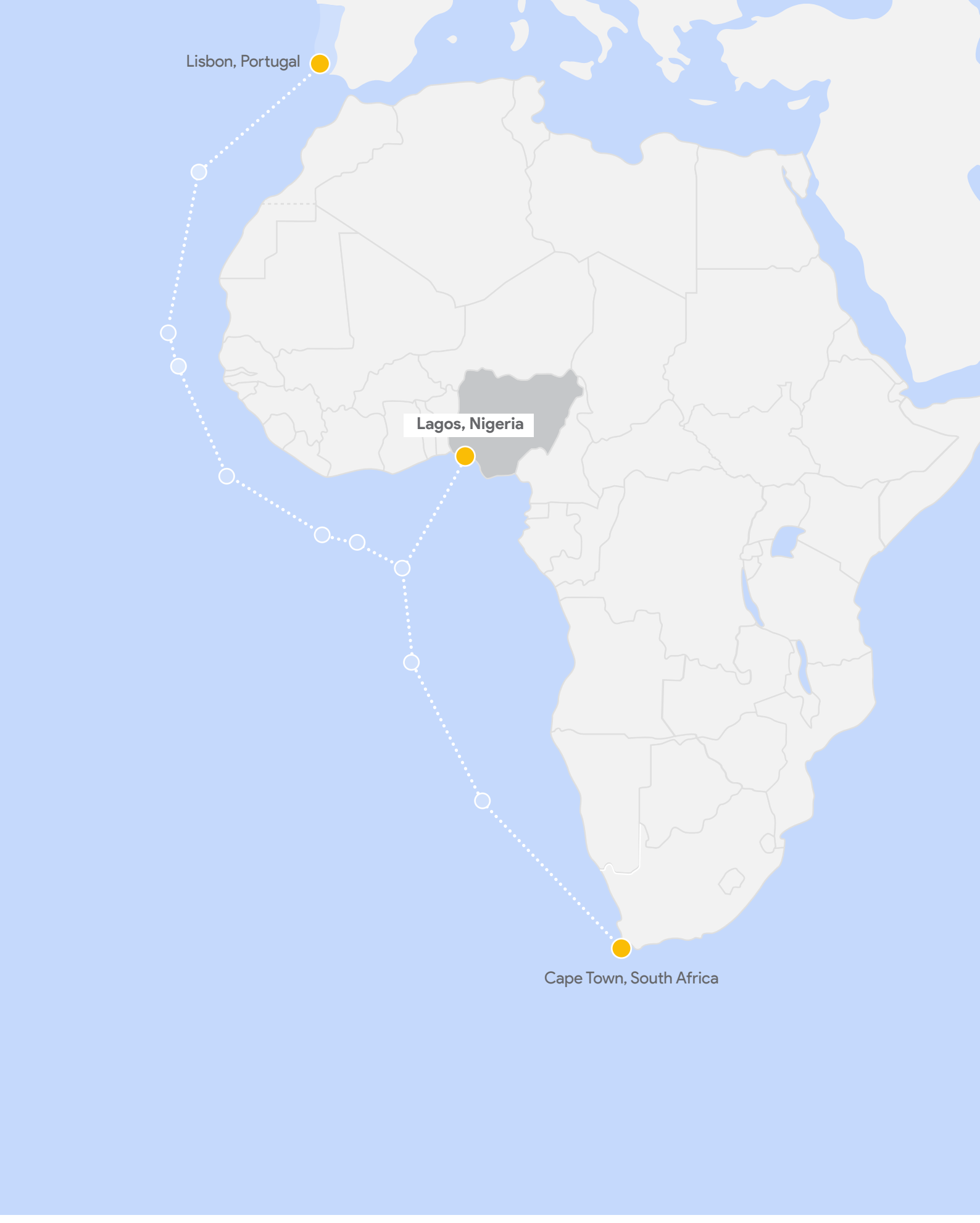
In 2013, SQW[25] estimated the environmental impacts of the increase in broadband speeds in the UK, arising from both public and private sector initiatives. Public and private investments in broadband infrastructure are projected to lead to an average increase in broadband speeds across the UK of approximately 48% annually between 2008 and 2025. This in turn is expected to lead to savings of 1.6 million tonnes of CO_2 emissions annually by 2024, and a total of 12.4 million tonnes of CO_2 emissions between 2009 and 2024.

These savings in greenhouse gas emissions are modelled to arise from the following reductions:

- 2.3 billion kms in annual commuting, predominantly in car usage due to increased remote working.
- 5.3 billion kms in annual business travel, largely in car usage, through increased use of video conferencing and online collaboration tools.
- 1 billion kWh of electricity usage per annum through the shifting of server capacity onto more energy-efficient public cloud platforms by broadband-using firms.

Despite this, internet usage and the ICT sector as a whole have their own carbon footprint, resulting from the energy requirements of running data centres, servers, applications and networks.[26] The ICT sector currently contributes 2 to 3% of global greenhouse gas emissions. There has therefore been an effort by various governments, businesses and organisations to mitigate the sector's carbon footprint through new energy-efficient data centres and servers, as well as the increased use of both renewable and carbon-free energy to power internet infrastructure.

24. Fuhr J.P., Pociask S., 2007, Broadband Services: Economic and Environmental Benefits, *The American Consumer Institute*.
25. SQW, 2013, UK Broadband Impact Study, Impact Report.
26. ITU, Dynamic Coalition on Internet and Climate Change (DCICC), 2009, OECD Conference on ICTs, the Environment and Climate Change.



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