ITU Publications

International Telecommunication Union
Development Sector

Connecting humanity

Assessing investment needs of connecting humanity to the Internet by 2030

August 2020

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Acknowledgement

This study was prepared under the leadership of Doreen Bogdan-Martin, Director of the Development Bureau of the International Telecommunication Union (ITU) and the direction of an ITU team composed of Nancy Sundberg, Senior Programme Officer; Catalin Marinescu, Head of the Strategy and Planning Division; and Vaggelis Igglesis, Strategy and Planning Advisor. The study was written by A4AI (Sonia Jorge, Executive Director, with support from Nathalia Foditsch, Senior Policy Specialist, Anju Mangal, Asia/Pacific Regional Coordinator, and Maiko Nakagaki, Senior Strategic Partnerships Manager) based on research and analysis they conducted with Xalam Analytics. The team would like to acknowledge the valuable contributions of Aminata Garba, Martin Schaaper, Sofie Maddens, Esperanza Magpantay, Tomas Lamanauskas and Alex Wong.

The study is a contribution of ITU as the lead Knowledge Partner of the G20 Digital Economy Task Force. It was developed with the kind support of the Kingdom of Saudi Arabia.

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Foreword

For those living in the world's handful of highly-connected countries, it can come as a shock to learn that nearly half the global population aged 10 years and over – equating to some three billion people – has never used the Internet. Many of the unconnected live in rural and remote areas, where connectivity remains a challenge. A disproportionate number are women, particularly in Africa and South Asia, where the digital gender divide is particularly marked. And of course most are poor, lack basic literacy, and, with only limited digital exposure, see little value in getting online.

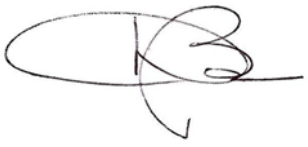
In a post-COVID world, this dire state of affairs is no longer something the world can live with. With the pandemic pushing so many essential services online, we face a real and present danger of those without broadband access being left ever further behind. This was not the vision global leaders signed up to we committed to meet the SDGs by 2030.

With just ten years remaining, this timely new report asks: What will it take to connect the world? How much investment is needed, where are the global 'pain points', and how can we mobilize the unprecedented levels of financing needed to extend networks to unserved communities?

Dramatically changing the picture will mean dramatically changing the way we work. Business-as-usual is not going to connect the remaining half of humanity. Cooperation is a must but it is not enough. We need innovative ways of connecting people, fostering innovation, and promoting new technologies. It is up to us to find new ways of collaborating on solutions to chronic financing barriers, investment brakes, and implementation hurdles.

As this report argues, enlightened, enabling regulatory frameworks can play a big part. So can a more cooperative approach between the many different players in the digital ecosystem. And if we are to stimulate, rather than stymie, network deployment, government policies need to prioritize broadband as basic infrastructure, as essential for development in the digital age as transport, energy and water networks.

This comprehensive new report estimates that achieving universal access to broadband will require bringing over three billion people online in the next ten years, at an estimated cost of USD428 billion. While this is an ambitious aim, it is in no way an unachievable one. It is my hope that as part of ITU's Connect 2030 Agenda efforts, this major new ITU contribution will provide clear, coherent evidence-based guidance for countries that will help them accelerate efforts to reach unconnected communities, so that equality of opportunity is finally within reach of all.



Doreen Bogdan-Martin
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1. Introduction and background

Assessing the investment needed to provide universal and affordable access to the Internet for all of humanity by 2030 is a considerable challenge. The good news is the clear commitment of the G20 countries "we recognize that improved connectivity and broadband access is a necessary condition for the development of the digital economy, as well as a powerful enabler of inclusive growth and sustainable development",[1] as set out in the G20 Ministerial Statement on Trade and Digital Economy of 2019. The 2019 Statement has, indeed, explicitly highlighted the importance of such a goal[2] and the role of the G20 Digital Economy Task Force (DETF), since its inception in 2017. Connectivity has become an even greater priority over the past months, as the world has faced an unprecedented pandemic (COVID-19) which has exposed different types of inequalities within and across countries and regions, including those related to quality of access, affordability and use of the Internet. Thus, assessing investment requirements to reach affordable universal connectivity matters to the G20 countries and to any country concerned with the ability to achieve the Sustainable Development Goals (SDGs).

In this study, the International Telecommunication Union (ITU), the official Knowledge Partner of the G20 Digital Economy Task Force, analyses the investment needed to achieve universal, affordable broadband for all of humanity by 2030. **For the purposes of this analysis, and throughout this study, reference to broadband should be understood to mean a 4G equivalent connection, and the target population as those aged 10 years and above.** The study provides an overview on the investment required for all countries of the world[3], examining costs at both the global and regional levels associated with infrastructure needs, policy and regulatory reform and basic digital skills and local content.

In 2019, approximately three billion people (aged 10 years and above) around the world were still unconnected to broadband, which is nearly half of the global adult population.[4] Over 12 per cent of the unconnected population lives in remote, rural locations where traditional networks are not easily accessible. Furthermore, the digital gender gap is still a major challenge. Across the globe, more men than women use the Internet with only 48 per cent of women compared to 58 per cent of men.[5] This is further amplified in developing regions, where the mobile Internet gender gap is as high as 51 per cent and 37 per cent in South Asia and Sub-Saharan Africa, respectively.[6] Taking all of this into account, achieving the 2030 goal of connecting everyone in the world will require bringing over three billion people online in the next 10 years, of which the majority are in Africa and South Asia[7] (see Figures 1 and 2 below).

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1 https://g20-digital.go.jp/asset/pdf/g20_2019_japan_digital_statement.pdf

2 The goal established in the G20 Ministerial Statement on Trade and Digital Economy was to provide universal and affordable connectivity to all people by 2025, not 2030 (see G20 Japan, 2019). A commitment further reiterated in the G20 Digital Economy Ministers Meeting, Ministerial Declaration, July 2020. https://g20.org/en/media/Documents/G20SS_Declaration_G20%20Digital%20Economy%20Ministers%20Meeting_EN.pdf

3 The latest World Bank country and income group classifications were used for this study. See: World Bank Country and Lending Groups, https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.

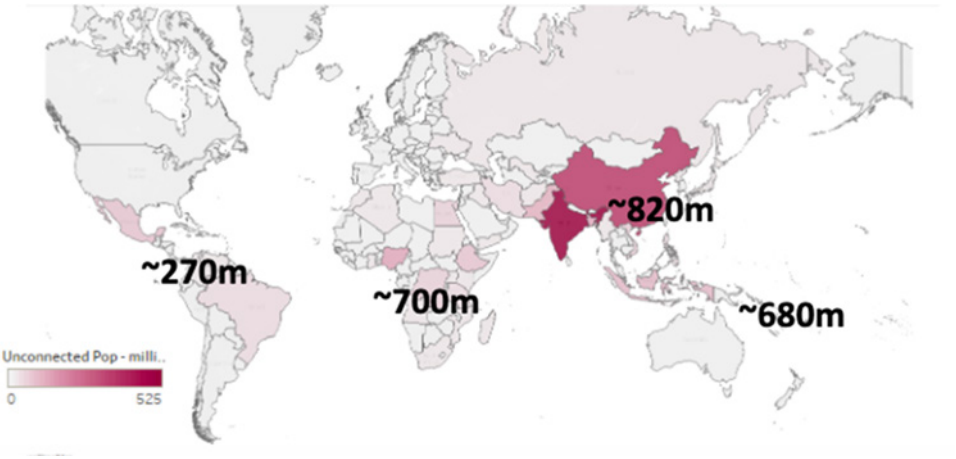
4 Using a broadband definition based on average download speeds > 10 Mbit/s, with 4G as the primary proxy; target population defined as aged 10 and above.

5 International Telecommunication Union (ITU). 2019. Measuring digital development: Facts and figures 2019. https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2019.pdf, pg 3-6.

6 GSMA, The Mobile Gender Gap Report 2020. https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/05/GSMA-The-Mobile-Gender-Gap-Report-2020.pdf

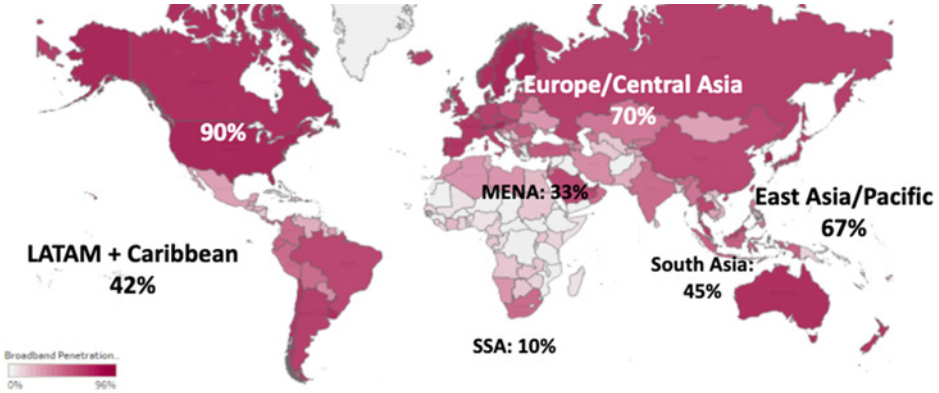
7 Estimates based on GSMA, ITU, United Nations (UN) population data.

