Google

Equiano

Economic Impact Assessment

South Africa

This assessment was commissioned by Google and delivered by Africa Practice based on economic modelling assistance from Genesis Analytics. It provides an overview of South Africa'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
Founded in 1998, Genesis Analytics was one of the first economics-based consulting firms in Africa. It uses its technical capabilities to improve decision-making and unlock substantial value for clients and society.

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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. The initial configuration of the cable system includes 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.

Globally, sub-Saharan Africa remains the most underserved region in terms of internet infrastructure. Penetration stands at 30%, 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.

South Africa is sub-Saharan Africa's largest economy after Nigeria. It is the continent's most industrialised, diversified and advanced economy, and one of only eight upper middle income countries in Africa. Accordingly, internet penetration is high by regional standards, with 70% of the population using the internet as of 2020 - almost triple the 24% penetration rate in 2010. This relatively high level of internet penetration, however, masks challenges in terms of affordability and access. Boosting the affordability and reliability of connectivity will accelerate economic growth, poverty reduction, human development and progress towards the Sustainable Development Goals.

Equiano will have a direct impact on connectivity in South Africa following its landing, resulting in faster internet speeds, improved user experience, and reduced internet prices. Internet speeds in the country are expected to almost triple from **28 Mbps** in 2021 to **75 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 **9.3 percentage points** over this period.

By increasing international bandwidth, Equiano will indirectly broaden access to the internet in South Africa. It will thus contribute 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 internet access can help South Africa fully leverage the opportunities created by the Fourth Industrial Revolution and unlock new pathways to collective prosperity. For South Africa'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 South Africa is expected to increase by **0.4 percentage points** due to Equiano. By 2025, real GDP in the country is forecast to be higher by **USD 7 billion** than it otherwise would have been without the cable. Between 2022 and 2025, Equiano is expected to lead to an additional USD 17.8 billion in total economic output in South Africa.

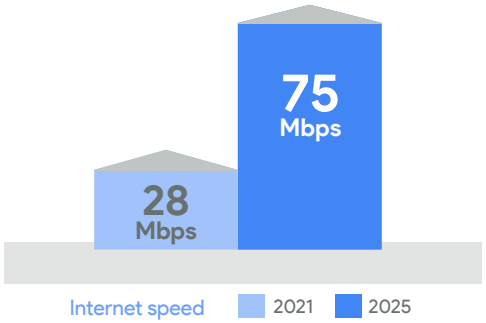
Improved connectivity also accelerates job creation. Between 2022 and 2025, Equiano should **indirectly create 180,000 new jobs**[1] - equivalent to **45,000 per year** over the assessment period - driven by the expansion of the digital economy and peripheral sectors.

1. 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.

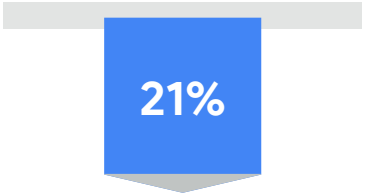
Equiano's key impacts in South Africa

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 7 billion

Equiano will boost job creation (2022 - 2025)

180 000 jobs

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

0.9 million tonnes

South Africa's connectivity ecosystem

The case for investing in South Africa's telecommunications infrastructure

The digital divide

As the continent's second largest economy, South Africa has one of the most advanced internet infrastructures in sub-Saharan Africa and one of its highest internet penetration rates. In 2020, an estimated 70% of the population used the internet. Consistent and high 3G coverage has been above 99% since 2016, while for other large economies, such as Kenya and Nigeria. it stood at 94% and 74%, respectively, in 2020. Similarly, while 4G coverage in South Africa reached over 97% of the population in 2021, up from 75% in 2016, in Kenya and Nigeria this figure stood at 77% and 41%, respectively.

Persistent and high inequality has, however, perpetuated a significant digital divide along urban/rural and income cleavages. Whereas 14% of metropolitan areas had access to the internet at home in 2020, this proportion drops to 6% for urban areas and 0.8% for rural areas. Similarly, 71% of households in urban areas accessed the internet using mobile devices, as did 66% of metro area households. Only slightly more than half of rural households (53%) accessed the internet via mobile devices.[2] According to 2022 estimates from the Alliance for Affordable Internet (A4AI), 15.9% of South Africa's urban population has access to meaningful connectivity,[3] compared with 5.7% of the rural population.[4] Device affordability and limited digital skills have also hindered progress towards universal access.

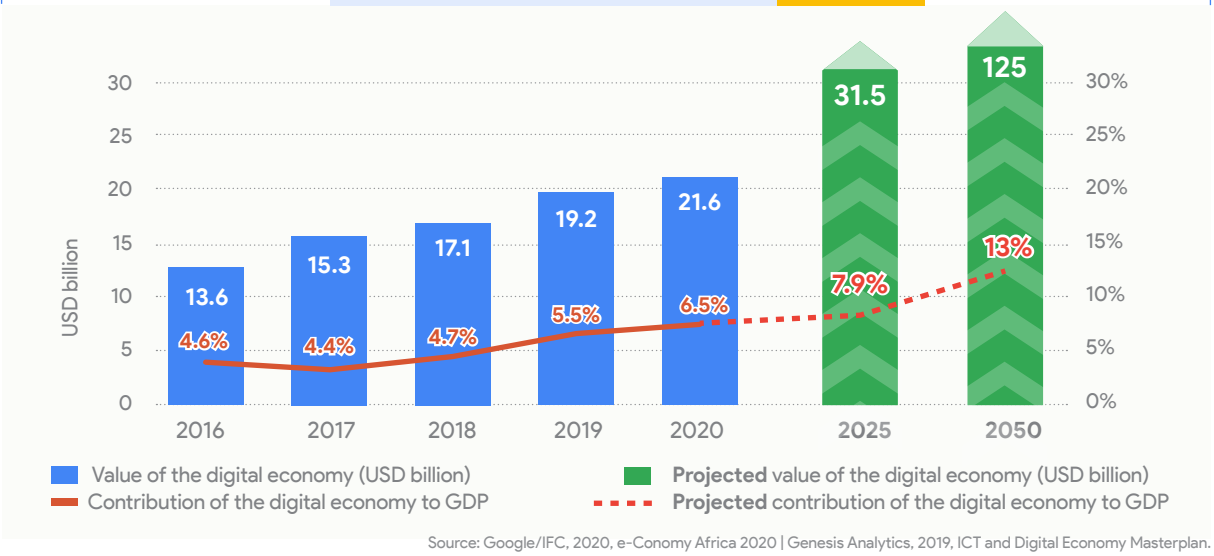
An expanding ICT ecosystem

As digital access becomes more universal, it offers South Africa a promising pathway to collective prosperity. In spite of the challenging economic environment, including in terms of reliable power supply, the digital economy continues to experience above-average growth compared to other sectors. In 2020, the size of the internet's GDP (iGDP) - defined as the internet's contribution to GDP - was estimated to be worth USD 22 billion - equivalent to 6.5% of GDP (see Figure 1).

South Africa's iGDP is expected to grow to 13% of GDP by 2050[5] and it is estimated that, with the appropriate policy and infrastructure investment decisions, the country could unlock at least 500,000 new jobs in the digital economy by 2030.

2. ICASA, 2022, The State of the ICT Sector Report of South Africa.
3. Meaningful connectivity is a framework and policy target to increase internet access within a country. It measures four key pillars of access: 4G-like speeds; smartphone ownership; an unlimited access point at home, work, or place of study; and daily use.
4. Alliance for Affordable Internet, 2022, South Africa Meaningful Connectivity Fact Sheet.
5. Google IFC, 2020, e-Conomy Africa 2020.

FIGURE 1 : South Africa's internet economy **2016 - 2020**



Source: Google/IFC, 2020, e-Conomy Africa 2020 | Genesis Analytics, 2019, ICT and Digital Economy Masterplan.

The services sector has been a key driver of growth in South Africa, and is the biggest beneficiary of the ongoing digital transformation. Its average growth between 2016 and 2019 was 0.64 percentage points higher than the rest of the economy. The sector's contribution to growth is likely to persist, spurred on by digital transformation, particularly in financial services, transport and communication, and commerce.

Other significant driving factors include the rising demand for internet services from the growing and youthful South African population, demand for higher-data services, and the expansion of remote-working during and in the wake of the COVID-19 pandemic. These factors have led to significant infrastructure investments by South Africa's mobile operators (see 'Internet Coverage', page 11).

There are four critical growth pillars for South Africa's internet economy:

Data Centres

Despite growing competition from Nigeria, South Africa remains the continent's preeminent data centre hub, with 25 co-location data centres in 2021 - the same number as Egypt and Nigeria combined.[6] More than two-thirds of data centre capacity in Africa is in South Africa, driven by the size and maturity of its economy, its strong links to subsea cables, and its liberalised telecoms market.

In January 2022, global data centre provider Digital Realty announced the acquisition of a majority stake in Teraco, valuing the South African data centre provider at USD 3.5 billion. Meanwhile, in 2021, Africa Data Centres announced it was doubling the capacity of its two existing data centres to 20MW each once fully built, with plans to ultimately expand capacity in South Africa to 100MW. Global provider Vantage Data Centres also announced a USD 1 billion 80MW data centre campus in Johannesburg in late 2021.

Venture capital and innovation

South Africa is a hotspot for African venture capital (VC) investment, having attracted USD 832 million in equity funding in 2021 - the second highest amount on the continent, behind Nigeria and ahead of Egypt and Kenya. South Africa also had the third highest number of VC equity deals that year.[7]

The creative economy

South Africa's creative industry forms an important part of the digital economy and was estimated to be worth USD 5 billion in 2019.

6. Africa Data Centres Association, 2022, State of the African Data Centre Market 2021.
7. Partech, 2022, 2021 Africa Tech Venture Capital Report.

E-commerce

In 2019, the e-commerce industry in South Africa was estimated to be worth USD 3 billion. The sector experienced annual growth rates of 15% between 2017 and 2019, driven by greater internet access and increased confidence in online transactions. E-commerce boomed during COVID-19 and an optimistic estimate predicts the sector will be worth USD 14 billion by 2025.[8]

The convergence of additional bandwidth from Equiano and other next-generation cables, together with local and international investments in digital infrastructure, is set to further benefit South Africa's innovation ecosystems.

An enabling policy environment

The South African government has demonstrated its commitment to unlocking the digital potential of the country through its policies and initiatives.

In its long-term development vision - the National Development Plan 2030 (NDP), published in 2012 - South Africa highlights the potential of ICT for economic growth and job creation. The plan recognises the importance of having adequate ICT structures in place for this potential to be realised, including in terms of infrastructure, high connectivity and broadband penetration, a coordinated and integrated ICT strategy, a competitive telecommunications market, and institutional competence.

Since 2012, several policies, initiatives and interventions have been launched to realise the vision outlined in the NDP, most importantly including:

- **South Africa Connect: Creating Opportunities, Ensuring Inclusion:** South Africa's Broadband Policy (2013), which aims to deliver broadband access to 100% of the population by 2030. As part of this, the government has committed to increasing the target speed for these connections from 10Mbps to 100Mbps for 80% of the population within this time frame.

  Under the policy, a plan was announced in 2022 to roll out over 33,000 community Wi-FI hotspots between 2022 and 2025, which will see the government invest over USD 160 million to provide internet services to 5.8 million households.

- **Presidential Commission on the Fourth Industrial Revolution**, which was established by President Cyril Ramaphosa in 2019 to develop a national strategy, includes interventions in key economic sectors such as ICT, agriculture, finance, mining and manufacturing.

- **National Infrastructure Plan (2050)**, which reiterates the goals set out in the NDP and aims for high-speed broadband to be universally accessible by 2050. The plan also includes a proposal that free basic data should be made available for low-income users.

8. Datareportal, 2020, Digital: South Africa Report, 2018-2020.

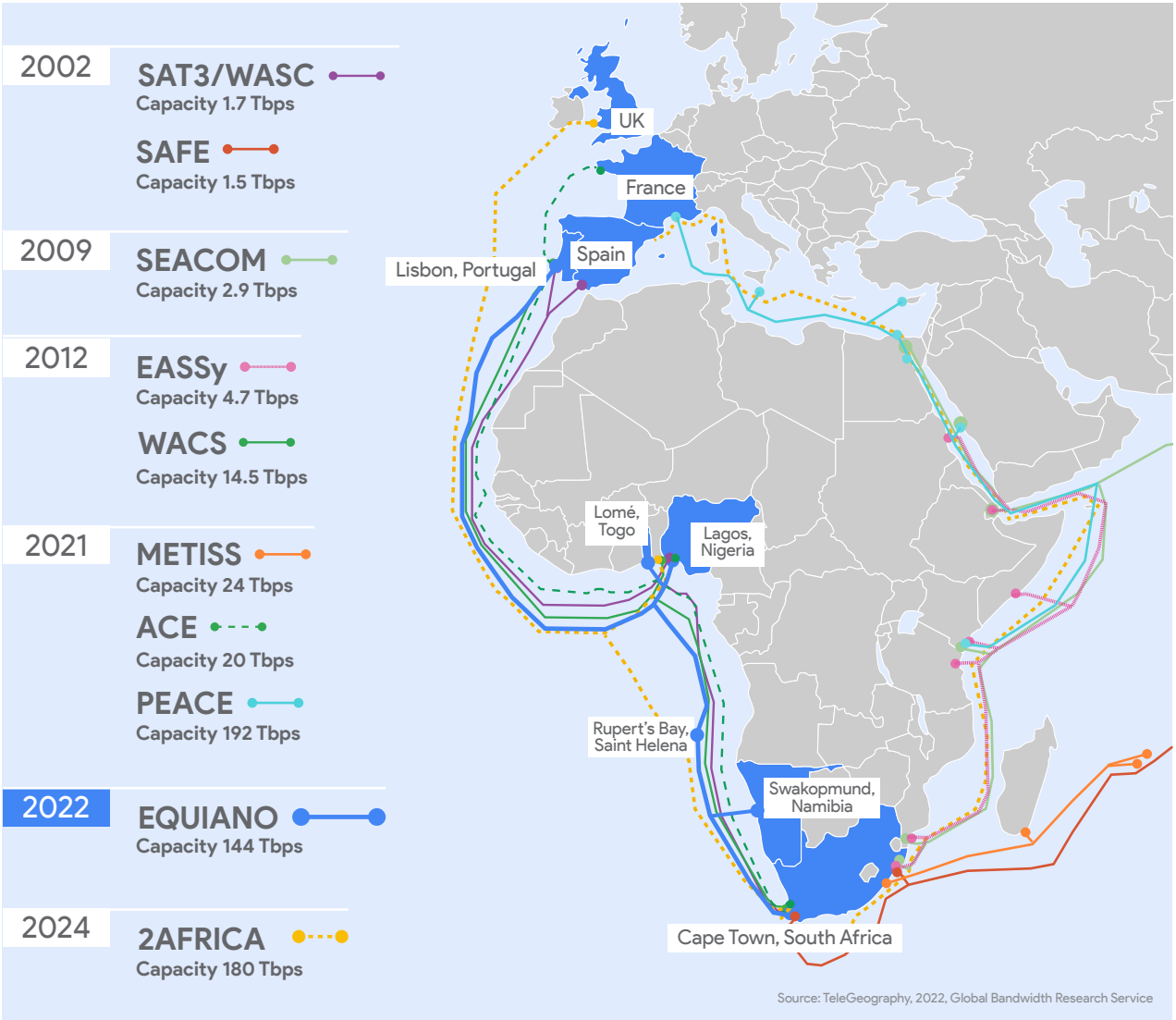
Sector diagnostic: taking stock of South Africa's connectivity infrastructure

The following section overviews South Africa's connectivity infrastructure, detailing the country's current and future submarine links, terrestrial infrastructure and internet coverage, as well as speeds and latency.

