Brazil Market Insight

5925-7125 MHz: The 6 GHz Band

May 2022

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The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

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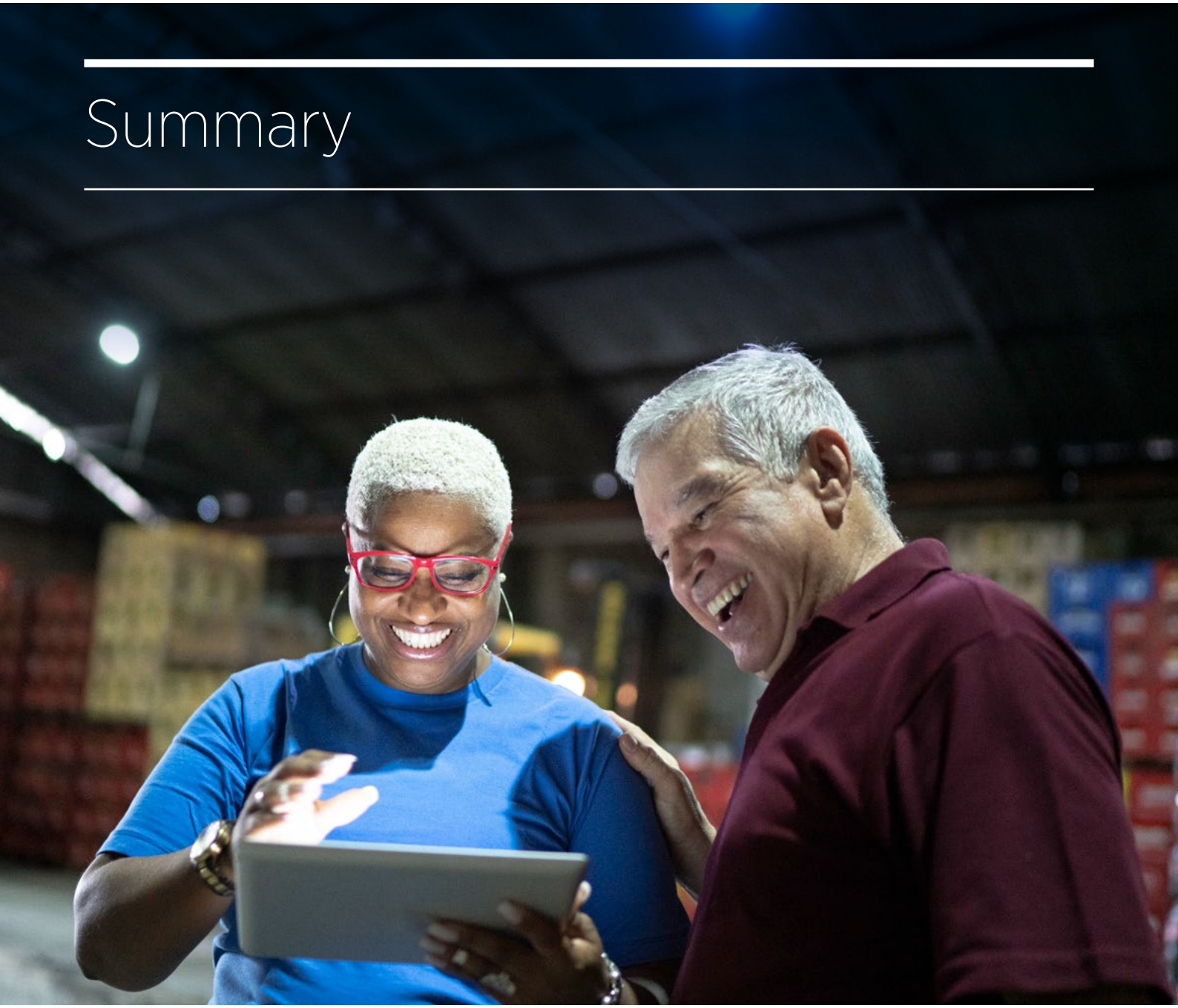


6 GHz 5G spectrum can play a central role in sustainable industrial development.

As connectivity, IoT, data, analytics, and insight permeate every aspect of industry, and enterprises transition from manufacturing or commerce to also becoming industrial data platforms, mobile networks will require spectrum capacity plans that are integrated into a long-term vision of each nation's industrial future. The race to net zero will be one of the most important features of the industrial landscape for decades to come and intelligent innovation and automation is now happening everywhere. Heavy industry and infrastructure must stay at the cutting edge of sustainable technology.