Figure 1 – The unconnected: Where they were in 2019



Sources: Estimates based on GSMA, ITU, UN population data

Figure 2 – 4G broadband penetration in 2019 (based on unique users)



Sources: Estimates based on GSMA and UN population data, with Xalama analysis

This study expands upon the Broadband Commission for Sustainable Development report, *Connecting Africa Through Broadband: A Strategy for doubling connectivity by 2021 and reaching universal access by 2030*[8], which looks at the investment needs to achieve universal, affordable broadband access by 2030 for all of Africa. The work presented hereunder uses the same approach and methodology while exploring additional primary and secondary data sources to examine investment needs of the entire world.[9]

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8 Broadband Commission for Sustainable Development (Broadband Commission). 2019. Connecting Africa Through Broadband: A Strategy for doubling connectivity by 2021 and reaching universal access by 2030. https://www.broadbandcommission.org/Documents/working-groups/DigitalMoonshotforAfrica_Report.pdf

9 The report uses the following data sources: GSMA, UN, World Bank, Alliance for Affordable Internet (A4AI), Xalam Analytics, World Economic Forum and ITU.

2. Approach and methodology

To analyse the investment required to achieve universal access to broadband connectivity for the entire world by 2030, this study examines investment estimates for infrastructure, skills, content and policy. The model takes a country-level approach, using the number of unconnected users as a foundational baseline to estimate the level of investment required to achieve universal access to broadband connectivity. **The number of unconnected refers to total users not connected to a 4G or equivalent connection (for mobile and fixed broadband if relevant) according to the assumptions outlined below.**

Once the number of unconnected users is determined, the model estimates the scale of infrastructure requirements needed to serve this population in terms of radio base stations and supporting backhaul infrastructure, and adjusting for individual country or regional considerations (based, for example, on coverage, the number of customers to be served per base transceiver station (BTS) and on given country traffic patterns).

These infrastructure requirements are then translated into estimates of capital expenditure (CAPEX), operating expenditure (OPEX) and maintenance costs, based on prevailing market numbers available from telecommunication operators around the world, with the necessary calibration for market differences; existing levels of infrastructure deployment; inflation and other factors. Related but separate estimates are generated for fibre backbone deployment costs, where such infrastructure is still required to achieve universal access to broadband; satellite costs for reaching remote populations; and policy, skills and content costs to provide the optimal context for the infrastructure to be deployed and utilized.

The key assumptions used for this study are:

- Good quality broadband Internet, defined as an average download speed of at least 10 Mbit/s and as technology neutral (meaning that data may be transmitted via cable, fibre, satellite, radio, or other technologies).
- 4G, used as the proxy for mobile broadband, and fixed broadband applied where most relevant.
- The target population aged 10 and older, used as the baseline for calculating broadband penetration – and universal access to connectivity, defined as 90 per cent penetration of the population aged 10 and older.
- The model, while based on estimates on a country-by-country basis across a sample of 218 countries and economies, carries some constraints with respect to country-level granularity and makes occasional region-wide, or cluster-based assumptions. For key network OPEX and CAPEX assumptions, the model relies on data from a sample of "anchor countries". Annex A on key model parameters and methodology provides further details.

For this study, the population of 10 years of age and older was set as a parameter for estimating the levels of broadband penetration and is different from ITU's calculations of unconnected population (which take into account zero-year-olds and above).[10] This parameter was also selected bearing in mind the many legal and regulatory frameworks around the world that aim to protect children's privacy and data.[11]

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10 ITU, Measuring digital development: Facts and figures 2019.

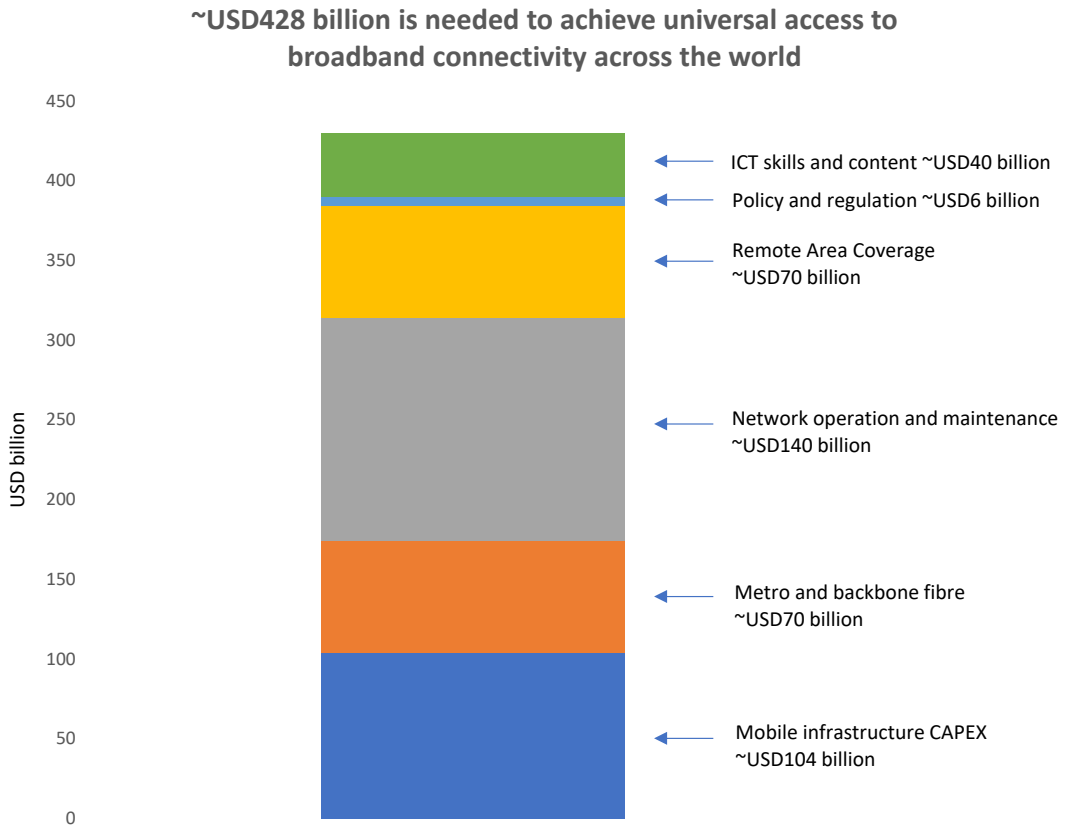
11 Broadband Commission, 2019, Connecting Africa Through Broadband: A Strategy for doubling connectivity by 2021 and reaching universal access by 2030. https://www.broadbandcommission.org/Documents/working-groups/DigitalMoonshotforAfrica_Report.pdf

3. Investment requirements to connect humanity: Global outlook

Nearly USD 428 billion is required to achieve universal access to broadband connectivity by 2030 at the global level (see Figure 3). This amount includes significant investment in infrastructure, investments to design and implement policy and regulatory frameworks that incentivize and promote growth in broadband connectivity and investments to support and equip populations around the world with the necessary basic digital skills (the skills necessary to navigate the Internet and to use commonly available local applications) and the content needed to benefit meaningfully from broadband access and use.

Achieving the target of connecting all of humanity to broadband Internet by 2030 is, above all, an infrastructure investment challenge. Around 2.6million 4G BTS and700 000 km of backbone fibre transmission infrastructure would have to be rolled out on top of the existing broadband network capabilities. Around 90 per cent of the required investments are directly tied to the need to roll out and maintain broadband networks to support the additional connected user base and related traffic. In addition, 40 per cent of total investments would have to be allocated to CAPEX buildout for last mile broadband and transmission networks capable of reaching and serving at least 90 per cent of the target population.

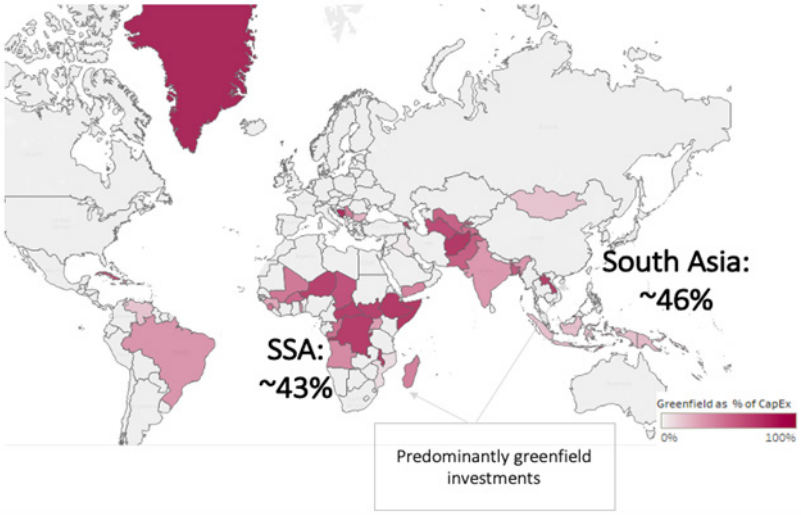
Figure 3 – Investment needed to achieve universal access to broadband connectivity by 2030



Sources: Estimates based on ITU, GSMA, A4AI, operator and regulator data

This shows that deploying new infrastructure and upgrading the existing one will be necessary to guarantee a 4G equivalent connection to everyone. While in some regions bridging the connectivity gap predominantly means upgrading existing coverage and capacity sites, nearly half of the required radio access network (RAN) infrastructure investment in Sub-Saharan Africa, South Asia and East Asia/Pacific will be greenfield (see Figures 4 and 5). This increases the overall weight of investments in such regions to a large extent, especially given the fact that greenfield CAPEX often demands equity premium. Moreover, considerably more capacity would be needed as technology evolves and demand grows, and this means existing infrastructure reach and capacity will constantly need to be expanded[12].