International connectivity links

South Africa has seven installed subsea cables, including the METISS cable launched in March 2021, with three more set for installation (i.e. Equiano, 2Africa and PEACE). The new subsea cable installations will lead to increased international bandwidth capacity. Coupled with the diversity of routes created, this will lead to an improvement in internet speeds and a reduction in IP transit prices. The Equiano cable - having a larger total design capacity than the sum of the existing cables (approximately 88 Tbps) - will have a distinct and significant impact on the internet landscape in South Africa.

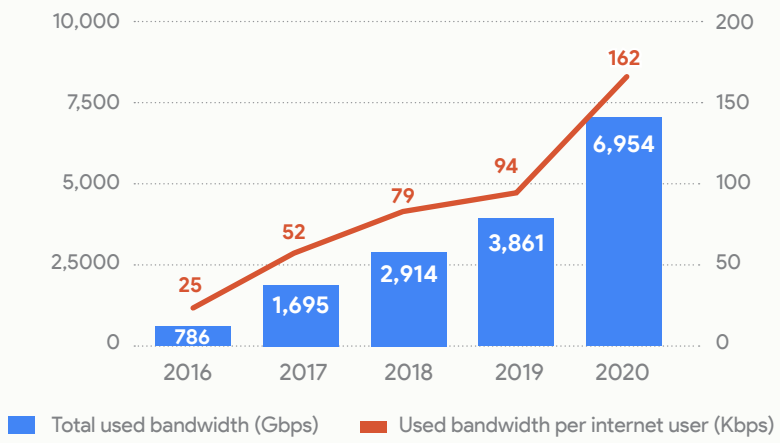
FIGURE 2 : Installed and soon-to-be installed subsea cables in South Africa



Source: TeleGeography, 2022, Global Bandwidth Research Service

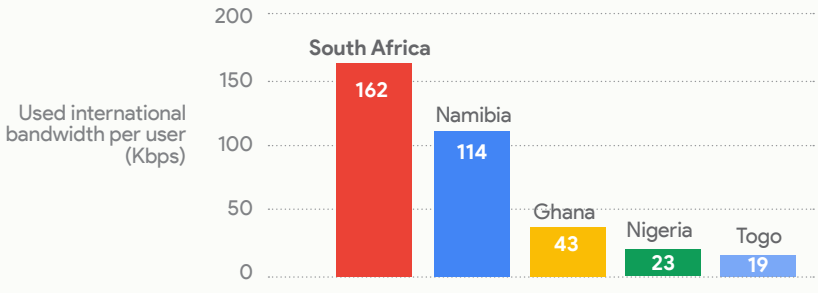
South Africa has experienced tremendous growth in its bandwidth capacity between 2016 and 2020, attaining a CAGR of 72% in used bandwidth and 595% in used bandwidth per user.[9,10] This growth partly stems from the increasing share of cable capacity that is activated or lit. Between 2016 and 2020, the average lit capacity on Europe-sub-Saharan Africa cable routes grew from 11% to 22% of total capacities between.[11] Additionally, in the same time frame, the SEACOM cable was upgraded twice, increasing its total capacity from 1 to 2.9 Tbps.[12] The increase in deployment of capacity by internet backbone providers also drives growing used bandwidth.

FIGURE 3 : South Africa's used bandwidth 2016 - 2020



Source: TeleGeography, 2022, Global Bandwidth Research Service | Genesis Analytics, 2022, team analysis.

FIGURE 4 : Comparison of used international bandwidth capacity per user in selected African countries 2020



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

9. TeleGeography, Global Bandwidth Research Services, Regional Analysis: Africa, 2022.
10. 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 networks. Used bandwidth does not refer to traffic, but rather to capacity.
11. TeleGeography, Internet infrastructure datasets, 2021.
12. Submarine Cable Networks, 2018, SEACOM Cable system upgrades to 2.9 Tbps.

CABLE DAMAGE AND DISRUPTION TO CONNECTIVITY IN SOUTH AFRICA

While submarine cables are designed to be physically durable, damage due to weather, other natural conditions and fishing vessels occasionally results in disruption to services. In January 2020, all South African internet providers experienced major outages following damage to the West Africa Cable System (WACS), which runs along the Atlantic coast. A second cable - SAT-3 - was simultaneously damaged. International internet access in South Africa was disrupted for a month, with providers having to activate back-up bandwidth to ensure their customers could remain connected. The incident is believed to have been caused by a massive underwater mudslide off the coast of the DRC, which impacted both cables.

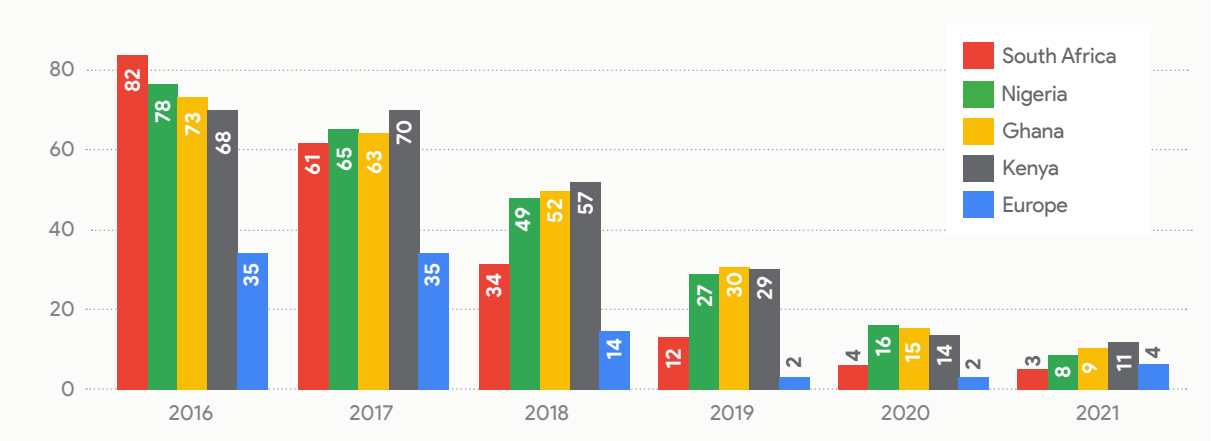
Users in South Africa experienced further disruption to connectivity in March 2020 - during the first COVID-19 lockdown - when WACS was damaged off the coast of the UK, requiring providers to reroute traffic to other cables.

Having a diversity of cable routes and landing stations provides safety in numbers. The landing of Equiano will provide South Africa 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

South Africa has experienced a sustained and significant decline in IP transit prices - from an average of USD 82 / Mbps / month in 2016 to USD 3 / Mbps / month in 2021. This translates to an average decline of 47% year-on-year over this period. The continued increase in international bandwidth capacity, arising from installation of new subsea cables such as Equiano, will likely drive the further decline of wholesale internet prices in South Africa.

FIGURE 5 : IP transit prices in South Africa and selected geographies (USD / Mbps / Month) 2016 - 2021



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

Internet coverage

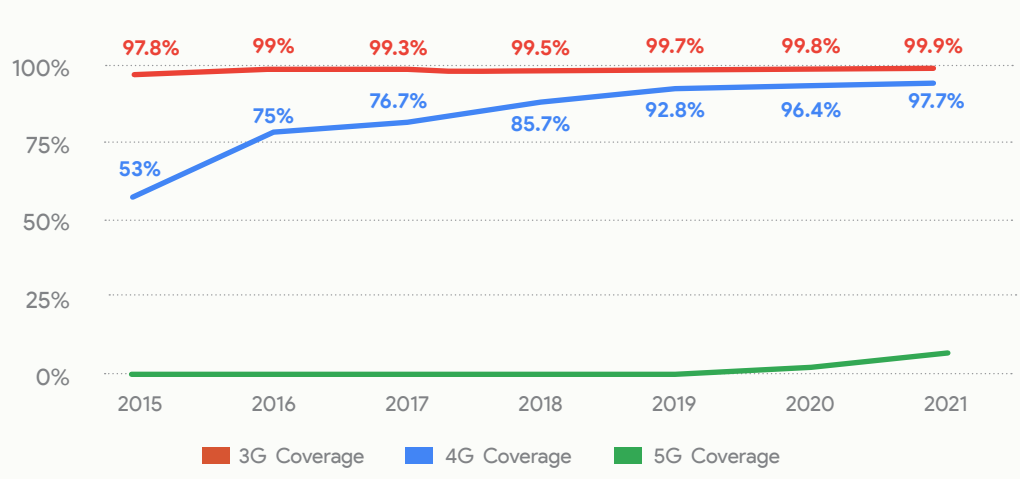
South Africa has strong 3G and 4G coverage that is higher than global averages (94% for 3G and 85% for 4G). Growth in 4G coverage has resulted in part from the substantial investments by South Africa's two largest mobile network operators, Vodacom and MTN.

South Africa has the most developed backbone infrastructure on the continent. Telkom's wholesale division Openserve operates the country's largest fibre network. At 169,000km, its footprint passes 707,400 homes as of September 2021, of which 331,000 dwellings had chosen the company as their fibre network provider. This is equivalent to over 18% of fixed broadband subscriptions. Openserve's infrastructure is used by its parent company for fixed line and mobile services, with additional capacity leased to other firms. The National Long Distance (NLD) consortium - formed by MTN, Vodacom, Liquid Intelligent Technologies (LIT) and the South African National Road Agency Limited (SANRAL) - has also been active in rolling out thousands of kilometres of fibre in a network grid that will gradually connect all major cities.

Vodacom spent about ZAR 62 billion (USD 4.1 billion) between 2016 and 2020 on internet network infrastructure. The operator expects to spend USD 3 billion on its capital investment programme between 2018 and 2023. In the financial year to end-March 2022, Vodacom spent ZAR 11.15 billion (USD 693 million) on its network, a record amount and a 10.8% increase on the previous year.[13]

Meanwhile, MTN has committed to invest ZAR 50 billion (USD 3.3 billion) in internet infrastructure between 2020 and 2025.[14] In 2022, the operator announced multi-million dollar investments in infrastructure in the provinces of Northern Cape, Western Cape, Limpopo, Mpumalanga, Free State and KwaZulu-Natal, with a focus on rural and peri-urban connectivity. The company is also investing to cover 25% of the population with 5G by the end of 2022, and will begin decommissioning its 3G network in 2025/2026.

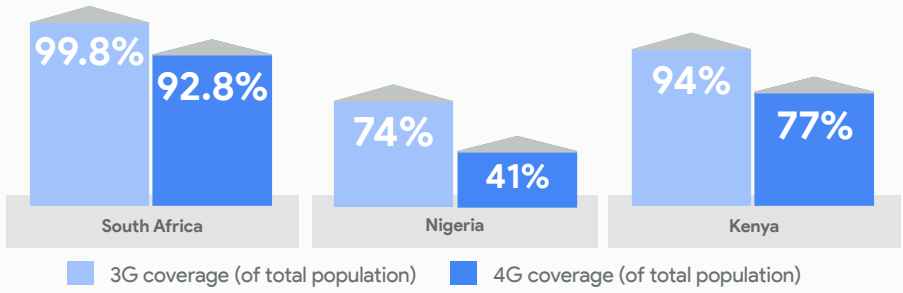
FIGURE 6 : 3G and 4G network coverage in South Africa (% of population) 2015 - 2021



Source: ICASA, 2022, The State of the ICT Sector Report of South Africa.

13. Vodacom, Integrated Annual Reports, 2016 - 2022.
14. MTN, Integrated Annual Report, 2020.

FIGURE 7 : 3G and 4G coverage in South Africa, Nigeria and Kenya 2020



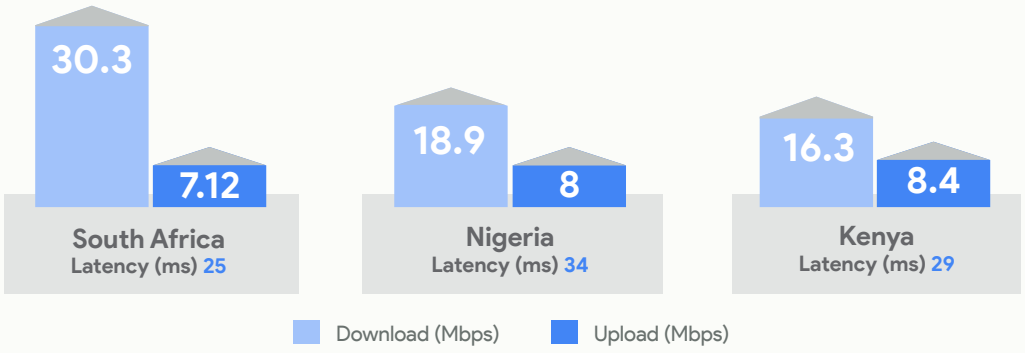
Source: ITU, 2022, ITU DataHub.

Internet speeds and latency

South Africa has relatively fast internet speeds, ranking 56th out of 138 countries for mobile broadband speeds on Ookla's Global Index as of January 2022. The country is ranked 98th out of 178 countries for fixed broadband.

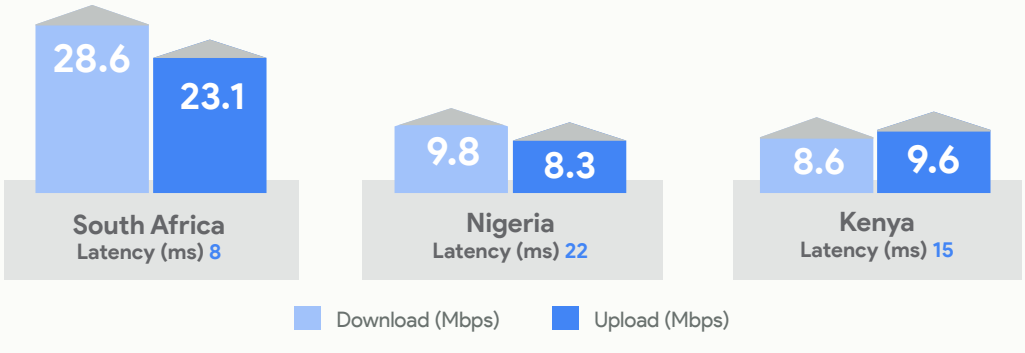
Average internet speeds have grown considerably since 2016. Mobile internet download speeds have grown at an average rate of 27% per annum between 2017 and 2020. Between 2019 and 2020, fixed broadband speeds, both for upload and download, grew by an average of 30% per year.