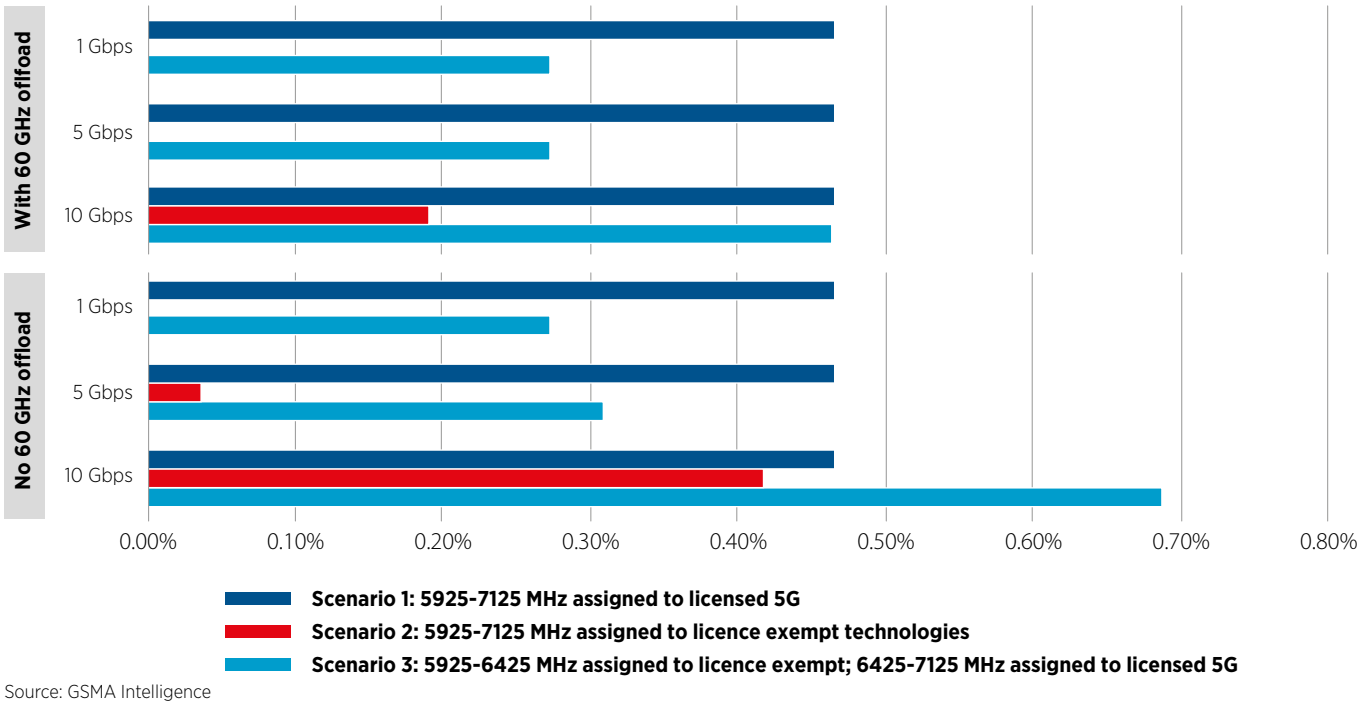
5G equipment using 6 GHz is under development at network and chipset level and its support from a number of large markets already guarantees its scale. Without the 6 GHz band, Brazilian operators do not have clarity on expansion of mid-band spectrum capacity beyond that recently auctioned. This risks network densification, increased capex and higher consumer tariffs. Without access to 6 GHz capacity, 5G networks will be slower and more expensive – consumers will pay more while commerce that relies on Industry 4.0 capabilities of 5G will be less competitive. The benefit for the Brazilian economy and tax revenue that the Brazilian government will receive from 5G will be lower.