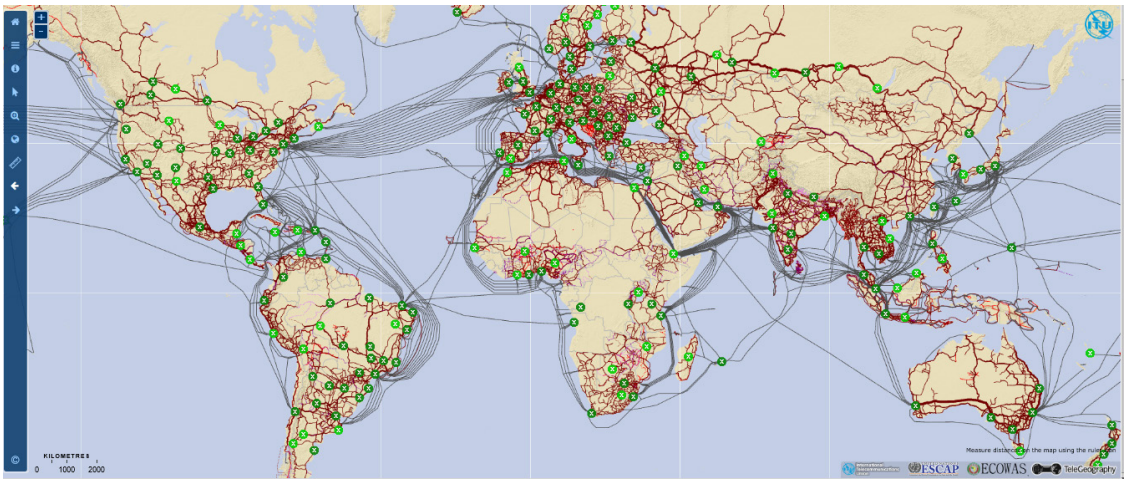
Figure 4 – Percentage of required CAPEX that is greenfield investments



Sources: Estimates based on ITU, GSMA, A4AI, operator and regulator data

[12] Refer to Annex B for investment breakdown for G20 countries, which account for 50 per cent of global investment requirements.

Figure 5 – ITU broadband map



Note: The Interactive Transmission Maps are a cutting-edge ICT-data mapping platform to take stock of national backbone connectivity (optical fibre, microwaves and satellite Earth stations) as well as of other key metrics of the ICT sector. The map is validated by network operators and administrations through the ITU regional offices and recorded in the Validation Framework. Underlying the map is a database, containing records of each individual link.

The following indicators are either compiled or calculated from this database: i) Transmission network length (route kilometress); ii) Node locations; iii) Equipment type of terrestrial transmission network; iv) Network capacity (bit rate); v) Number of optical fibre within the cable; vi) Operational status of the transmission network indicator; vii-a) Percentage of population within reach of transmission networks; vii-b) Percentage of area within reach of transmission networks.

Source: ITU[13]

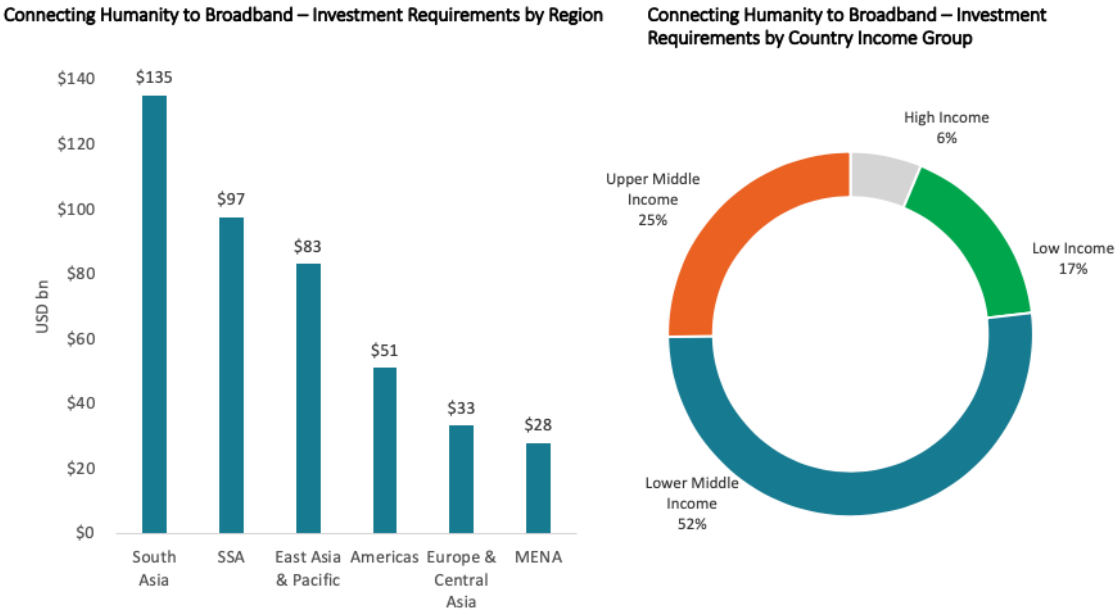
[13] https://www.itu.int/itu-d/tnd-map-public/

4. Investment requirements to connect the unconnected: Regional outlook

4.1. Investment requirements by regions and income groups

The challenges described above present a situation in which new types of global investments will be needed, as well as new ways of thinking about them. To scale operations and to achieve economic benefits offered by universal and affordable broadband Internet access, significant investment is undoubtedly required for the Sub-Saharan Africa, South Asia, and East Asia/Pacific regions (see Figure 6). Nearly 70 per cent of the investment required will need to be allocated to low and lower middle-income economies, particularly the unconnected population living in rural and remote areas (see Figure 6). At a broad level, the distribution of investment requirements is a function of the overall size of the unconnected population. The regions just cited account for around half of the unconnected population and 55 per cent of required investments. At the same time, the economic and social contexts vary across regions, with unique realities that must be addressed to achieve universal meaningful connectivity.

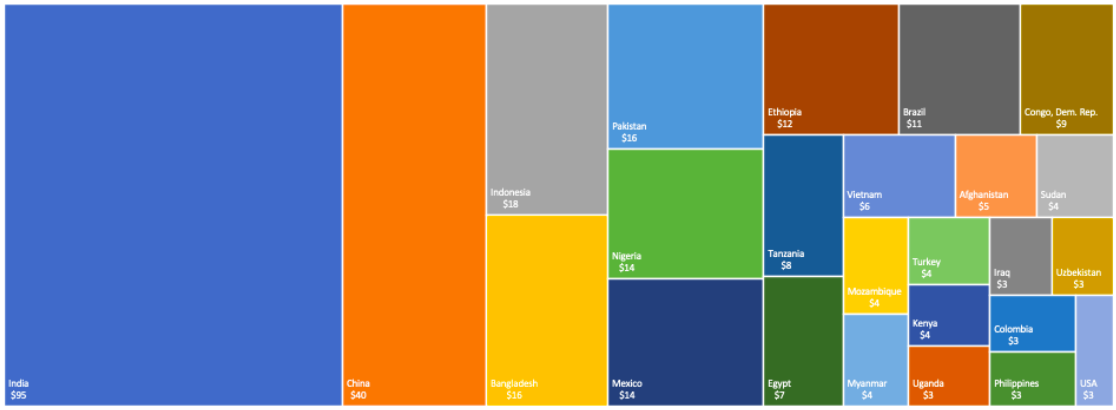
Figure 6 – Investment needed by regions and income groups



*Country and ncome groups based on World Bank classification.
SSA (Sub-Saharan Africa) and MENA (Middle East and North Africa)
Sources: Xalam estimates based on ITU, GSMA, A4AI, operator and regulator data

When examined at the country level, the top 25 countries in need of investment account for nearly 75 per cent of all the investment requirements at USD 312 billion. Further, 20 of these 25 countries are in Sub-Saharan Africa, East Asia/Pacific and South Asia and all are low and lower-middle income countries.