FIGURE 8 : Mobile broadband internet speeds and latencies in South Africa, Nigeria and Kenya January 2022



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

FIGURE 9 : Fixed broadband internet speeds and latencies in South Africa, Nigeria and Kenya January 2022



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

Using the internet

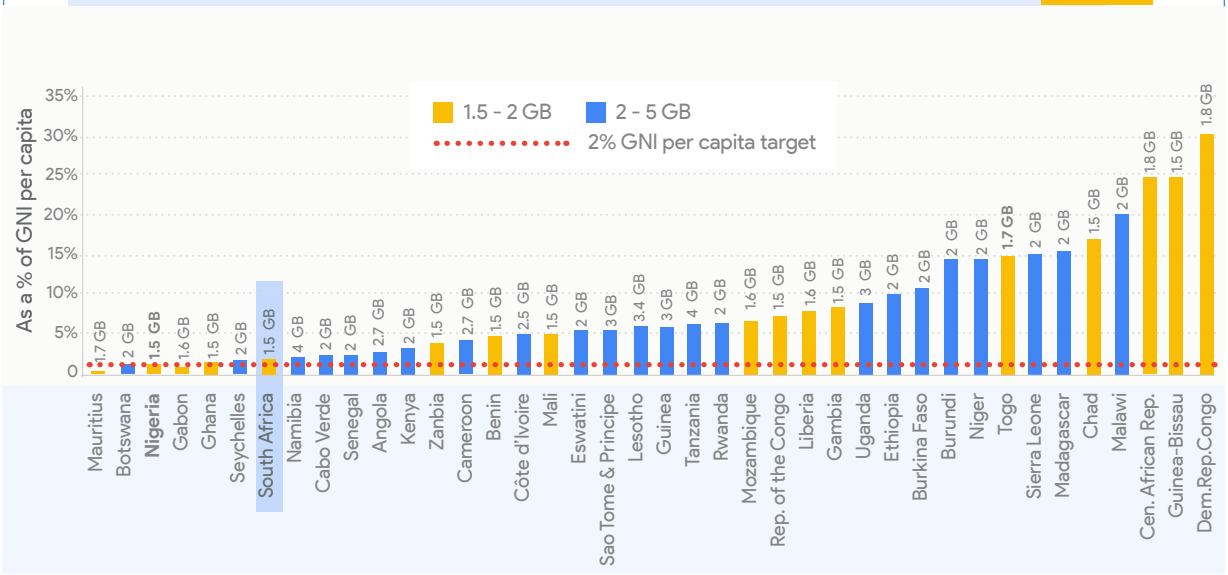
Improving the adoption of broadband, quality of access and affordability has significant potential to accelerate South Africa's socio-economic development. The subsections below detail the country's connectivity infrastructure, highlighting key trends, progress and challenges.

Affordability

South Africa performs well in terms of mobile data and fixed line bundle affordability, driven by a highly competitive market and interventions by sector regulator ICASA - often in coordination with the Competition Commission - to ensure competition and promote lower prices for consumers.

Figure 10 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. As shown in the figure below, South Africa is among the countries in Africa where internet access is the most affordable for consumers.

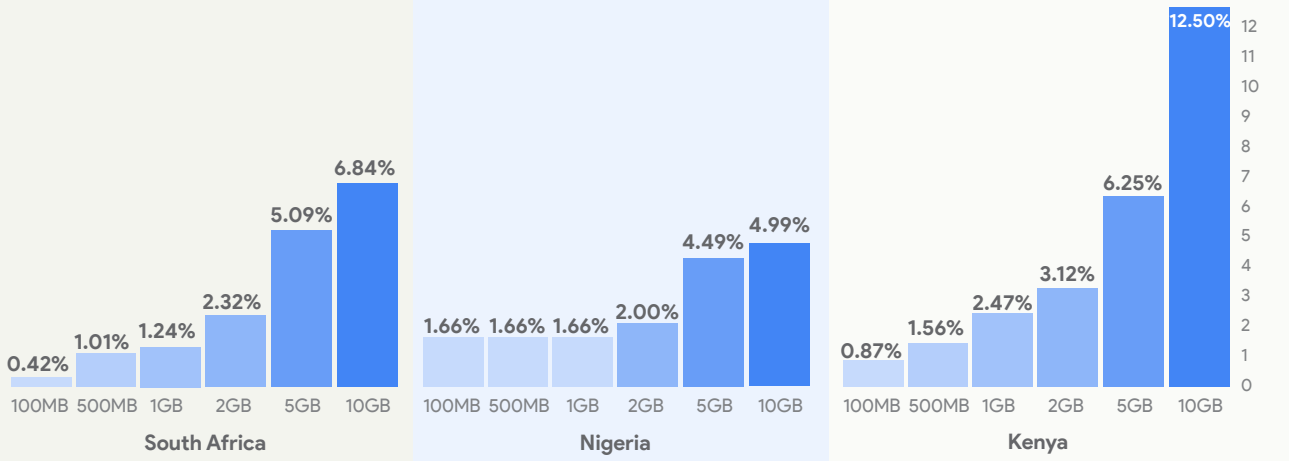
FIGURE 10 : Mobile data prices as a percentage of GNI per capita and monthly data allowance in Africa 2020



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

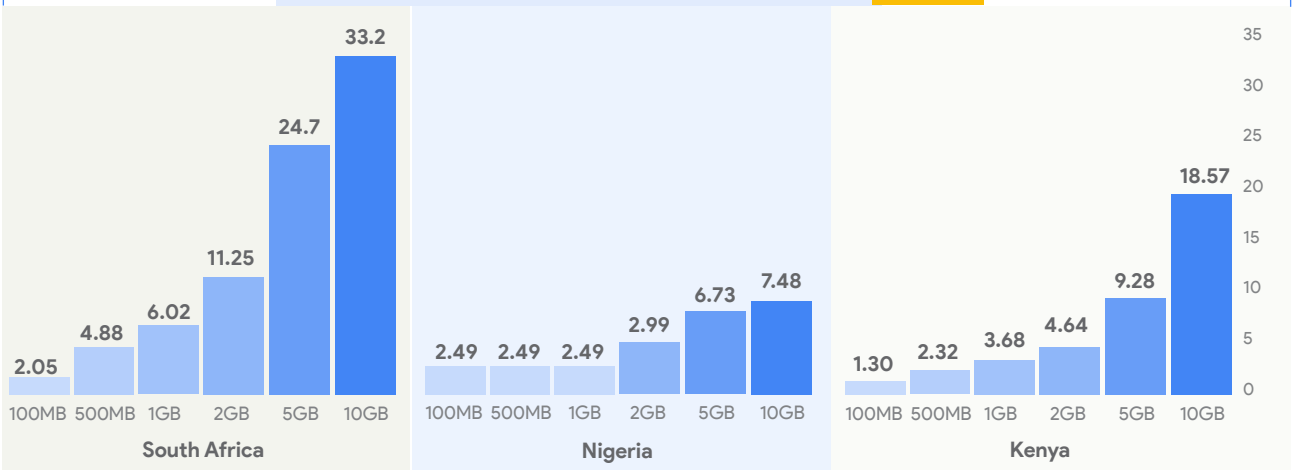
Figures 11 and 12 below illustrate the affordability of mobile broadband in relation to average incomes and in absolute terms (USD) in South Africa, Nigeria and Kenya. South Africa performs well in relative terms, particularly for smaller bundles, but it still failed to meet the Broadband Commission's affordability target, with a benchmark 2GB bundle costing 2.32% of GNI per capita in 2021.

FIGURE 11 : Affordability of mobile broadband bundles as a percentage of monthly average incomes 2021



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

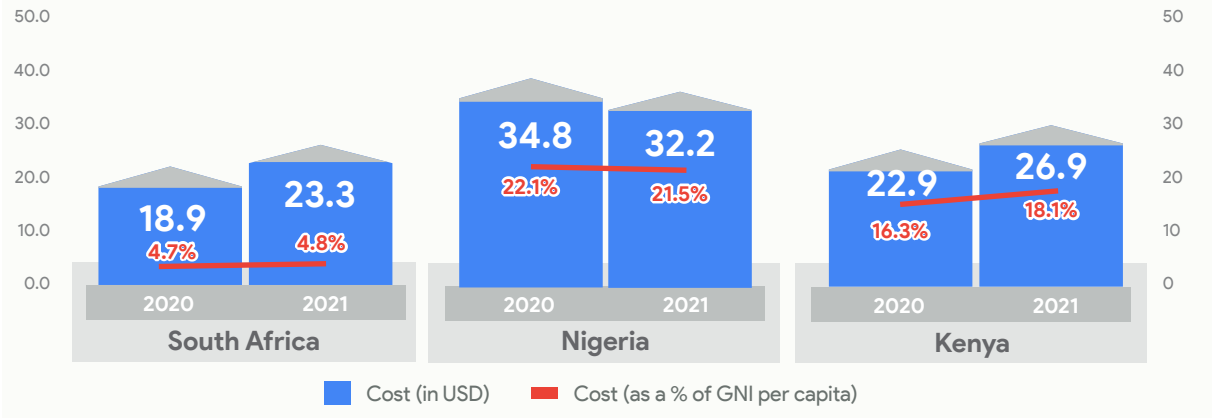
FIGURE 12 : Affordability of mobile broadband bundles in USD 2021



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

With regard to fixed broadband basket affordability, South Africa performs significantly better than Nigeria or Kenya in both absolute and relative terms, as illustrated in the figure below. According to the ITU, South Africa was ranked fourth out of 32 countries - after Seychelles, Mauritius and Cabo Verde - in terms of fixed broadband affordability in 2021. Nigeria and Kenya were ranked 21st and 15th, respectively.

FIGURE 13 : Fixed-broadband bundles in South Africa, Nigeria and Kenya 2020 - 2021

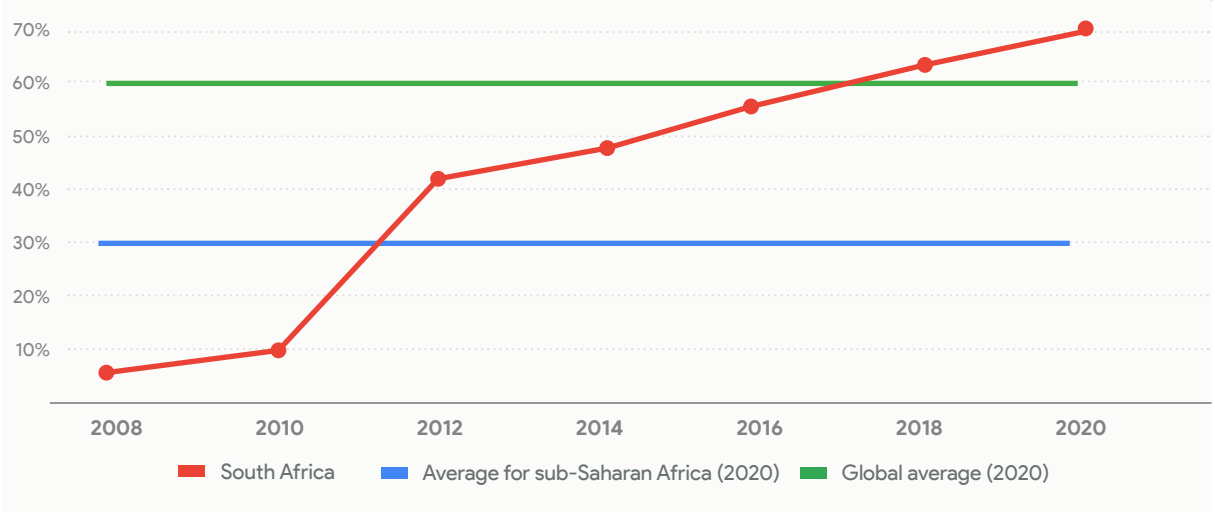


Note: Refers to the cheapest plan providing at least 5GB of monthly high-speed data (>256 Kbps) from the operator with the largest market share in each economy. Source: International Telecommunication Union, 2022, ICT Price Baskets.

Penetration and usage

The share of the population using the internet in South Africa has risen rapidly over the last decade, more than doubling to reach 70% between 2011 and 2020. This is significantly higher than sub-Saharan Africa's average of 30% in 2020. Globally, 60% of individuals were internet users in 2020.

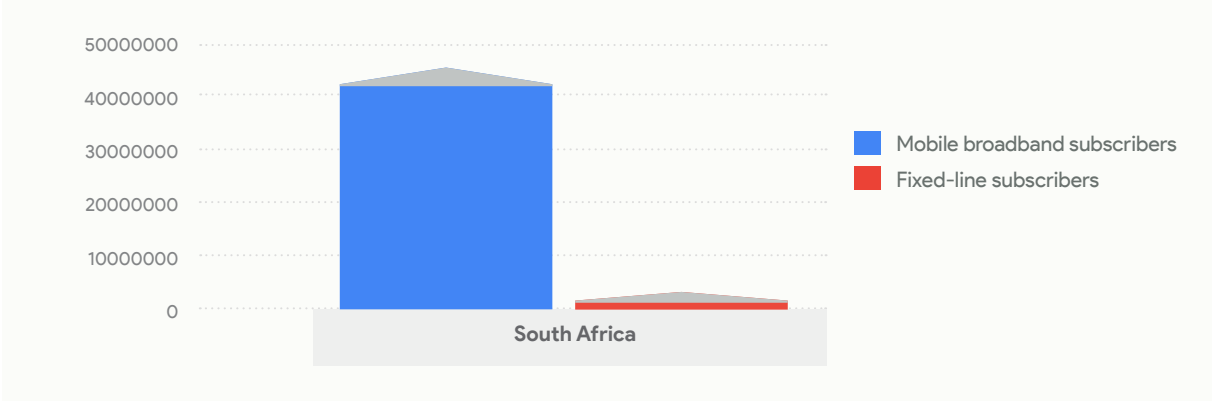
FIGURE 14 : Internet penetration in South Africa 2008 - 2020



Sources: ITU World Telecommunications / ICT Indicators Database, 2022.

Internet usage is primarily via mobile broadband. According to ICASA, as of September 2021, there were 40.5 million active mobile data subscriptions, versus 1.8 million fixed broadband subscriptions. While the number of fixed broadband subscriptions increased by 20.4% in 2021, mobile data subscriptions dropped by 46% over the same period.

FIGURE 15 : Mobile versus fixed-line subscriptions 2021



Source: ICASA, 2022, The State of the ICT Sector Report of South Africa.

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 South Africans into six different user profiles, outlining their internet needs and use cases.

FIGURE 16 : Internet user profiles

Large enterprises[15]

Description
While South Africa 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.

Digital requirements
Access fast and reliable broadband internet to connect their offices and facilities and be integrated into global value chains.

SMEs[16]

Description
SMEs account for 98% of businesses in South Africa, employing between 50% and 60% of the country's workforce across all sectors. SMEs account for a quarter of job growth in the private sector.