Figure 7 – Top 25 countries based on the size of investment requirements (in USD billion)



Sources: Estimates based on ITU, GSMA, A4AI, operators and regulators data

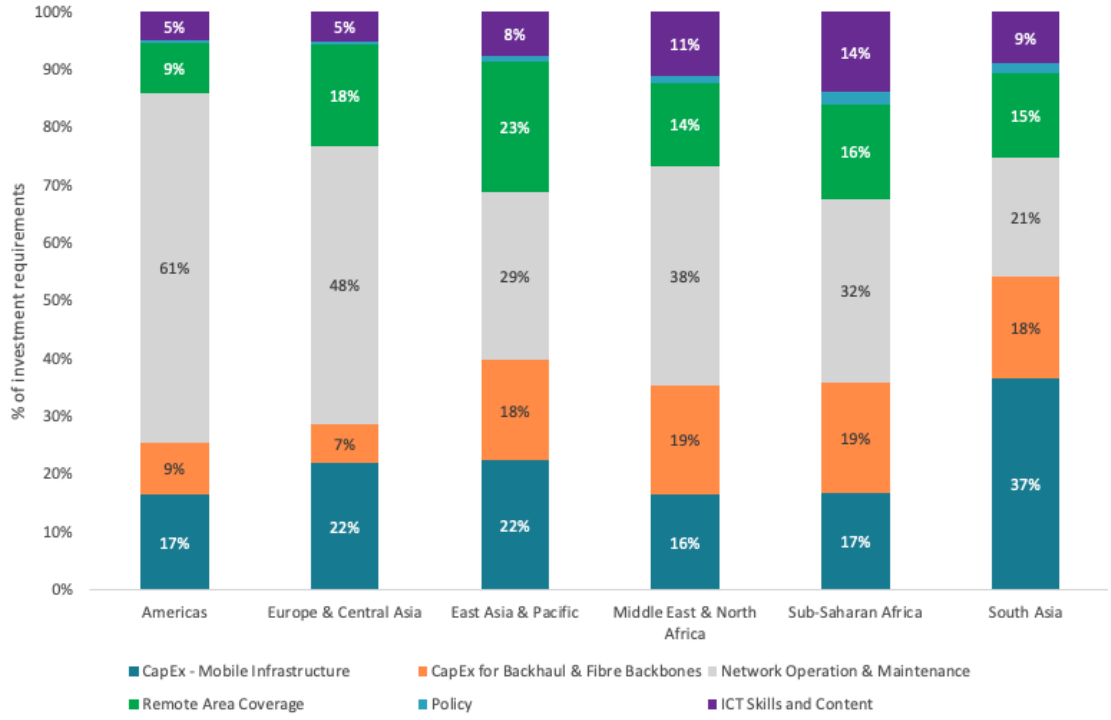
4.2. The structure of investment requirements by regions

Investment requirements vary according to each country and region, and greatly depend on the level of economic development of the country; the level of its investment in infrastructure, the policy framework in place and the different geographical and demographic conditions.[14] A number of characteristics were selected (see Figure 8) to examine the structure of investments by region. The weight of CAPEX requirements is most significant in South Asia, East Asia and the Pacific and Africa, and requires long-term investments. In contrast, the OPEX requirements are relatively more significant in other regions with ongoing and/or recurring costs primarily associated operations and maintenance of existing networks, such as electricity supply costs. In addition to affordability issues, the need to boost investments for improving or building Internet user ICT skills and support the development of relevant content is most pressing in Sub-Saharan Africa.

Connecting populations in remote and rural areas accounts for around a fifth to a quarter of investment requirements in Africa and in East Asia/Pacific. Reaching remote and rural communities poses added obstacles and challenges, including demographic and geographic barriers. Small landlocked countries and Pacific Island countries and territories require larger OPEX and CAPEX due to different factors such as reduced economies of scale, higher international transit costs and interconnection rates (See A4AI, 2018).[15] This warrants a new approach to address the challenges of remote rural areas, from sound policy and regulatory frameworks to innovative public-private partnerships (PPPs) to support the investments needed to secure universal access to broadband in those regions.[16]

14 Refer to Annex A for more details on key drivers of differences in investment requirements.
15 A4AI. Affordability Report 2018. See https://a4ai.org/affordability-report/report/2018/
16 For more information and recommendations specific to rural digital development see A4AI's Rural Broadband Policy Framework and ITU's Broadband development and connectivity solutions for rural and remote areas .

Figure 8 – Investment requirements by key category and region



Sources: Estimates based on ITU, GSMA, A4AI, operator and regulator data

4.3 Beyond infrastructure needs: Affordability, digital skills and local content

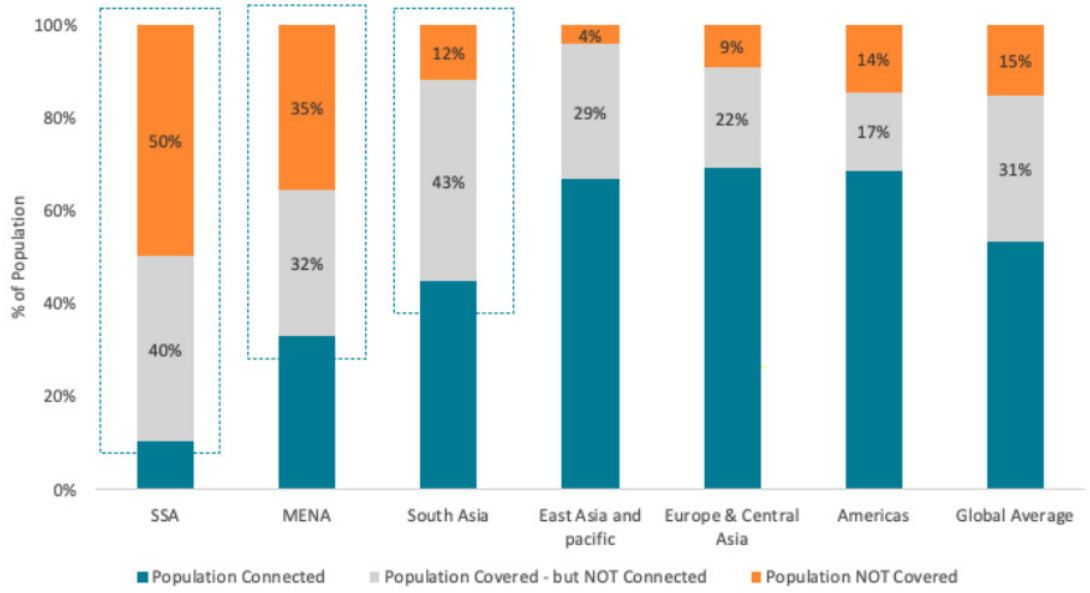
It is important to highlight that approximately 85 per cent of the global population is already covered by global broadband networks, and around 70 per cent of the global unconnected are within a 4G coverage area (see Figure 9). Yet, in Sub-Saharan Africa, around 80 per cent of those covered by a 4G network are not connected because of lack of affordable access,[17] limited relevant content and the skills to benefit from Internet access. Such realities disclose economic and social disparities which affect the rate of adoption, use and ultimately the opportunity to benefit from broadband access. While only 15 per cent of the global population might be in areas that are not covered by broadband, the reality is that the percentage of persons without "meaningful connectivity" is much higher, and for this reason it is also crucial to think beyond infrastructure.

As the Broadband Commission highlighted in the 2019 State of Broadband report, the concept of meaningful universal connectivity "encompasses broadband adoption that is not just available, accessible, relevant and affordable, but that is also safe, trusted, empowering users and leading to positive impact".[18]

[17] According to A4AI's Affordability Report 2019, only 10 out of 45 African countries have affordable internet, calculated as 1 GB of mobile prepaid data of 2% or less of average monthly income. See: A4AI, 2019. Affordability Report 2019, Africa Regional Snapshot, https://1e8q3q16vyc81g8l3h3md6q5f5e-wpengine.netdna-ssl.com/wp-content/uploads/2019/12/AR2019_Africa-Regional_Screen_AW.pdf.

[18] Broadband Commission. 2019. The State of Broadband 2019: Broadband as a Foundation for Sustainable Development. https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.20-2019-PDF-E.pdf

Figure 9 – 4G Coverage of population by region (2019)



Sources: estimates based on GSMA, Xalam, UN population data

In order to build on and benefit from broadband infrastructure it is, therefore, imperative to focus on and invest in complementary initiatives that will support billions to be connected. This requires a more holistic approach to broadband investment, one which encompasses innovative and collaborative policy and regulatory approaches as well as strategies to stimulate demand for broadband services – increase and support device affordability; affordability of data and services; as well as digital skills programmes and content, with a special focus on closing the digital gender divide given that the majority of people offline today are women[19].

[19] ITU, Measuring digital development: Facts and figures 2019.

Box 1 – Device costs in low and middle-income countries remain a key barrier

The Alliance for Affordable Internet (A4AI)'s new study of device costs in low- and middle-income countries[1] estimates that nearly 2.5 billion people live in countries where the cost of a smartphone is a quarter or more of the average monthly income. This is equal to what the average European household spends on housing and utilities as a fraction of their monthly income.

The report benchmarks the cost of a smartphone across different countries in the "Global South". This barrier remains high across different regions (see table right); however, at the country level, consumers can face completely different markets, with extremely wide smartphone price ranges. Several factors influence the retail price that a user can expect to pay for a new smartphone – in many cases, that price is still too high.

Estimated cost of a new smartphone as a fraction of average monthly income (March 2020).

Region	Cost
Africa	62.8%
Americas	11.7%
Asia–Pacific (excluding India*)	16.2%

*Estimated at 206 per cent in India.
Source: A4AI, 2020

Estimated cost of an Internet-capable device as a fraction of average monthly income (March 2020).

Region	Cost
Africa	49.5%
Americas	10.0%
Asia–Pacific (excluding India)	16.9%

Source: A4AI, 2020

Feature phones/Internet-capable devices and other entry devices can help scale the affordability problem. These devices offer a number of the key functionalities of a smartphone, along with several of the benefits of Internet access.

They also lower the price threshold for a first-time user who may have yet to build extensive digital skills or experiences that would justify the expense of a more high-end device. These numbers more readily approach parity at the price level; however, when we understand these prices as percentages of average monthly income, the disparities of affordability are evident (see table left).

Some countries see enormous jumps in affordability with feature phones. While they are not found in all analysed markets, the cheapest feature phones offer, on average, an Internet-capable device at 50 per cent or less of the cost of the cheapest smartphone available in the market. One extreme example is India, where one particular phone model represented 23.9 per cent of average monthly income compared to the cheapest smartphone on sale by the operator, sold at more than twice the average monthly income in the country.

[1] Alliance for Affordable Internet (2020). From luxury to lifeline: Reducing the cost of mobile devices to reach universal internet access. Web Foundation. https://a4ai.org/research/from-luxury-to-lifeline-reducing-the-cost-of-mobile-devices-to-reach-universal-internet-access/

5. Next steps: What should be done next?

A number of key actions are critical to secure the investment needed to achieve the 2030 target. It is also crucial to undergo constant re-evaluation as demand increases, technology evolves and social and political scenarios change.

5.1. Fostering an Enabling Policy and Regulatory Environment

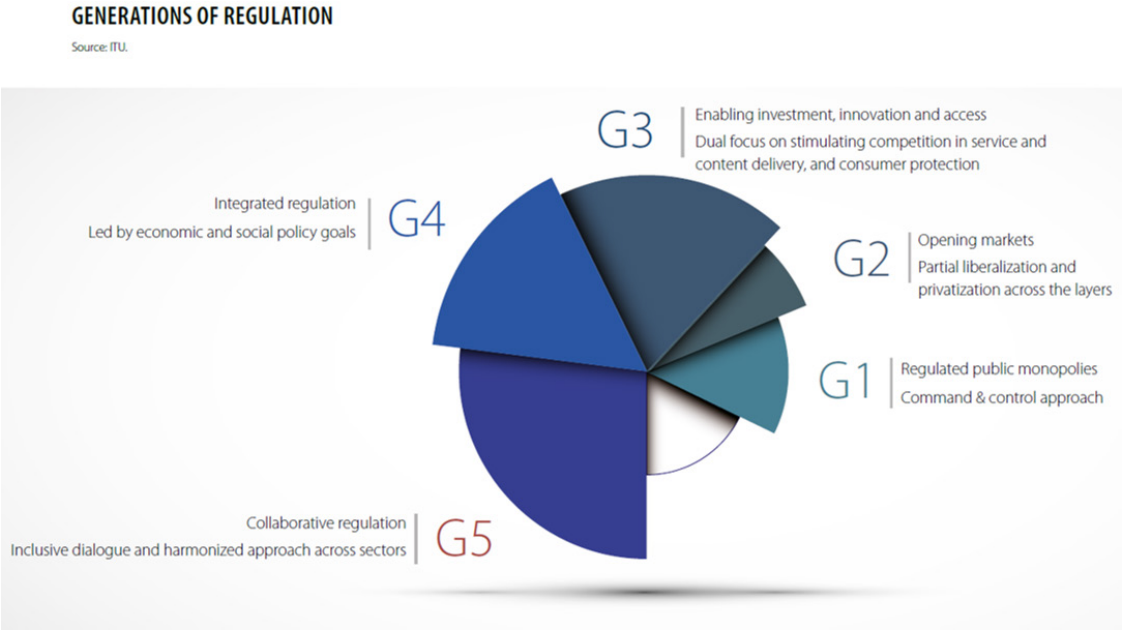
Establishing an enabling policy and regulatory environment is essential to foster predictability and consequently attract long-term investment and support the digital economy, especially in low and lower and middle income countries. As this study highlights, having innovative policy and regulatory frameworks is critical to achieving the 2030 targets. ITU has provided extensive guidance to policy-makers around the world on how to approach policy and regulatory challenges and opportunities. The study stresses the importance of collaboration in all aspects of policy-making and regulatory support (see Figure 10).

Box 2 – ICT regulatory maturity worldwide

ITU regulatory metrics sets out the levels of maturity of regulatory frameworks for the ICT sector and for the digital economy itself. The analysis shows that while digital has been gaining ground and shaping regulatory response, more remains to be done. Today, 8 per cent of countries have holistic, forward-looking regulatory frameworks in place enabling digital transformation across their economies (G5) and more than 50 additional countries have achieved G4 (integrated ICT regulation led by social and economic goals), being the countries with the lowest proportion of unconnected population and having thriving markets for ICT services. In stark contrast, as many as 40 per cent of countries languish in G1 or G2, missing development opportunities and running the risk of remaining disconnected from global digitization and how this can transform their economies and attract greater investment. More than half of the world's population is concentrated in G2 and G3 countries, poised to leapfrog to near-universal digital inclusion and lead vibrant ICT markets. A quarter of countries is only half way through the journey, still in the G3 category: making steady progress in strengthening policy and regulatory frameworks but unable to unlock the full potential of ICT markets.

Source: Adapted from ITU. 2020. Global ICT Regulatory Outlook 2020 - Pointing the way forward to collaborative regulation.
https://itu.foleon.com/itu/global-ict-regulatory-outlook-2020/home/

Figure 10 – ITU generations of regulation



Source: ITU

The golden rules for fixed and mobile broadband adoption outlined in Table 1 were developed by ITU (2020) and were designed as "regulatory recipes" for successful fixed and mobile deployment and adoption. Analysis shows how the golden rules are accelerating take-up of mobile broadband and fixed broadband alike removing barriers and incentivizing various stakeholders and market players. These rules highlight the actions and decisions that are likely to support sector growth and development, and provide evidence of their impact across regions.[20] [21] Chapter 3 of the Global ICT Regulatory Outlook 2020 (ITU, 2020) provides a concise summary of the golden rules.

[20] ITU. 2020. Global ICT Regulatory Outlook 2020 - Pointing the way forward to collaborative regulation. https://itu.foleon.com/itu/global-ict-regulatory-outlook-2020/home/

[21] ITU's ICT Regulatory Tracker https://www.itu.int/net4/itu-d/irt/#/tracker-by-country/regulatory-tracker/2018

Table 1 – The "golden rules" for fixed and mobile broadband adoption

	Golden rules	
	Fixed broadband	**Mobile broadband**
Market approach	General authorization regime	Band migration allowed
Infrastructure sharing	Infrastructure sharing mandated	Co-location/site sharing mandated
Competition	Full competition in cable modem, DSL, fixed wireless broadband	Number portability available to consumers and required from mobile operators
	Legal concept of dominance or significant market power (SMP)	Full competition in IMT (3G, 4G, etc.) services
	Full competition in international gateways	Full competition in international gateways
Foreign participation/ ownership	Foreign participation/ownership in Internet service providers (ISPs)	No restrictions to foreign participation/ownership in spectrum-based operators
Quality of service	Quality of service monitoring required	