Digital requirements
- Access digital platforms and tools to manage their business.
- Access competitive suppliers and markets to sell to customers.
- Leverage the growing e-commerce ecosystem.

Students

Description
Students across all levels of education from pre-primary to tertiary level constitute one of the largest and least resourced groups requiring devices and learning content.

Digital requirements
Access online educational and entertainment content to learn from home and leverage digital jobs to earn an income.

Medium-to-high skilled workers

Description
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.

Digital requirements
Access fast, reliable and affordable broadband internet with professional hardware and software to conduct work (remotely).

15. Defined as businesses with more than 250 employees.
16. Micro, Small and Medium Enterprises are generally defined as businesses with fewer than 250 employees.

Informal workers and job-seekers

Description
Informal employment accounts for around a third of employment in South Africa, while unemployment reached a high of 35% in Q4 2021.

Digital requirements
- 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

Description
Service providers on platforms like Uber, Airbnb, SweepSouth and Bolt provide low-skill and temporary services independently.

Digital requirements
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.[17] 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. So far in 2022, it has landed in Sesimbra (Portugal), 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).

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.

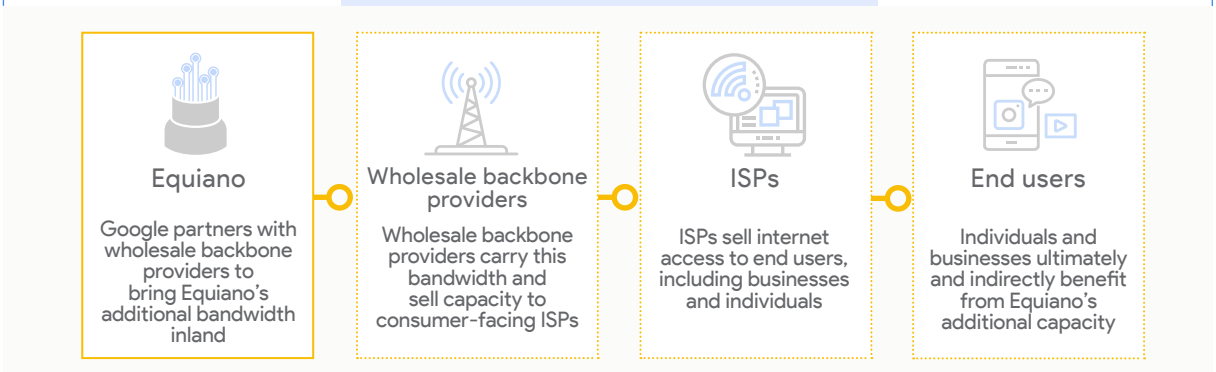
A cable system that serves the wider ecosystem's needs

While Google is spearheading the construction of the Equiano cable, other partners - namely wholesale backbone providers - will be able to use and benefit from the cable's additional capacity. Google does not directly provide broadband 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 17 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.

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

FIGURE 17 : How Equiano indirectly benefits end users



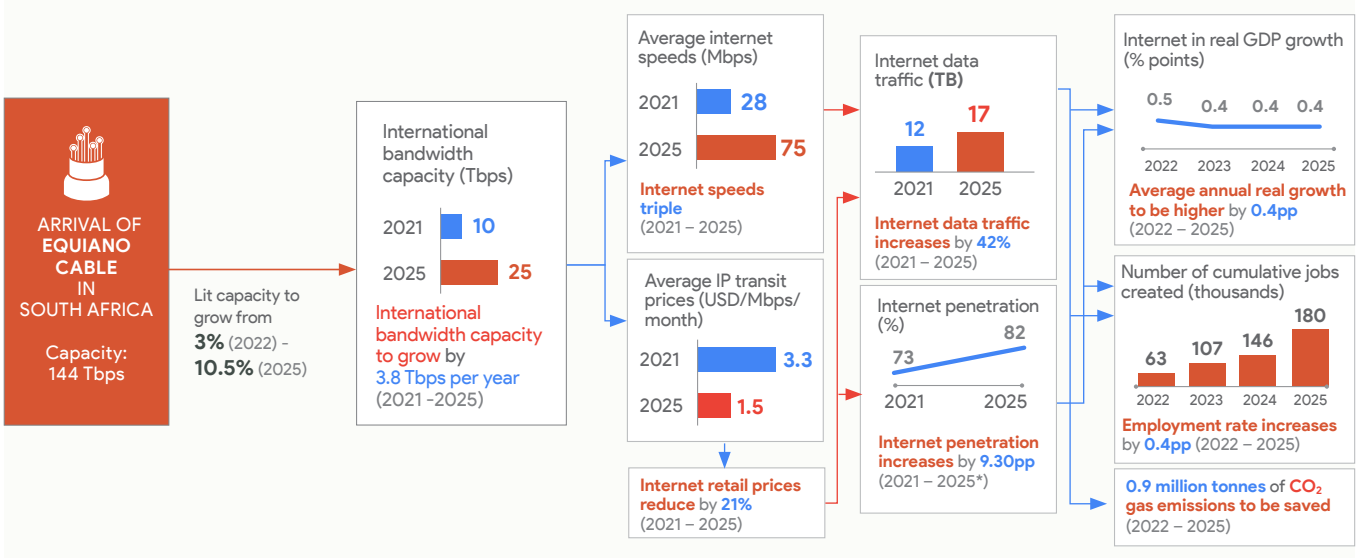
Source: Genesis Analytics, 2022

Equiano's cable landing stations will operate on an open-access and non-discriminatory model where all network 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 South Africa, 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 18 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.

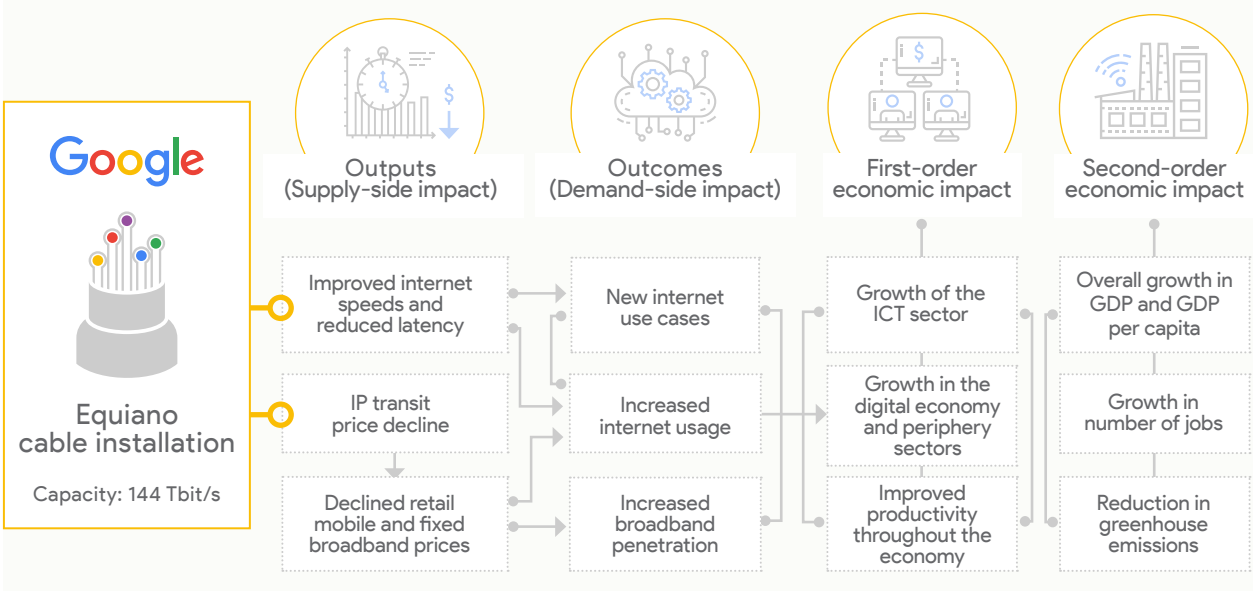
FIGURE 18 : Overview of Equiano's impacts 2021 - 2025



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 19 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 19 : 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)**

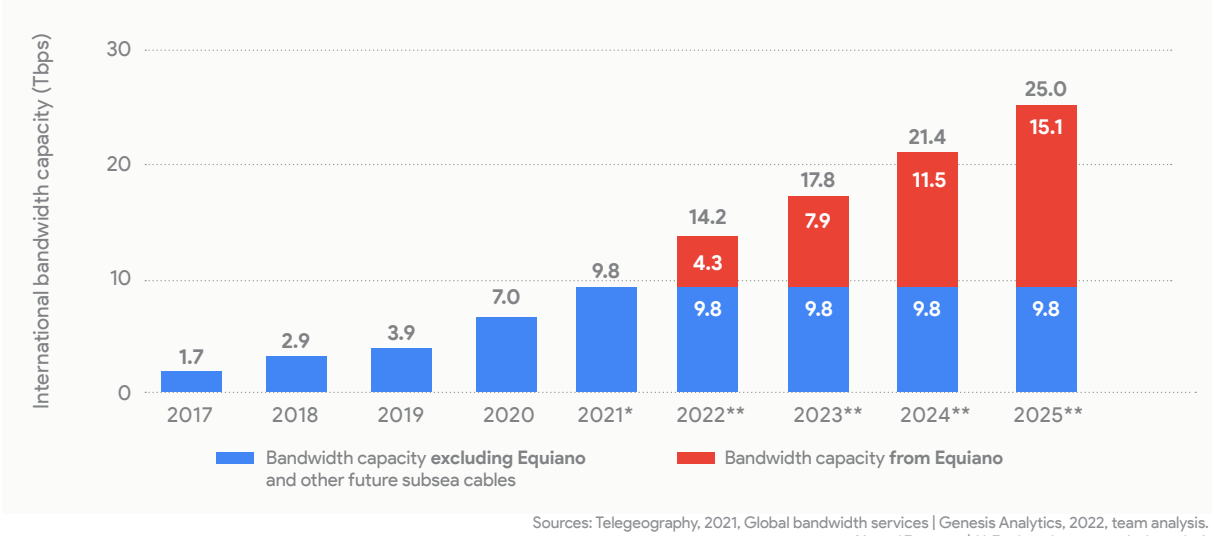
Table 1: Equiano's impact pathways and effects on the economy

	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. • 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 20) is expected to have an immediate impact on average IP transit prices, speeds and latency. For end users in South Africa, this will translate to cheaper and more reliable internet access, leading to a substantial growth in traffic and internet penetration.

FIGURE 20 : International bandwidth capacity in South Africa 2017 - 2025

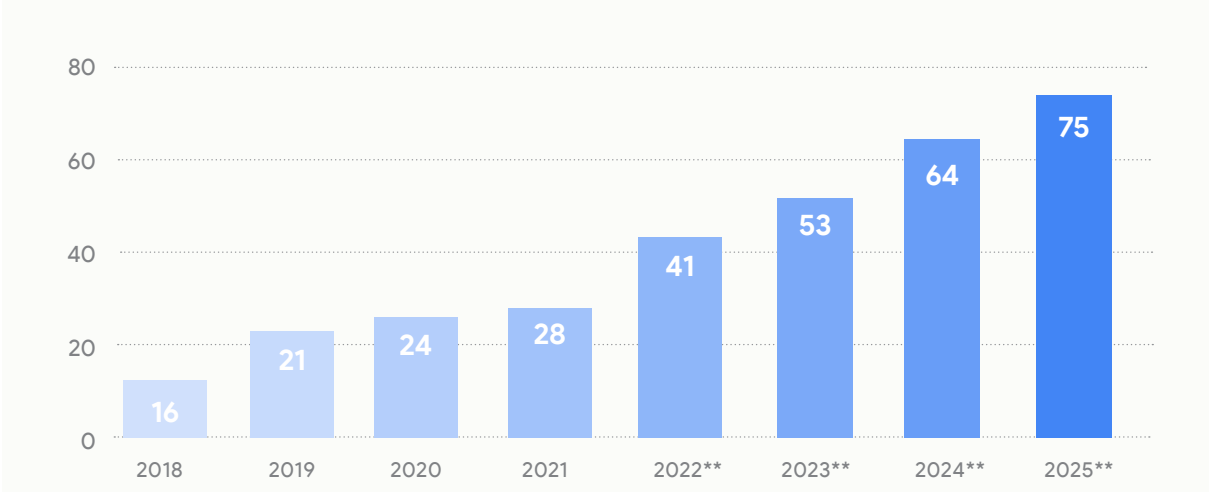


Sources: Telegeography, 2021, Global bandwidth services | Genesis Analytics, 2022, team analysis.
Note: *Forecast | ** Equiano impact analysis period.

Accelerating internet speeds

The increased international bandwidth capacity from the Equiano cable means that more data can be transmitted to South Africa 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 21 : Equiano's impact on internet speeds (Mbps) 2018 - 2025



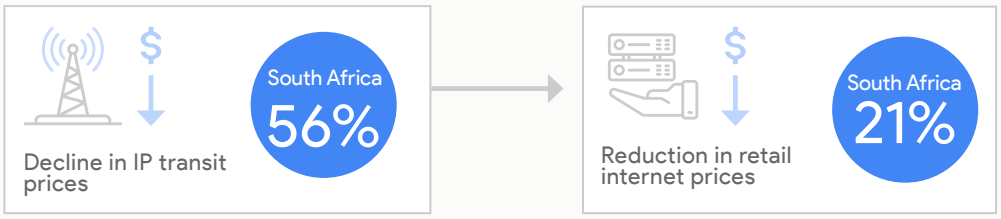
Sources: Ookla, 2022, Speedtest Global Index | Genesis Analytics, 2022, team analysis.
Note: **Equiano impact analysis period.

Making the internet more affordable

While entry-level mobile and fixed broadband bundles in South Africa are comparatively affordable by regional standards,[18] there is scope for prices to drop further and for the country to meet the Broadband Commission's targets by 2025. The cost of long-haul transmission of data is a major determinant of local IP transit prices. Equiano's landing in South Africa 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 directly through decreases in internet prices, or indirectly - through the provision of more data, uncapped data limits or higher speeds at the same price.

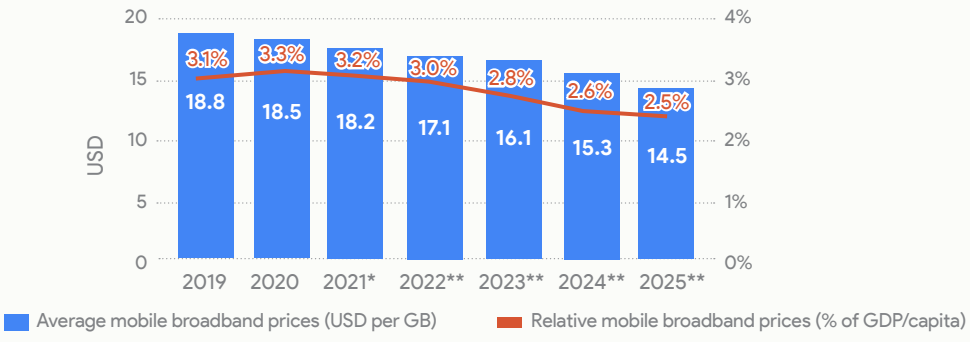
FIGURE 22 : Equiano's impact on internet prices **2021 - 2025**



Source: Genesis Analytics, 2022, team analysis.