Source: Adapted from ITU, 2020

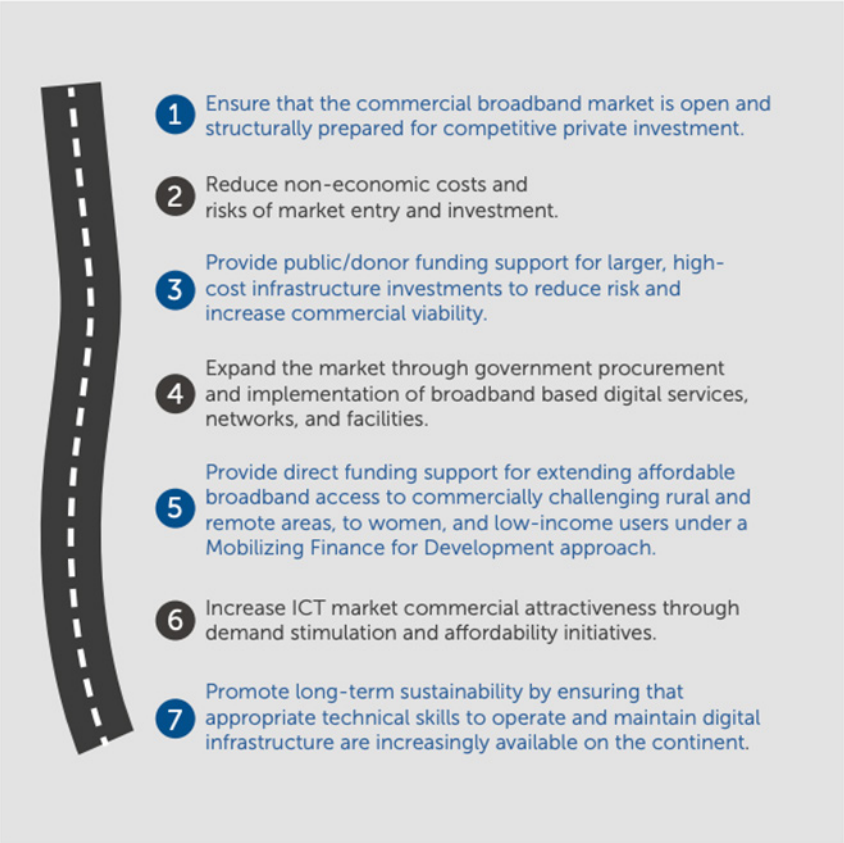
5.2 Developing a clear roadmap

Developing a clear roadmap is key to turning high-level strategies and plans into concrete steps that can be followed by decision-makers, policy-makers and regulators. The golden rules presented above provide valuable "recipes" defined through ITU's vast experience in assisting governments to strengthen their policy and regulatory frameworks. Further, several studies have already provided in-depth analysis of goals, best practice, guidelines and roadmaps upon which this study builds.[22] While general roadmaps provide critical guidance, it is important that these be adapted and adjusted to meet the needs and realities of the country and environment where they are being applied. To achieve the 2030 target, in addition to the estimated investment costs, a clear strategy and roadmap are needed. The main features of the broadband development roadmap by 2030 may include a similar sequence of objectives, as those suggested in the Broadband Commission's report, *Connecting Africa Through Broadband* (see Figure 11). It is also critical for policy-makers to embrace a "whole-of-government approach," one which is holistic, includes a whole-of-government investment strategy and integrates planning, design and delivery of services through well-coordinated efforts across all relevant ministries in a country.[23]

[22] Examples are the ITU Best Practices Guidelines and the UN Secretary-General's Roadmap for Digital Cooperation.

[23] For a detailed discussion of this approach, see ITU, 2020, Building Smart Villages: A Blueprint.

Figure 11 – Roadmap for universal access to affordable and good quality broadband



Source: Broadband Commission, 2019

5.3 Securing financing

With an estimated USD 428 billion needed to connect all of humanity to the Internet by 2030, an unprecedented multi-stakeholder effort will be required to finance this goal. In line with the recommendations from the report of the Broadband Commission for Sustainable Development, this study also recommends drawing mostly private investments for infrastructure and public investments for skills and policy[24].

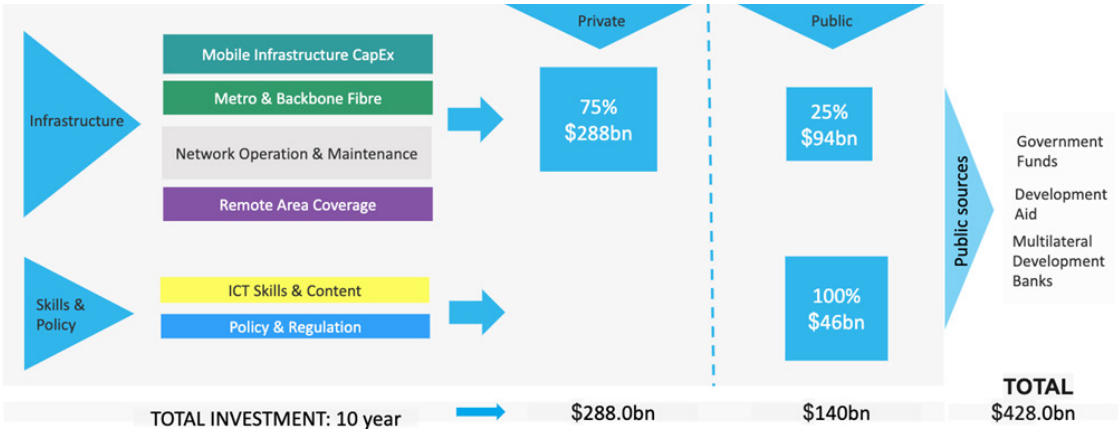
Public investment and financing sources should include government funds, development aid and multilateral banks. Additional sources and financing mechanisms are also being considered by the Broadband Commission for Sustainable Development's Working Group on 21st Century Financing Models for Sustainable Broadband Development [25] and Working Group on School Connectivity,[26] both created in September 2019. Such groups understand it is crucial to develop investment, funding and financing mechanisms that go beyond the traditional ones outlined above. Further, public-private partnerships have also been instrumental in expanding infrastructure and strengthening affordability through the absorption of early stage risks and

[24] Broadband Commission, 2019, Connecting Africa Through Broadband: A Strategy for doubling connectivity by 2021 and reaching universal access by 2030.
[25] Broadband Commission's Working Group on 21st Century Financing Models for Sustainable Broadband Development. See https://broadbandcommission.org/workinggroups/Pages/WG6-2019.aspx
[26] Broadband Commission's Working Group on School Connectivity. See https://broadbandcommission.org/workinggroups/Pages/WG5-2019.aspx

building infrastructure to be used by new entrants, as the experience of Sao Tome and Principe, Nigeria, Uganda and South Africa show[27].

An indicative cost sharing for the estimated USD 428 billion investment needs suggests that about USD 288 billion in infrastructure investment may be covered by the private sector, while about USD 140 billion in investment will be required by public sources (see Figure 12). These amounts and percentages were calculated based on the same rationale proposed by the "World Bank Group's Mobilizing Finance for Development (MFD) approach"[28], which assumes that public resources should be targeted at areas that are not perceived as viable to the private sector. As Figure 12 illustrates, private investments should be primarily focused on infrastructure while public investments should be focused on both infrastructure and skills development. This does not mean that all other parts of society should not be involved in investing in digital skills, but rather that the public sector needs to be responsible for providing basic skills to all citizens, allowing them to use applications that are common in their locations and to navigate the Internet to their benefit.

Figure 12 – Financing the investment needs: Indicative cost sharing



Source: A4AI (2020)

[27] Id.

[28] See World Bank' Group's Mobilising Finance for Development (MFD): https://www.worldbank.org/en/about/partners/maximizing-finance-for-development#:~:text=Maximizing%20Finance%20for%20Development%20(MFD)%20is%20the%20World%20Bank%20Group's,support%20developing%20countries'%20sustainable%20growth.

6. Conclusion

No single actor alone can achieve the ambitious goal of connecting everyone to universal, affordable broadband connectivity by 2030. As this study outlines, different stakeholders should come together to tackle the challenge. The investment should take a regional approach – with a special focus on Sub-Saharan Africa and South Asia – to bring the unconnected online in the next 10 years. While infrastructure investment is the main challenge, investing in policy and regulatory reform and digital skills and local content development are also critical. What is more, complementary efforts on improving affordability – of data, devices and services – will be key to helping close the global digital divide. As ITU is committed to connecting all the world's people, wherever they live and whatever their means, through these analysis, together with ITU's Connect 2030 Agenda efforts, connecting all of humanity will get closer to becoming a reality.

Abbreviations

A4AI	Alliance for Affordable Internet
BTS	Base transceiver station
CAPEX	Capital expenditure
GSMA	GSM Association
ICT	Information and communication technologies
IMT	International Mobile Telecommunications
ITU	International Telecommunication Union
LATAM	Latin America
MENA	Middle East and North Africa
OPEX	Operational expenditure
PPP	Public- private partnerships
RAN	Radio access network
SSA	Sub-Saharan Africa
UN	United Nations
3G	Third-generation mobile telecommunication technology
4G	Fourth-generation mobile telecommunication technology
5G	Fifth-generation mobile telecommunication technology
All dollar amounts are US dollars unless otherwise indicated.	

Annexes

Annex A: Key model parameters and methodology[29]

Model parameters

- The focus and scope of the modelling exercise are strictly on estimating the cost to achieve the stated targets – namely anticipated capital expenditures, infrastructure operation and maintenance costs, and policy and skills CAPEX. While other components of feasibility are acknowledged to warrant strong consideration (notably service affordability, economic feasibility, sources of funding and a broad assessment of the sustainability of the proposed investments), they are beyond the scope of this particular modelling exercise. These additional factors can be assessed in more detail in separate, dedicated phases of analysis.
- While based on estimates on a country-by-country basis across a sample of 218 countries and economies, the model carries some constraints with respect to country-level granularity, and makes occasional region-wide, or cluster-based assumptions. The resulting estimates should thus be considered high-level and directional in nature. More detailed country modelling must be carried out to get a deeper picture of individual country investment requirements and constraints.
- The modelling for this exercise uses a variety of data sources, principally the ITU datasets, GSMA Intelligence, A4AI's Affordability Drivers Index, The World Bank database, the United Nations, The World Economic Forum and extensive data collected by Xalam Analytics.

Defining broadband

- The definition of broadband across countries continues to evolve as technologies improve, new generations of wireline and wireless broadband emerge and baseline expectations continue to be raised of what constitutes minimum download speeds for the optimal end-user experience. The quantitative forecast model used in the present study seeks to adhere to these changes by applying a definition of broadband that is consistent with the minimum levels of download (and upload) speeds expected to prevail during the period under assessment. For the purposes of achieving the 2030 universal access to broadband target, it is anticipated that the definition of what constitutes a basic level of broadband speed is likely to evolve. In turn, "broadband" speeds are defined as 10 Mbit/s or above (download).
- While this assessment is broadly technology agnostic, the model uses 4G technology as a broad proxy for preferred minimum download speeds, and in recognition of the fact that mobile networks will be central to achieving the proposed targets.

Target population

- For the purposes of this analysis, the population aged 10 and above is used as the baseline for calculating broadband penetration. In addition, connectivity penetration numbers are based on the estimated number of "unique" broadband connections – i.e. adjusted where applicable for multi-SIM usage. Finally, universal access to connectivity is defined as 90 per cent penetration of the population aged 10 and above.
- The target age is set at 10 years and older in recognition of data protection and privacy laws of various countries that seek to protect children when accessing the Internet. The 90 per cent penetration target is used to define universality to take account of that segment

[29] The key parameters and methodology used for this study are similar to the ones employed in the Broadband Commission's report, Connecting Africa Through Broadband: A Strategy for doubling connectivity by 2021 and reaching universal access by 2030, with additional data sources used.

of the population which chooses not to use personal ICTs, those who are prevented from doing so (for example, prisoners) and those who use shared facilities.

Infrastructure investment requirements

- Infrastructure investment requirements are estimated for three main network segments: mobile radio, network backhaul (metro and backbone) and satellite access.
- **Mobile radio network CAPEX**: Mobile network infrastructure costs are based on the capital expenditure needed (1) to extend coverage to the unconnected population and (2) provide adequate capacity and allow for network upgrades once new users have been connected and traffic expands. Estimates include a mix of greenfield and upgraded sites, along with existing levels of broadband network buildout and coverage.
- **Network backhaul**: Infrastructure capital investment estimates integrate the need to invest in adequate transmission infrastructure based on metro fibre, microwave or satellite. The forecast model assumes that a countrywide fibre backbone must be in place to achieve universal access to connectivity, using 4G speeds. For this, the model assumes that at least 50 per cent of the population must be within 10 km of a fibre backbone node. CAPEX estimates are based on the total fibre backbone kilometres required to meet this overarching objective, based on available data and/or minimum fibre density target levels. These estimates further assume that a proportion of 4G sites will need to be connected to optical fibre.
- **Satellite for remote areas**: It is generally anticipated that due to a variety of reasons, a proportion of the rural population in remote locations will typically be out of the reach of traditional mobile networks. The forecast model assumes this proportion at between 10 and 20 per cent of the rural population in most countries, with variations depending on population density levels. Populations in remote locations will generally need to be covered by localized solutions consisting of satellite backhaul and fixed wireless access (predominantly Wi-Fi) for the last mile. In turn, infrastructure investment estimates include a satellite/Wi-Fi requirement for remote communities.
- **Network operational expenditure (OPEX) assumptions**: For the purposes of this analysis, infrastructure investment requirements include estimates of network operating expenses, applied on an annual basis. Network operating expenses typically include repair and maintenance, site leases and other site operating costs. For satellite/Wi-Fi infrastructure, network OPEX includes support, user management platform and bandwidth capacity recurring costs.
- **Policy and regulation costs**: The forecast model assumes that most countries will require some form of policy and regulatory intervention to develop and strengthen frameworks that promote cost-effective roll-outs, lower connectivity retail prices and increased broadband usage. This includes fostering the availability of adequate spectrum, infrastructure sharing, open access fibre and other relevant regulations. Top line policy and regulation investment requirements are estimated using assessments of policy support needed in each country and based on the policy and regulation components of the Affordability Driver Index (ADI) score as developed by A4AI.
- **Skills and content costs**: The availability of local, relevant content and adequate end-user skills are vital to a broader, more inclusive adoption of broadband connectivity services. Investments in skills and content may take the form of establishing tech hubs, local content ecosystems, or Internet literacy training programmes. The model integrates these components by including per-user costs for training and content. Baseline estimates are based on a broad framework as outlined by the World Economic Forum.

Using anchor markets for CAPEX and OPEX estimates

- While based on estimates on a country-by-country basis across a sample of 218 countries and territories, the model carries some constraints with respect to country-level granularity, and makes occasional region-wide, or cluster-based assumptions. For key network OPEX and CAPEX assumptions, the model relies on data from a sample of anchor countries. Anchor countries are selected within each sub-region, typically based on their size. Site CAPEX and OPEX estimates are generated within each anchor market, based on operator financial data and other reports. These estimates are then applied within the sub-region. Sample anchor countries include China, India, Nigeria and South Africa.

Data sources

The model uses the following sources of data:

Category	Indicator	Sources
Population	Population	UN database (2019)
	Country land area, population density, % rural	UN database
Broadband connections	Broadband Connections	GSMA, ITU, Xalam Analytics
	Connections/user ratio	GSMA
Network indicators	Connections per 4G BTS	Mobile network operator data
	Number of active BTS (2019)	Mobile network operator data
	2G/3Gsites	Mobile network operator and regulator data
	4G sites	Mobile network operator and regulator data
	Population covered by 4G	Mobile network operator and regulator data
	% of Population within 10 km of backbone	ITU
	Kilometres of backbone available	ITU, Xalam Analytics
OPEX and CAPEX	CAPEX per site (upgrades and greenfield)	Mobile network operator data
	% sites connected to fibre	Mobile network operator data
	Network OPEX/site	Mobile network operator data
	CAPEX per Km of backbone fibre	Operator data, Xalam Analytics
	Skills/content cost per user	World Economic Forum
	Connected user per satellite terminal unit	Based on Intelsat, OneWeb estimates
	CAPEX per satellite terminal unit	Based on Intelsat, OneWeb estimates
	Satellite monthly capacity costs	Based on Intelsat, OneWeb estimates