Figures 23 and 24 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).

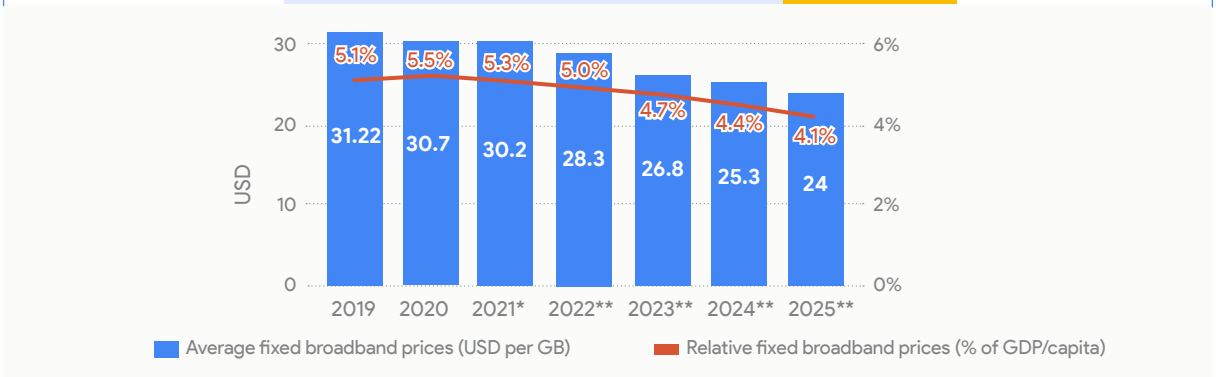
FIGURE 23 : Average mobile data retail prices[19] **2019 - 2025**



Source: International Telecommunication Union, Measuring digital development, ICT price trends, 2019 - 2020 | Genesis Analytics, 2022, team analysis.
Note: *Forecast | ** Equiano impact analysis period.

18. With entry-level data bundles costing marginally more than the Broadband Commission's 2% of GNI target, while entry-level fixed broadband packages cost approximately two-and-a-half times as much.
19. 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 24 : Average fixed broadband retail prices 2019 - 2025



Source: International Telecommunication Union, Measuring digital development, ICT price trends, 2019 - 2020 | Genesis Analytics, 2022, team analysis.
Note: *Forecast | ** Equiano impact analysis period.

Equiano impact on internet penetration and traffic

Lower prices, combined with improved speeds and latency, are expected to increase internet penetration in South Africa by 9.3 percentage points between 2021 and 2025. Figure 25 below illustrates the two pathways which lead to this increase, while Figure 26 highlights the anticipated growth in the number of internet users and penetration following Equiano's landing.

FIGURE 25 : Lower prices and improved speeds increase internet penetration and improve user experiences

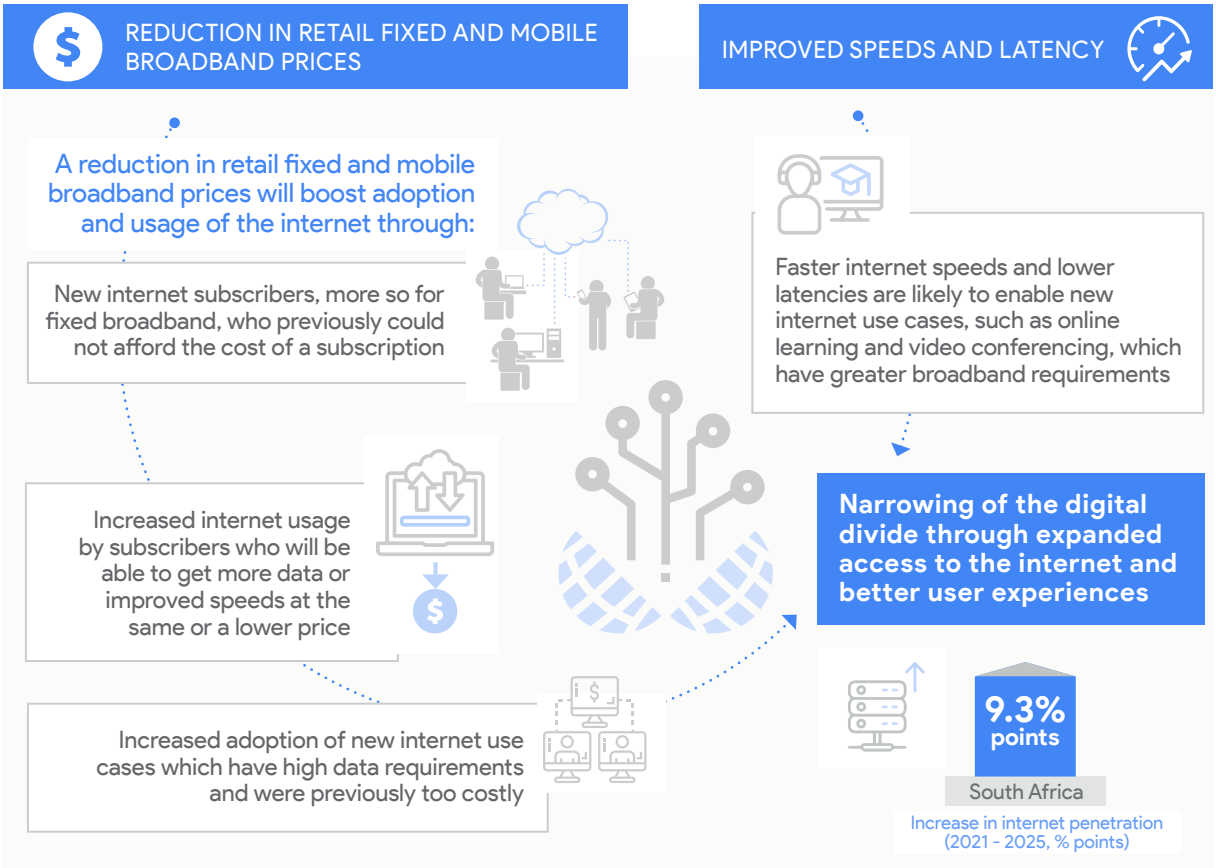
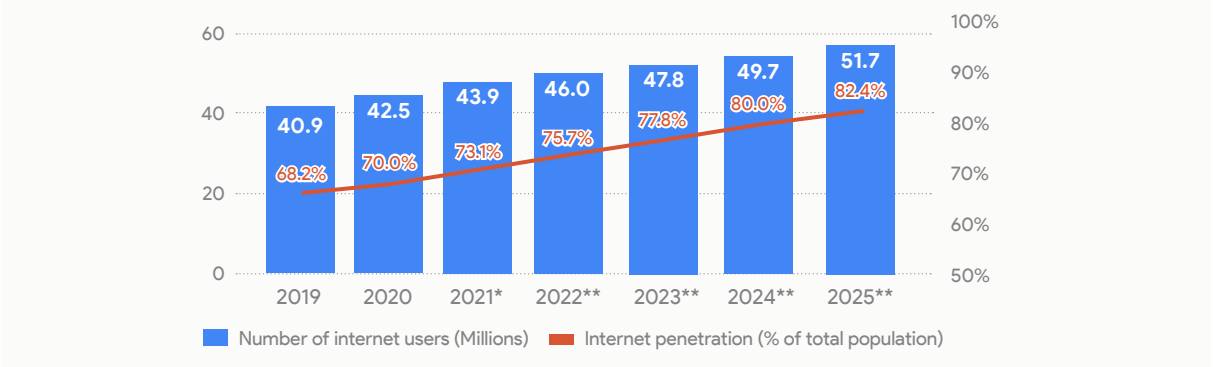


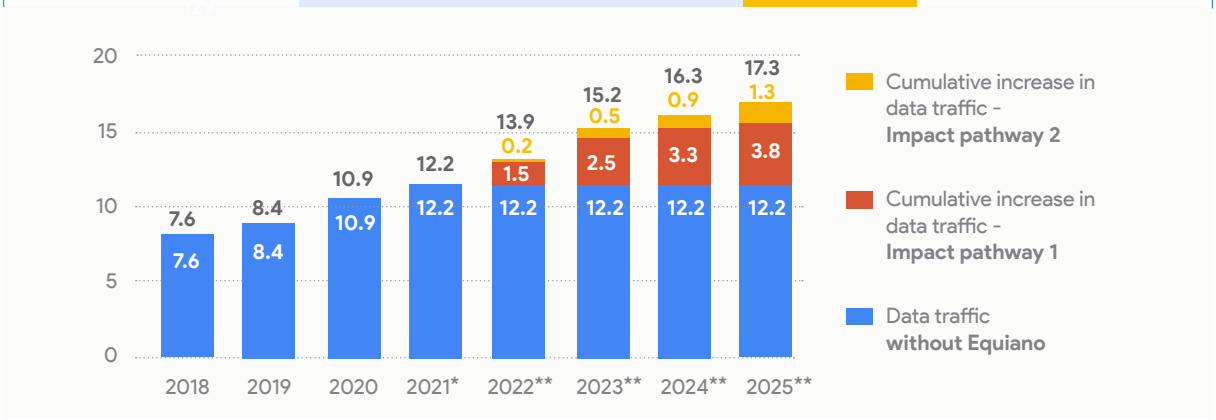
FIGURE 26 : Number of internet users and internet penetration in South Africa 2019 - 2025



Source: ITU World Telecommunications / ICT Indicators Database, 2022 | 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 providing 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 South Africa following Equiano's landing estimated from faster internet and more affordable access is illustrated in Figure 27 below.

FIGURE 27 : Total data traffic in South Africa 2018 - 2025



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

Catalysing network expansion

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.

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 Table 2 below. More reliable connectivity will improve the quality of their experience using latency-sensitive products and applications.

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

USE CASE	MINIMUM DIGITAL REQUIREMENTS	EQUIANO CABLE IMPACT
Online learning Many educational institutions in South Africa transitioned to a virtual learning experience 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 almost triple from 28 Mbps in 2021 to 75 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 19, 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 Users are now increasingly using the internet for entertainment and live gaming **User profile:** Content creators and consumers.	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 and Showmax. 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. Careers24, CareerJunction, SAGovJobs, Grow with Google, Google Meet, and Zoom. 3. Job forms and remote interviews require ~5 GB per month.	
Remote and hybrid work Remote and hybrid 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 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. **User profile:** Gig economy workers.	1. Internet bandwidth of ~500 Kbps to ~2 Mbps. 2. Uber, Bolt, SweepSouth, Google Maps, Waze, UberEats 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. Google Cloud, Google My Business, WhatsApp Business, Shopify, Takealot, Sage, Yoco. 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. ABSA app, Snapscan, Hello Paisa, Google Pay. 3. Payment rails (P2P, P2B, P2G, B2P, and G2P) require < 1 GB per month.	

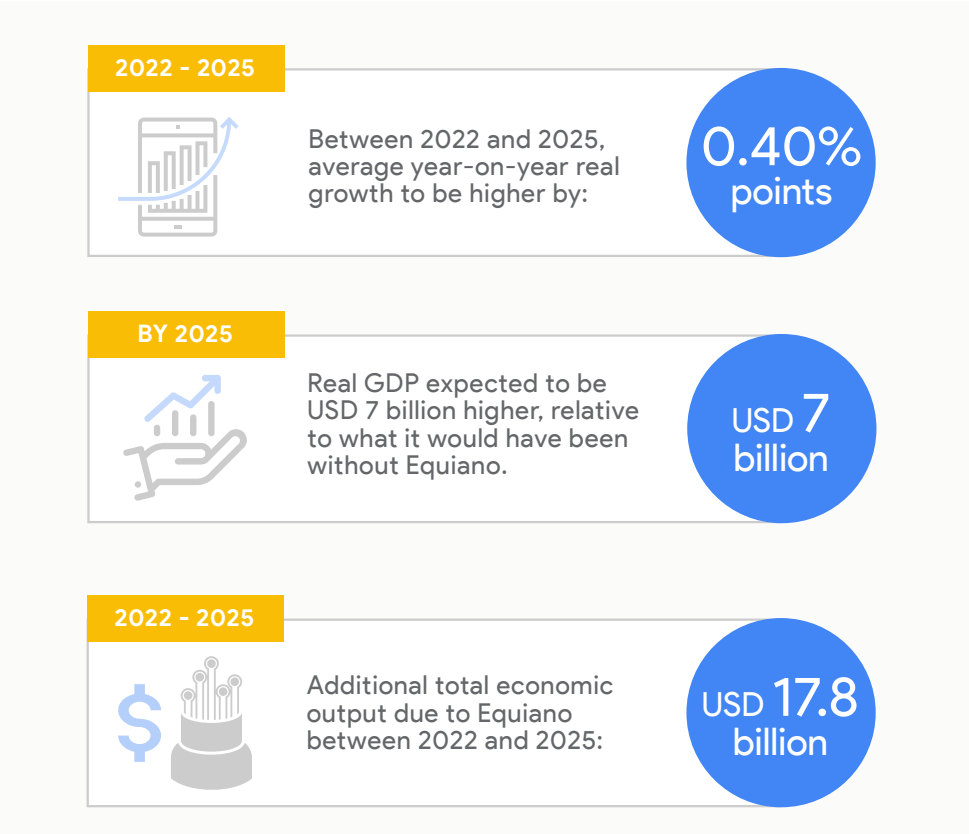
Macroeconomic impact of Equiano

Internet connectivity unlocks significant economic opportunities, more so in developing countries than 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%.[20] 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%.[21]

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 28 : Equiano's impact on the economy



Source: Genesis Analytics, 2022, team analysis.

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

Underpinned by reliable connectivity, the digital economy can be a game-changer for South Africa's economy and society: it represents an opportunity to leverage the benefits of the Fourth Industrial Revolution, accelerate growth, innovate, and improve people's lives. This takes place through a wide range of mutually reinforcing and overlapping pathways, classified below by three key stakeholder categories:

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.