Figure A.1 – Model logical flow

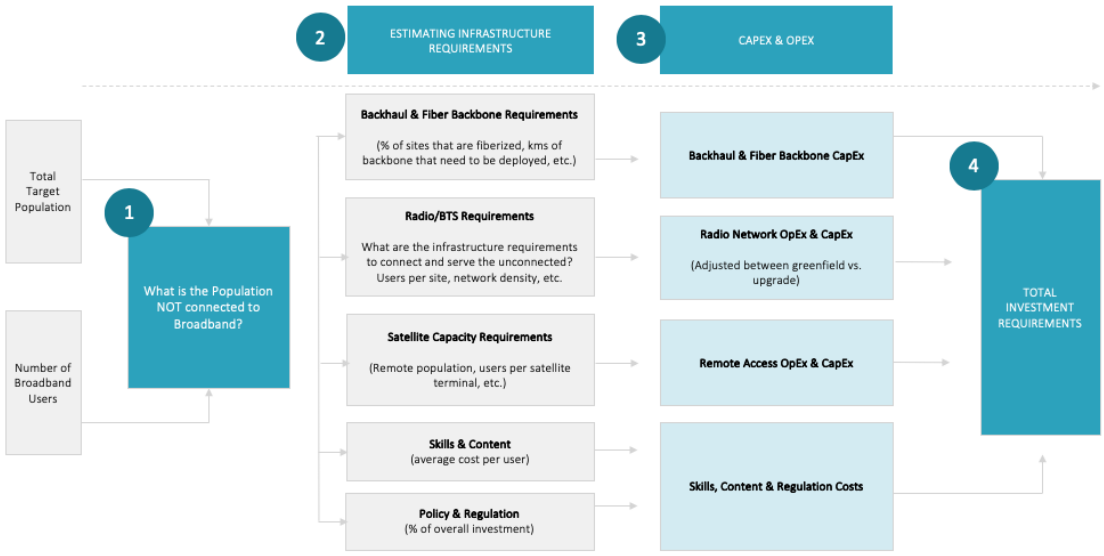


Figure A.2 – Key drivers of differences in investment requirements

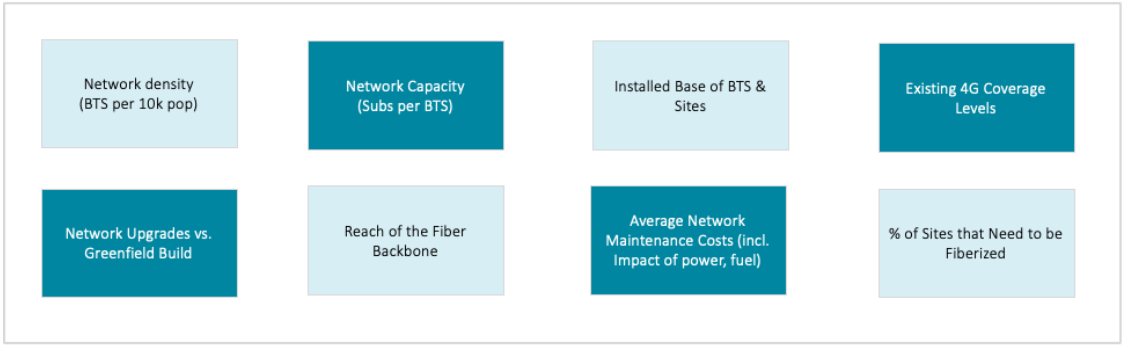


Figure A.3 –Model structure

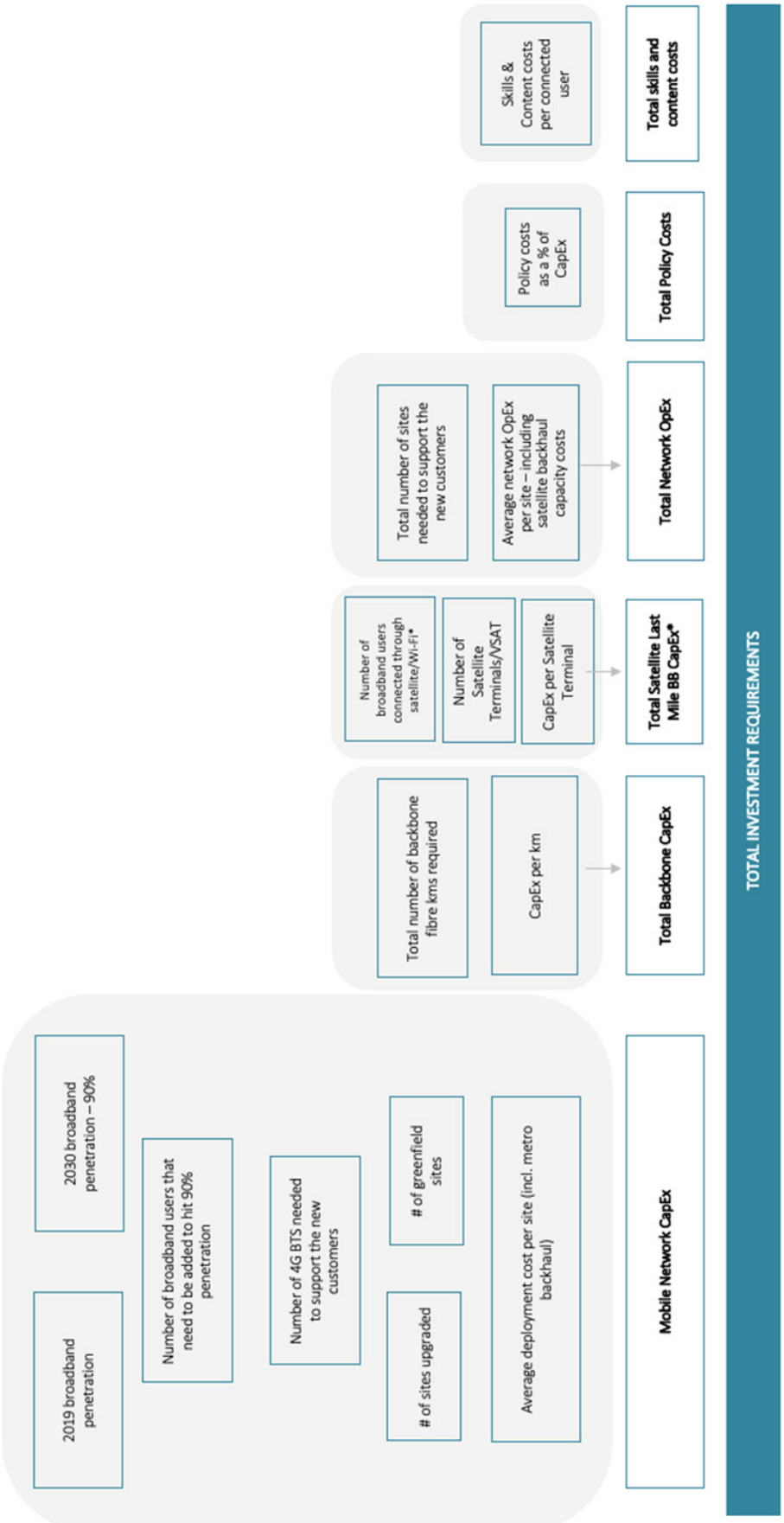


Figure A.4 – Example of model structure calculations for Sub-Saharan Africa

REGION		SUB-SAHARAN AFRICA							
Number of Countries in Sample	[units]	49							
Target Population as of 2019 - > 10 year old	[million]	786	million in 2019						
2030 Target - Taking penetration from		10%		to	90%	by 2030	Adding	883	

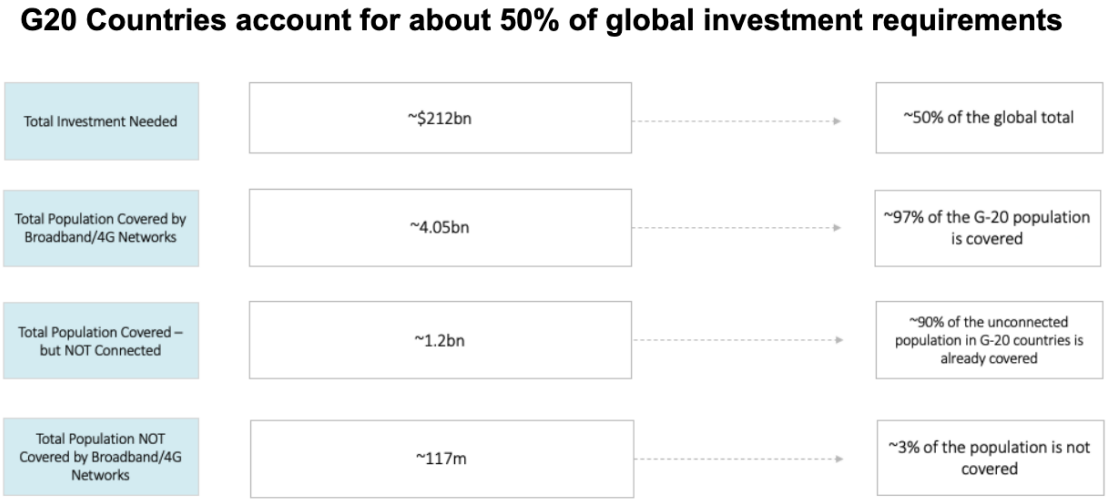
2030 Target				
Nominal Broadband Penetration at 2019 Baseline - Average		7%		
Unique User Broadband Penetration at 2019 Baseline - Average		10%		**2030 Target**
Unique User Broadband Penetration at 2019 Baseline - Median		7%		90%
How much investment is needed to achieve the 2030 target (USD bn)?	[USD bn]	$97	bn	(Including satellite CapEx/OpEx for remote areas)

Total Investment Requirements - Undiscounted			
USD million - cumulative requirements - Undiscounted			
			Contribution
CapEx - Mobile Infrastructure	[USD m]	$16,187	17%
CapEx - Fibre/Backhaul Infrastructure	[USD m]	$18,701	19%
OpEx - Operation & Maintenance	[USD m]	$31,066	32%
Satellite CapEx	[USD m]	$1,672	2%
Satellite OpEx	[USD m]	$14,210	15%
Policy	[USD m]	$2,183	2%
ICT Skills and Content	[USD m]	$13,473	14%
			Req per year
Total - US$ million		$97,492	$8,124
Number of new users to connect - million	[million]	883	
Number of BTS to build	[thousand]	254,931	
Kms of fibre - thousand	[thousand]	417	
Requirements per user	[USD]	$110	
Nominal BB Connections - 2019	[million]	81	
Unique users - 2019	[million]	81	
Target Population - 2019	[million]	786	

Annex B: A Closer look at the investments needed in the G20 countries

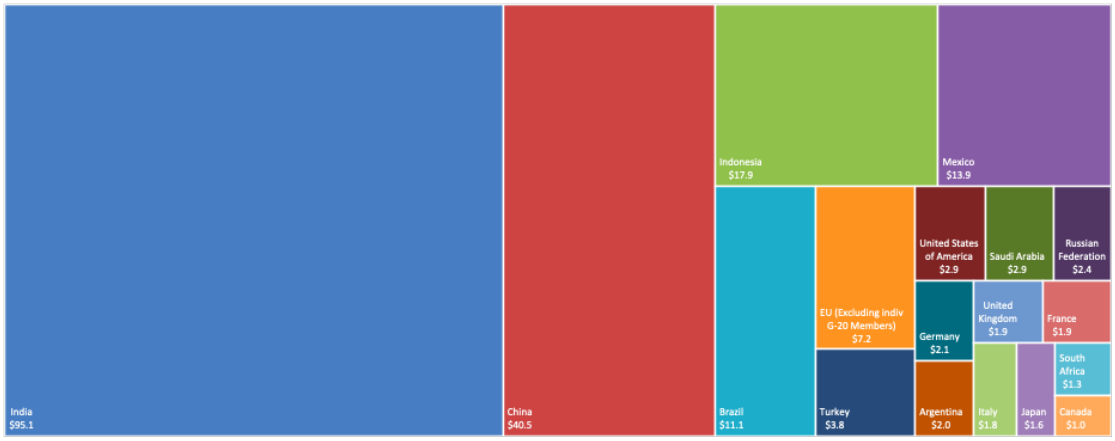
When the investment needs are grouped by the G20 members[30], it becomes evident that a significant portion of the required investments involve G20 countries. The following is a summary of investments grouped by G20 countries.

Figure B.1. Total Investments needed in the G20 countries



Sources: Xalam estimates based on ITU, GSMA, A4AI, operator and regulator data

Figure B.2. Investments across the G20 countries (USD billion)



Sources: Xalam estimates based on ITU, GSMA, A4AI, operator and regulator data

[30] See the official list of G20 members here: https://g20.org/en/about/Pages/Participants.aspx

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ISBN: 978-92-61-32221-2

9 789261 322212

Published in Switzerland
Geneva, 2020
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