Accelerating job creation

Between 2022 and 2025, Equiano is expected to indirectly create **180,000 new jobs** in South Africa following the cable's landing.[22] By 2025, the employment rate is expected to be **0.41 percentage points higher** as a result of Equiano, driven by two main pathways:

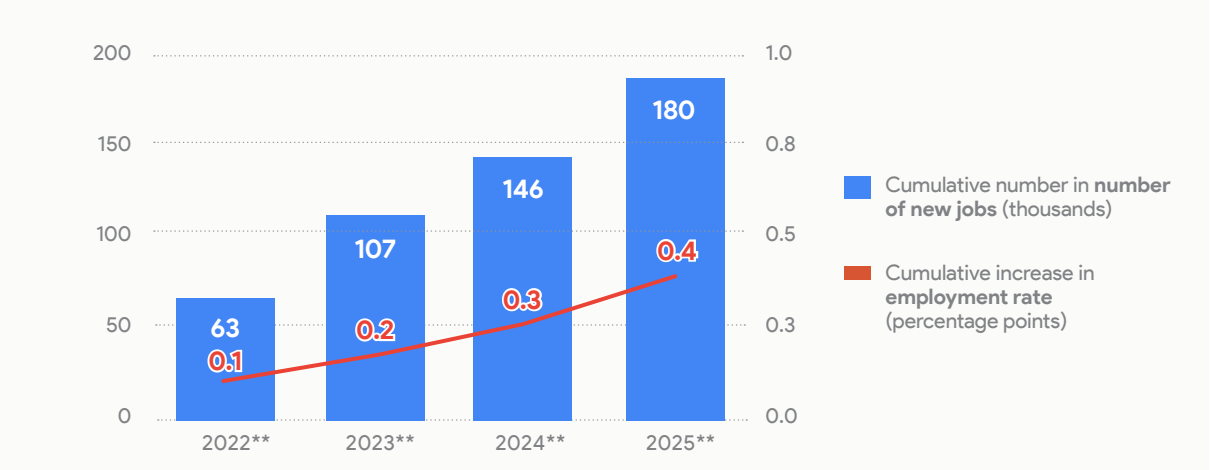
Growth of the digital economy and peripheral sectors.
The decline in internet retail prices and improved speeds lead to growing adoption by new users, and more intensive usage by existing ones. In turn, this facilitates the entry of new firms, particularly so in sectors that rely heavily on ICT such 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.

22. 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.

Figure 29 below illustrates expected job creation following the cable's landing and the associated increase in the employment rate.

FIGURE 29 : Increase in employment due to Equiano 2022 - 2025



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

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

Adoption of more sustainable and efficient electronic communications and a reduction in the consumption of paper

2

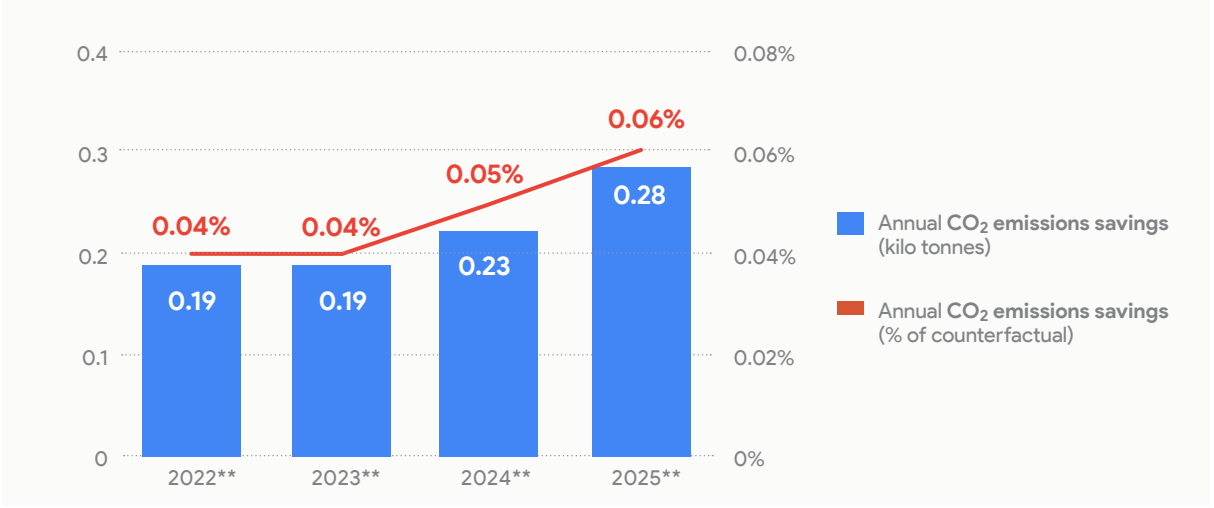
Adoption of teleconferencing and telecommuting, leading to savings in the consumption of petrol

3

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 30 below illustrates the annual savings in CO_2 gas emissions from Equiano. Cumulatively, these amount to 0.9 million tonnes over the 2022-2025 period, equivalent to annual CO_2 emissions savings of 221 kilo tonnes (or approximately 0.05% of annual emissions in 2020).

FIGURE 30 : 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

South Africa's digital ecosystem is a vital component of the economy. It directly and indirectly employs hundreds of thousands of people, and underpins trade and value addition, particularly in the services sector.

While South Africa's internet market is comparatively mature by regional standards and benefits from high 3G and 4G coverage, relatively high internet penetration and speeds, as well as declining prices, there remain significant opportunities to further improve nationwide connectivity and fully leverage the benefits of the Fourth Industrial Revolution.

Attracting domestic and international investments in internet infrastructure - at all stages of the value chain, from submarine cables to terrestrial fibre networks that bring access to end users - is central to growing the digital economy and reducing the stark digital divide. The expansion of the internet market and increased adoption of digital services can help break South Africa's ongoing cycle of lacklustre growth and chronic unemployment, especially among the youth.

The arrival of Google's Equiano cable in South Africa is expected to raise the country's real economic year-on-year growth rate by an average of 0.4 percentage points between 2022 and 2025. This higher growth rate will result in additional economic output worth USD 17.8 billion over the same time frame. Additionally, the installation of the cable is expected to indirectly yield a total of 180,000 new jobs between 2022 and 2025, averaging over 45,000 new jobs annually, driven by the expansion of the digital economy and peripheral sectors.

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 to obtain licences and permits for laying and landing submarine cables will stimulate private sector investment. Likewise, having a single agency facilitate licence and permit applications will streamline the process and attract investment. Investment policies should be flexible, allowing majority ownership of submarine cables by foreign investors, while 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 only be limited to promoting investment in and maintenance of submarine cables, but should also facilitate the expansion of the country's internet backbone and last-mile connectivity. These 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:[23]

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 economic opportunities and quality of life for South Africa's population.

23. 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.

SOUTH AFRICA ECONOMIC IMPACT ASSESSMENT: Technical Annex

Table of contents

Introduction and methodology

This study provides technical background to the South Africa Economic Impact Assessment, which features an overview of South Africa's connectivity ecosystem, the national policy environment, background on Equiano, and insights into the role of submarine cables in the global economy. The South Africa 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 South Africa'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.

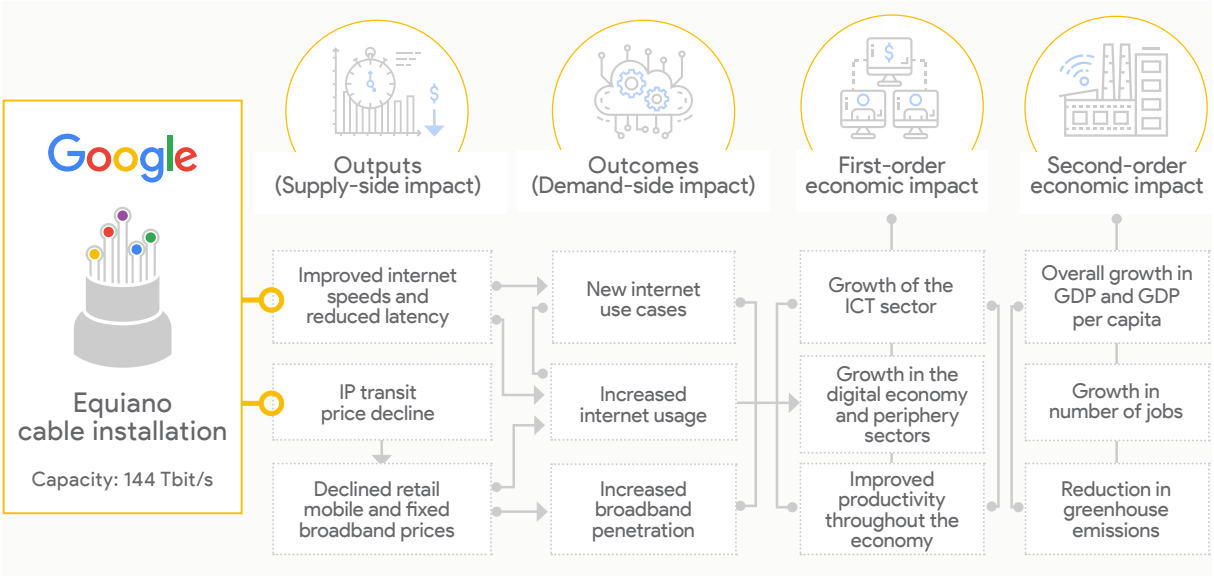
In order to estimate the impact of the Equiano cable on South Africa's economy, we establish the relationship between the different variables within the impact pathways. The change coefficients quantifying these relationships are obtained from the results of several studies which have run empirical models 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 South Africa'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. • 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.		

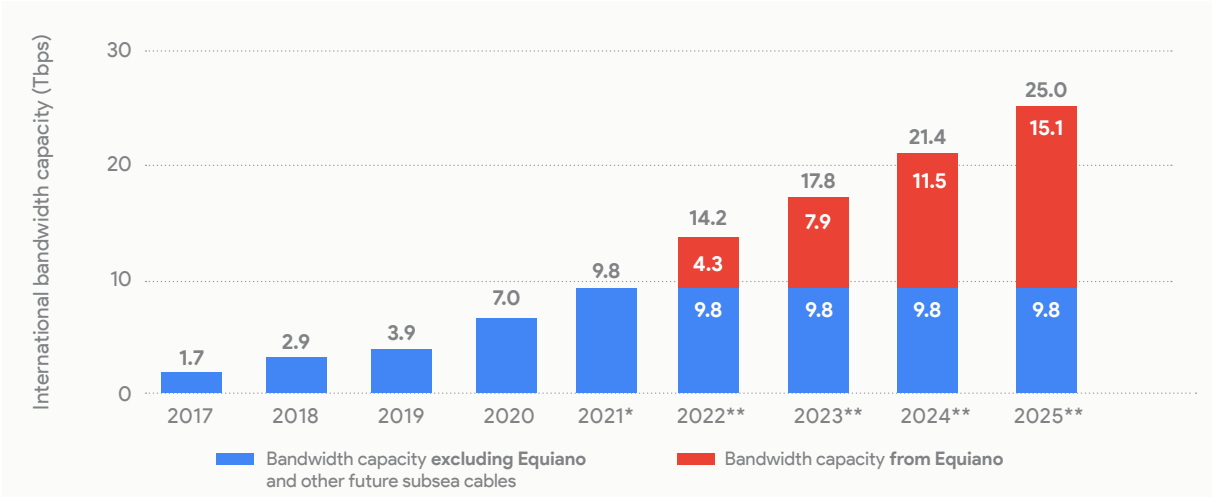
Equiano cable impact analysis

Based on the impact pathways shown in Figure 1, this section presents the results of the Equiano cable impact assessment in South Africa, 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 will be utilised and thus translated into additional international bandwidth capacity for South Africa.[1] Given that there are three additional subsea cables expected to land in South Africa in the next few years,[2] the share of Equiano's capacity that will be utilised will likely start off low to match the lower demand for bandwidth.

We therefore model the share of utilised capacity of the cable to start off at 3% of potential capacity (144 Tbps) in 2022. As demand for bandwidth increases in response to additional steady and affordable supply, the utilised capacity relative to the potential capacity is expected to increase by 2.5 percentage points every year, to reach 10.5% in 2025. This additional utilised capacity will then translate, one-for-one, into a higher total used bandwidth for South Africa, as shown in Figure 2. This increase in bandwidth capacity in turn affects South Africa's internet market's supply-side metrics.

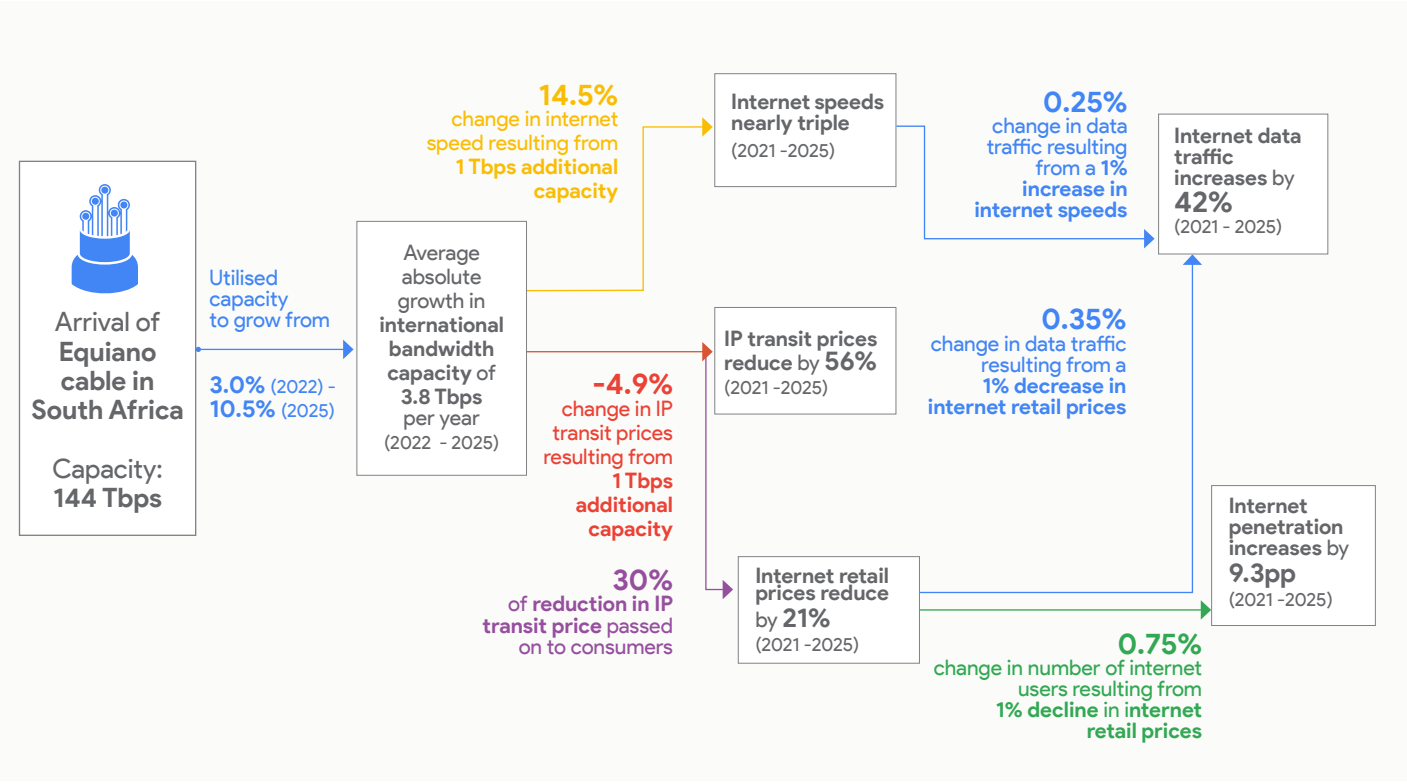
FIGURE 2 : International bandwidth capacity in South Africa **2017 - 2025**



Sources: Telegeography, 2021, Global bandwidth services | Genesis Analytics, 2022, team analysis.
Note: *Forecast | ** 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, according to TeleGeography in 2018. We calculate the average lit capacity for cables that landed in South Africa before 2020 currently stands at 15%.
2. 2Africa should be completed by 2024. The PEACE consortium has not yet announced a completion date for the planned South Africa branch.

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. According to a 2019 study by Hjort and Poulsen[3] performed across 12 sub-Saharan African markets 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 respectively.[4] 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.

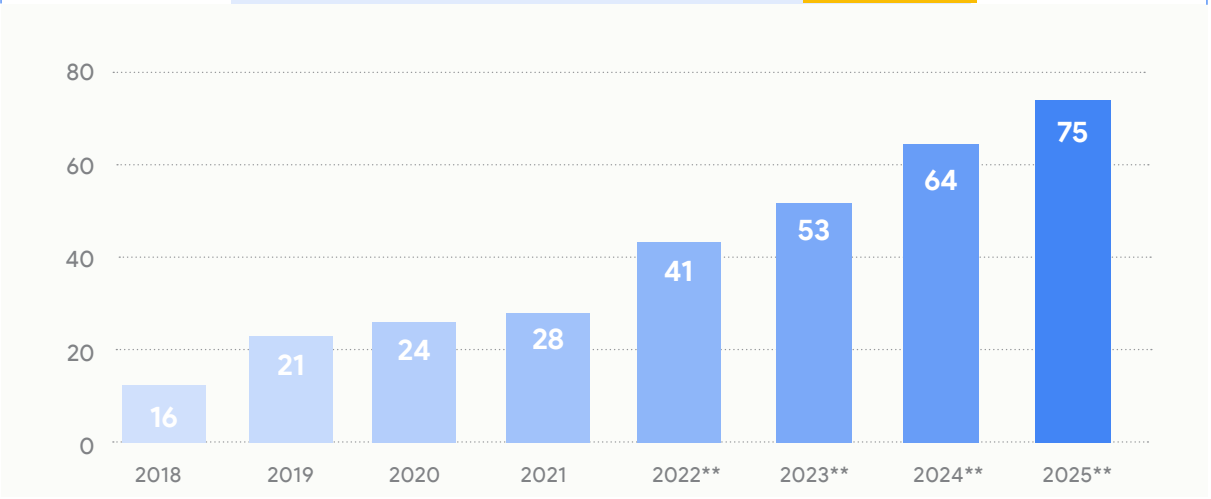
An average increase of 0.6 Tbps in international bandwidth capacity improved internet speeds by 35% on average. Accordingly, we calculate that an increase of 1 Tbps in international bandwidth capacity would have led to an increase in internet speeds of 58%.

1. Hjort, J. and Poulsen, J., 2019, The Arrival of Fast Internet and Employment in Africa, American Economic Review.
2. The stated design capacities of the subsea cables mentioned pertain to the period 2007-2014, i.e. the time frame of the study of Hjort and Poulsen. They therefore do not take into account subsequent cable capacity upgrades..

Given that the average internet speeds today are much higher than they were between 2007 and 2014, we apply a 75% 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%.

Applying the above coefficient results in internet speeds in South Africa almost tripling between 2021 and 2025.[5] Average internet speeds are expected to rise from 28 Mbps in 2021 to 75 Mbps in 2025 as a result of Equiano's arrival (see Figure 3).

FIGURE 3 : Average internet speeds in South Africa (Mbps) 2018 - 2025



Sources: Ookla, 2022, Speedtest Global Index | Genesis Analytics, 2022, team analysis.
Note: **Equiano impact analysis period.

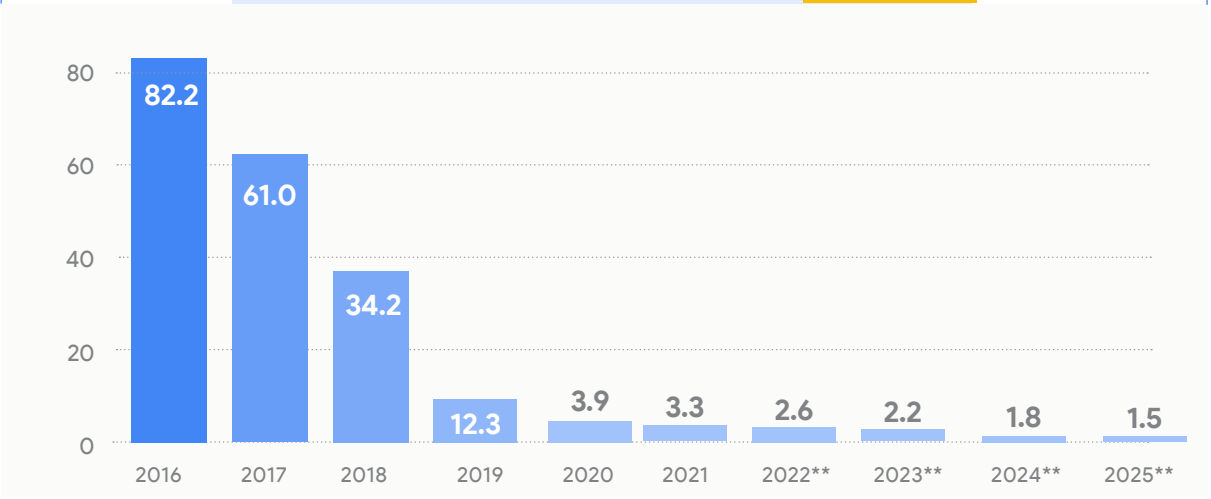
The change in IP transit prices due to increased international bandwidth capacity is derived from the results of a 2020 Analysys Mason study,[6] which quantifies the impact of Google's investment in internet network infrastructure within the Asia-Pacific (APAC) region. The results from the Analysys Mason study can be applied in this study on South Africa, as the state of the APAC region internet market during the period covered by the study (2010 -2019) was comparable to the current and predicted near-future state of connectivity in sub-Saharan Africa.

The Analysys Mason study finds that as a result of the growth in the network of subsea cables, IP transit prices declined by 74% between 2010 and 2019 in countries that connected to these cables. The subsea cables Google invested in the APAC 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 implies an additional bandwidth capacity of 15 Tbps from the three cables. This implies that an additional 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% between 2021 and 2025, from an average of USD 3.3 Mbps/month to USD 1.5 Mbps/month as a result of Equiano's landing (see Figure 4).

5. Based on median speeds provided by Ookla's Global Index.
6. Analysys Mason, 2020, Economic Impact of Google's APAC Network Infrastructure.

FIGURE 4 : Equiano's expected impact on IP transit prices **2016 - 2025**



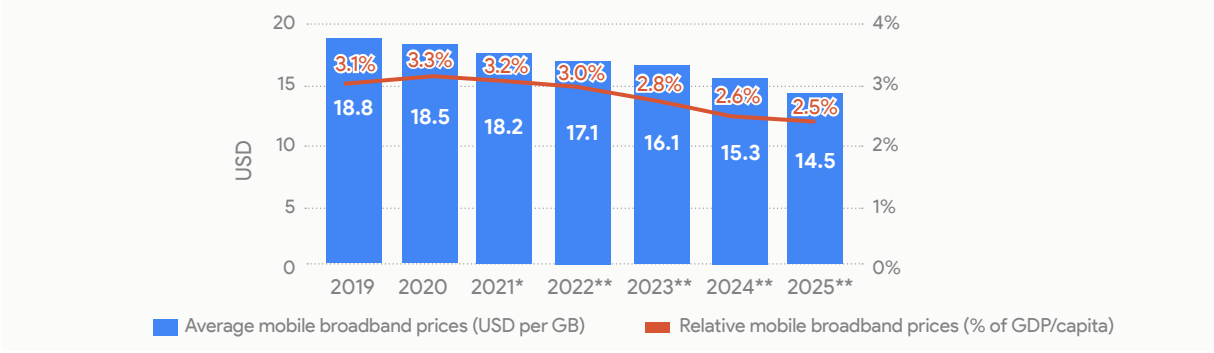
Sources: Ookla, 2022, Speedtest Global Index | Genesis Analytics, 2022, team analysis.
Note: **Equiano impact analysis period.

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. Last-mile infrastructure investments are more likely to be made in rural areas, where connectivity is low due to limited infrastructure networks and challenging topographies.[7]

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 as a result of Equiano's landing.**

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

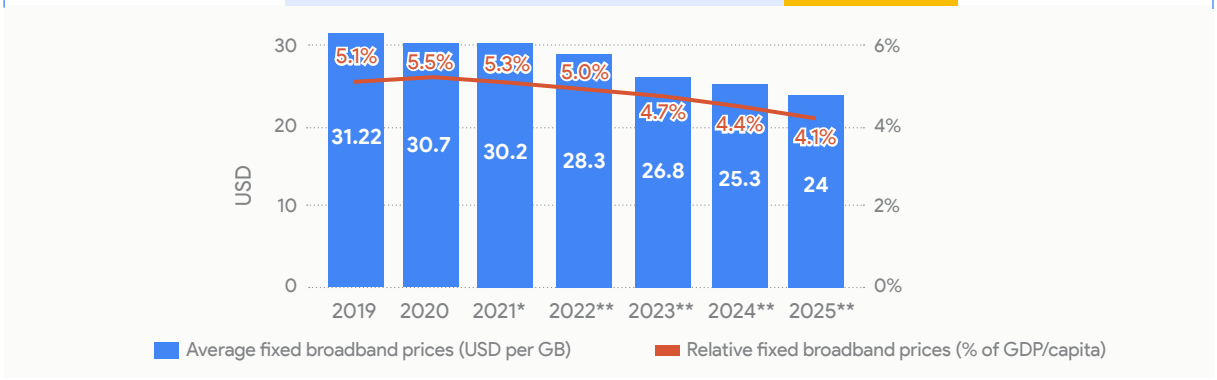
FIGURE 5 : Average mobile data retail prices **2019 - 2025**



Source: International Telecommunication Union, Measuring digital development, ICT price trends, 2019 - 2020 | Genesis Analytics, 2022, team analysis.
Note: *Forecast | ** Equiano impact analysis period.

7. We note that commercial operators have typically been reluctant to invest significantly in unprofitable, remote areas that are characterised by low population density, relative to investing in more urban areas. In this respect, incentives by governments, minimum coverage requirements established by telecommunications regulators, and investments by universal service funds, all play an important part in bringing connectivity to underserved areas.

FIGURE 6 : Average fixed broadband retail prices 2019 - 2025



Source: International Telecommunication Union, Measuring digital development, ICT price trends, 2019 - 2020 | 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 South Africa, leading to better user experiences and a higher demand for data traffic. To establish the extent to which higher internet speeds will lead to a growth in internet data traffic, we refer to the Hjort and Poulsen study. 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%.

In 2018, approximately 34% of South Africans used the internet less frequently than daily, while 12% used the internet less frequently than weekly.[8] Assuming that as a result of using the internet daily, daily data consumption increases by four times and weekly data consumption increases by 4.5 times, then the data consumption will have increased by 17.8% in the context of Hjort and Poulsen's study.

As there is no robust data on the contribution of faster speeds and lower prices to data traffic, we assume growth in traffic is driven equally by faster internet speeds and lower internet retail prices. The change in internet data traffic resulting from faster speeds is therefore 8.9%, owed to the 35% increase in internet speeds reported by Hjort and Poulsen. The implied change coefficient is therefore 25.4% - a 100% increase in internet speeds leads to an increase in data traffic by 25.4%. **By this change coefficient, the total increase in data traffic between 2021 and 2025 due to improved speeds following Equiano's landing is expected to be 32%.**

8. Statista, 2020, Internet usage frequency in South Africa as of January 2018.

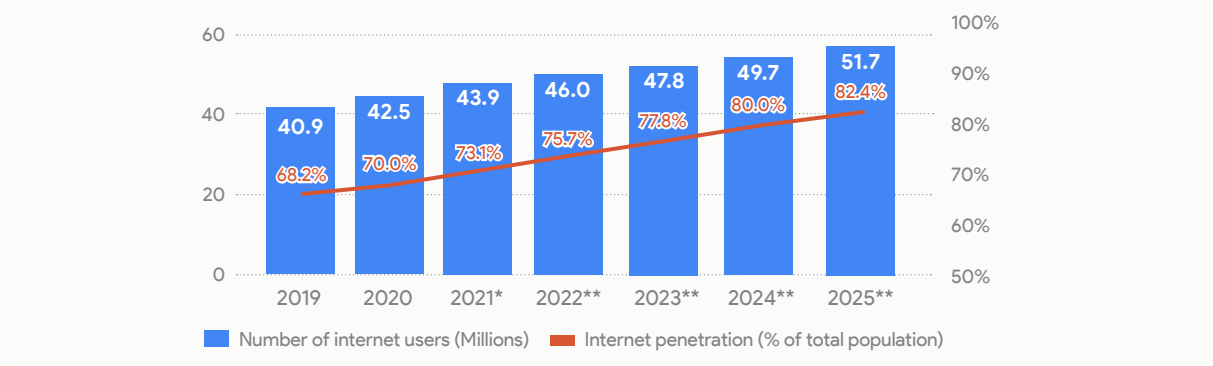
Lower retail prices (impact pathway 2)

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 this can be derived from data on the price elasticity of demand for satellite TV, given the average pricing of satellite TV across different plans and packages is comparable to the average pricing of various internet subscription packages.

A 2012 study by the Commonwealth Telecommunications Organisation[9] charts the number of subscribers of satellite TV as a function of price. From this, we estimate the elasticities at different price points. We take the most conservative price elasticity of -0.75 - the average price elasticity between the USD 100 and 70 price points. By this price elasticity, it is expected that the projected overall decline in retail prices of 21% between 2021 and 2025 will increase the number of internet users by 18%. **This translates to an increase in internet penetration of 9.3 percentage points over the same time frame, as shown in Figure 7 below.**

FIGURE 7 : Number of internet users and internet penetration in South Africa 2019 - 2025



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

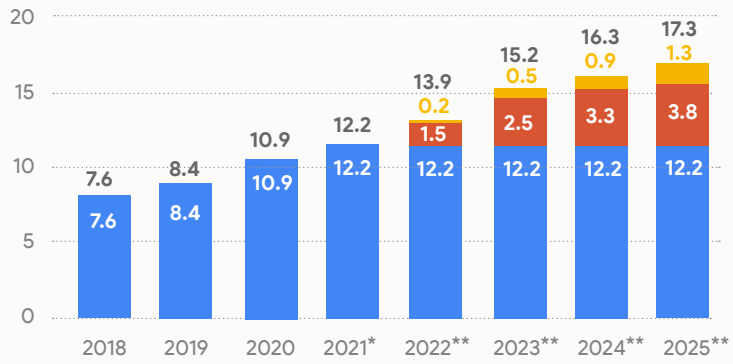
As mentioned in the above section, the total increase in internet data traffic based on Hjort and Poulsen's study is estimated at 17.8%. Half of this increase is attributable to improved internet speeds, while the other half is attributable to lower internet retail prices. This translates to an increase in internet usage of 8.9%, attributable to a 25.7% decline in internet retail prices. This yields a change coefficient of 34.6%. **By this coefficient, the total change in data traffic between 2021 and 2025 arising from 21% lower internet retail prices is 9.6%.**

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 total modelled increase in data traffic of 42% between 2021 and 2025 therefore encapsulates both intensive and extensive increases in internet usage.**

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

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

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



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

First-order economic impact

Examining the first-order economic impact of Equiano[10] is critical to assessing the cable's overall contribution to South Africa'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 sectors have experienced growth in revenues from their physical stores concurrently with growth in their online sales.

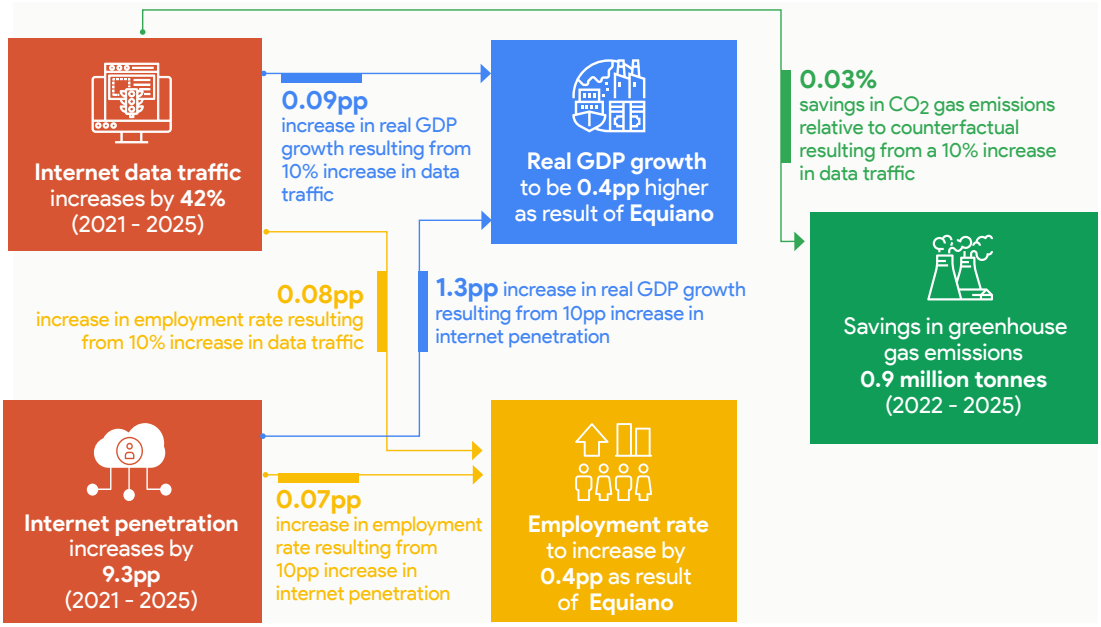
Growth of the digital economy will also spill over into peripheral sectors, such as transport and storage due to the growth of e-commerce. A greater share of business operations being undertaken online will enable improved coordination, collaboration and automation. This in turn will boost the productivity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

Second-order economic impact

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

10. 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

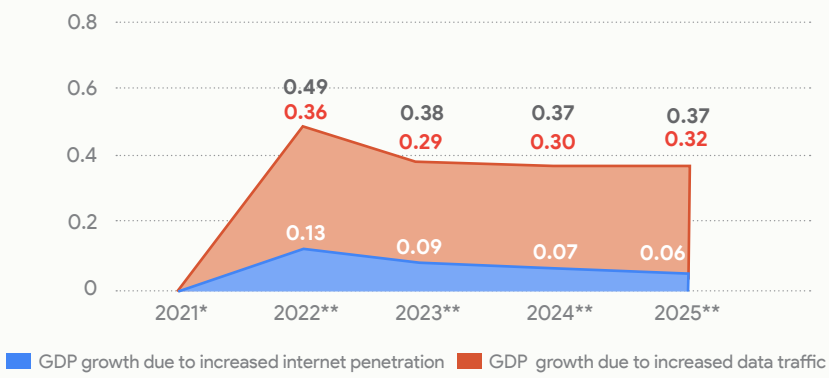
Based on the literature review, increased internet usage and broadband penetration are expected to yield higher real economic growth. A 2020 RTI study[11] found that a 10% increase in international bandwidth consumption per user in South Africa results in a 0.15% increase in GDP per capita. By reconstructing 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 in per capita income - 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.[12] The resultant increase in average real GDP growth between 2021 and 2025 - due to the 42% predicted increase in data traffic by the same year - is thus 0.34%.

Two separate studies[13] - by Scott and Qiang et al.[14] - 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 South Africa of 9.3 percentage points between 2021 and 2025 will lead to an increase in real GDP of 1.3% within the same time period.**

Accordingly, South Africa's real GDP is expected to be USD 7 billion more than it otherwise would have been in 2025, reflecting an increase in the average year-on-year real economic growth rate of 0.40 percentage points between 2022 and 2025. The Equiano cable will have led to an additional USD 17.8 billion in total economic output between 2022 and 2025. In the context of an average population growth rate of 1.2%, the additional overall economic growth will result in a higher GDP per capita growth rate of 0.40 percentage points.

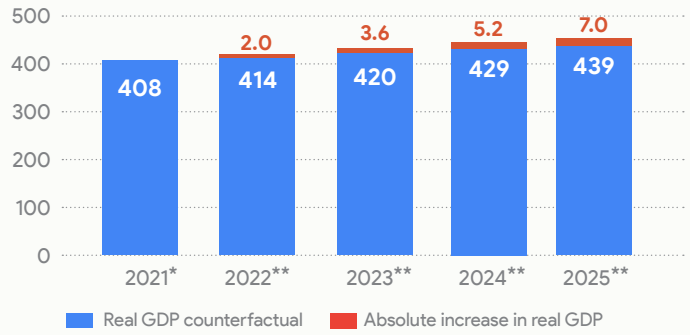
11. RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in South Africa.
12. At the stage of the analysis, population growth – which impacts GDP per capita – is not yet factored in. It is however incorporated into the modelling, as outlined in the last sentence above Figure 10.
13. Scott C., 2012, Does Broadband Internet Access Actually Spur Economic Growth?
14. 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



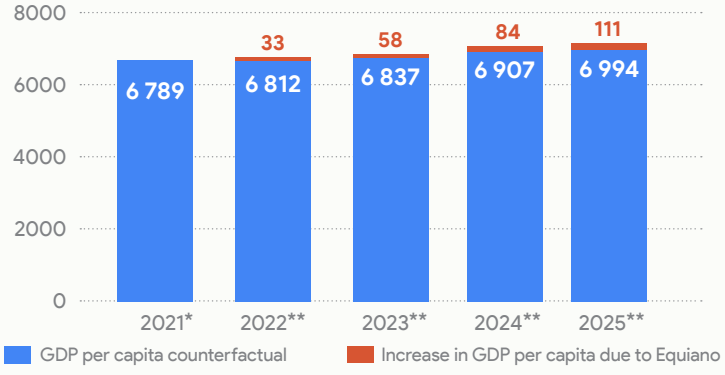
Source: Genesis Analytics, 2022, team analysis. Note: *Forecast | **Equiano impact analysis period.

FIGURE 11 : Increase in real GDP due to installation of Equiano (USD billions) 2021 - 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) 2021 - 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 will allow many South Africans to access the digital world for the first time. 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 South Africa, we incorporate the findings of Hjort and Poulsen's study on the impact of the arrival of new submarine cables on employment in the country.

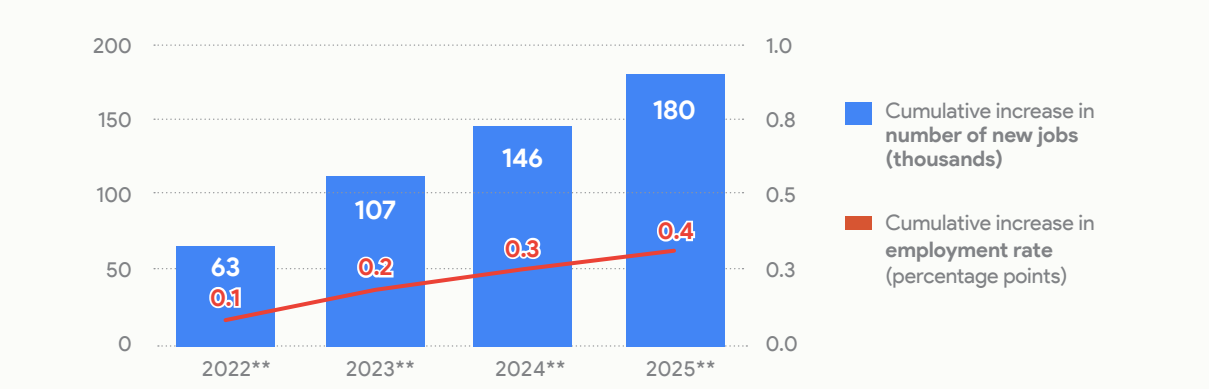
The study finds that on average, the arrival of a subsea cable in South Africa led to an increase in the employment rate by 2.2 percentage points in the connected areas, defined as those within 500m of a terrestrial fibre optic cable. There was no impact on the employment rate in the areas not connected to the internet network backbone of the country.

We assume that the proportion of South Africa's population living in connected areas equated to 20% of the urban population, translating to 12.5% of the country's total population. In this context, and based on the Hjort and Poulsen study, a 2.2 percentage point increase in the employment rate among the 12.5% of the total population translates to an increase in the country-wide employment rate of 0.27 percentage points.

We further assume that the contribution of increased data traffic and increased number of internet users to the 0.27 percentage points increase in employment rate is split equally. By constructing the implied increase in data traffic and internet penetration, within the context of the paper, we find that the change coefficients for employment with respect to data traffic and number of internet users are 0.78 percentage points and 0.73 percentage points. A 100% increase in data traffic will therefore lead to an increase in the employment rate of 0.78 percentage points, while a 100% increase in the number of internet users will lead to an increase in employment rate of 0.73 percentage points.

Therefore, the growth in data traffic of 42% between 2021 and 2025 is thus expected to increase the employment rate by 0.29 percentage points. Meanwhile, the increase in internet penetration of 9.3 percentage points over the same time frame should result in an increase in the employment rate of 0.12 percentage points by 2025. **The employment rate in South Africa should therefore be 0.41 percentage points higher by 2025, representing a cumulative total of approximately 180,000 new jobs created between 2022 and 2025 as a result of Equiano's landing. This equates to an average of 45,000 jobs created annually over this time frame.**

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



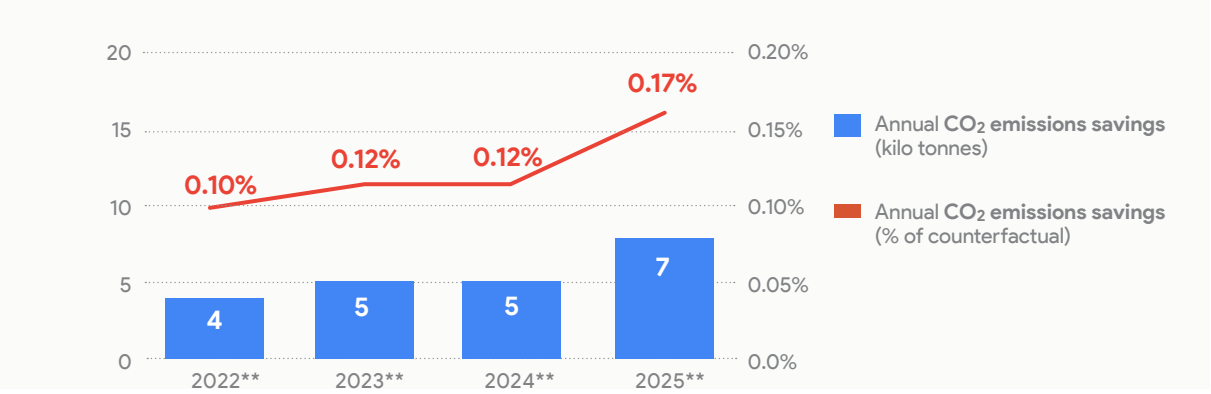
Source: Genesis Analytics, 2022, team analysis. Note: **Equiano impact analysis period.

Greenhouse gas emissions

According to a 2013 SQW study[15] 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. This is equivalent to 0.14% of the counterfactual CO_2 gas 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 an 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 cumulative savings in CO_2 emissions of 0.9 million tonnes over the period 2022 to 2025. This averages out to annual CO_2 emissions savings of 221 kilo tonnes, or approximately 0.05% of annual emissions in 2020.

FIGURE 14 : Savings in CO_2 gas emissions 2022 - 2025



Source: Our world in data, Annual CO_2 emissions, 2021 | Genesis Analytics, 2022, team analysis. Note: *Forecast | **Equiano impact analysis period.

15. 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

RTI analysed the impact of the landing of subsea fibre optic cables and improved broadband connectivity on South Africa between 2009 and 2014.[16] 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 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[17] 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.

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.

16. RTI International, 2020, Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in South Africa.
17. Net firm entry refers to the number of new firms entering a market minus the number of firms closing.
18. Hjort J. and Poulsen J., 2019, The Arrival of Fast Internet and Employment in Africa, *American Economic Review*.

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.

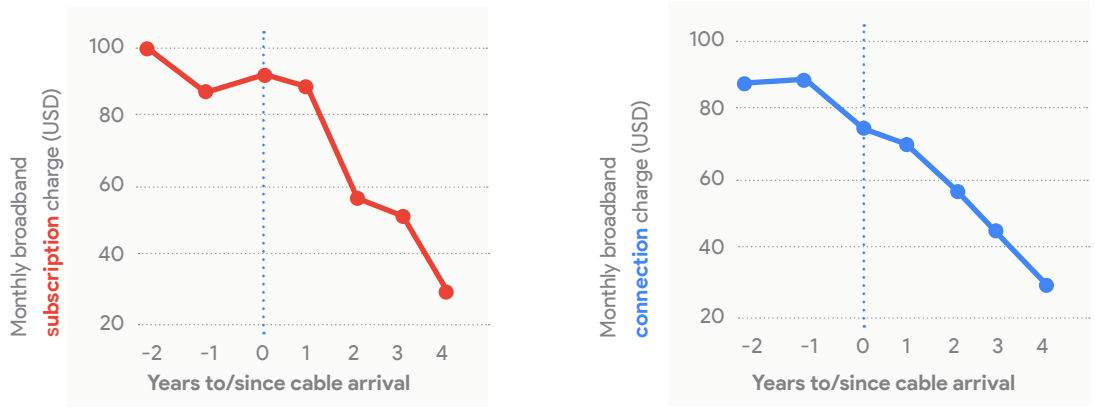
Impact of increased broadband penetration on economic output

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%.

19. Analysys Mason, 2020, Economic Impact of Google's Apac Network Infrastructure.
20. Katz R., Callorda F., 2018, The Economic Contribution of Broadband, Digitization and ICT Regulation. *ITU Publications.*

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]



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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