The economic benefits of 5G are shown in Section 5 of this report. By 2030 5G can be responsible for 0.68% of global GDP. 5G's benefits are precisely linked to its access to spectrum to provide sufficient affordability and throughput and without enough mid-band spectrum the 2030 GDP impact will be reduced to 0.42%.

Meanwhile, the economic benefits of additional licence exempt / Wi-Fi spectrum are precisely tied to the capability of fixed line connectivity speeds. GSMA preliminary analysis shows that the greatest socio-economic benefit from the 6 GHz band will be driven by using it fully for licensed 5G while fibre to the premises (FTTP) speeds in Brazil remain under 10 Gbps. This speed should be compared to a current market average in Brazil of 90 Mbps, meaning fibre speeds will need to increase 100 x. Until this point, Wi-Fi 6 and 7 requirements can be met with 2.4 GHz and 5 GHz capacity. Once FTTP speeds reach 10 Gbps (and assuming 60 GHz Wi-Fi spectrum is not used) Wi-Fi in the lower half of the 6 GHz band at 5925-6425 MHz becomes beneficial.

Impact of Licensed 5G vs Licence-Exempt Use of 6 GHz in Brazil

IMPACT ON BRAZILIAN GDP OF 6 GHz CHOICES - 2035



Source: GSMA Intelligence

The graph shows the economic benefits of 6 GHz spectrum as a percentage of of GDP in 2035 against a range of theoretical FTTP download speeds (1, 5 and 10 Gbps) for three different 6 GHz scenarios.

There is no benefit today and never the most economic benefit in assigning the full 6 GHz band to licence-exempt technologies in Brazil. With significant improvement in fibre capacity and its availability to all Brazilians, there may be some benefit in the future of allowing 5925-6425 MHz for licence exempt. Allowing licence-exempt technologies in the full band will never be the most beneficial option.

Any use of this spectrum by Wi-Fi requires wide and equitable access to fibre-optic networks. We show in more detail in Section 3 that any socio-economic benefit derived from licence-exempt use of 6 GHz spectrum only appears once each premise has access to home fibre speeds over 5 Gbps. Only once fibre speeds are over 10 Gbps does splitting the band between Wi-Fi and licensed 5G become feasible. The use of Wi-Fi 6E also requires certified equipment. There has been a wait of one year since the Brazilian decision on 6 GHz and none has been certified on the market as yet. Any meaningful early-mover advantage has now disappeared. In any case, such advantage never existed as the Brazilian fibre network – indeed the fibre networks of the vast majority of the world – do not have the capacity to support Wi-Fi 6E. At the same time, the lack of access to 6 GHz spectrum will have a negative impact on 5G in Brazil by lowering download speeds and raising costs.

Wi-Fi-only approach will widen economic divide in Brazil

Analysis of the Brazilian market shows that enabling only those consumers that have access to fibre while lowering the access to connectivity of those without fibre will widen the financial divide in the country. Fibre penetration – and thus the benefits from additional 6 GHz Wi-Fi spectrum – is highest in the wealthiest Brazilian states.

In Section 4 we discuss the impact of affordability on consumer take-up and analyse how any benefits from Wi-Fi capacity will be felt in the wealthiest areas while raising the costs of mobile connectivity in poorer areas. In Brazil the link between a state's wealth and its fixed-line penetration is very clear meaning that Wi-Fi use of 6 GHz spectrum will benefit the wealthiest states the most

In Section 5 we analyse the overall socio-economic benefit from 5G and show how much will be lost, including in countries like Brazil, if no additional mid-band spectrum is assigned. Finally, in Section 6 and Section 7, we look at spectrum needs of 5G and the impact of such needs on the Brazilian situation.

5G in Brazil is at a crossroads. One road means that it will be restricted and constrained by limited spectrum assignment, and its economic value to the people of Brazil repressed.

The other opportunity will see the Brazilian government can create a clear pathway towards assigning the resources required to enable 5G to flourish, drive business productivity and become a launchpad for industrial growth.

1. GSMA Vision for the 6 GHz Band in Brazil

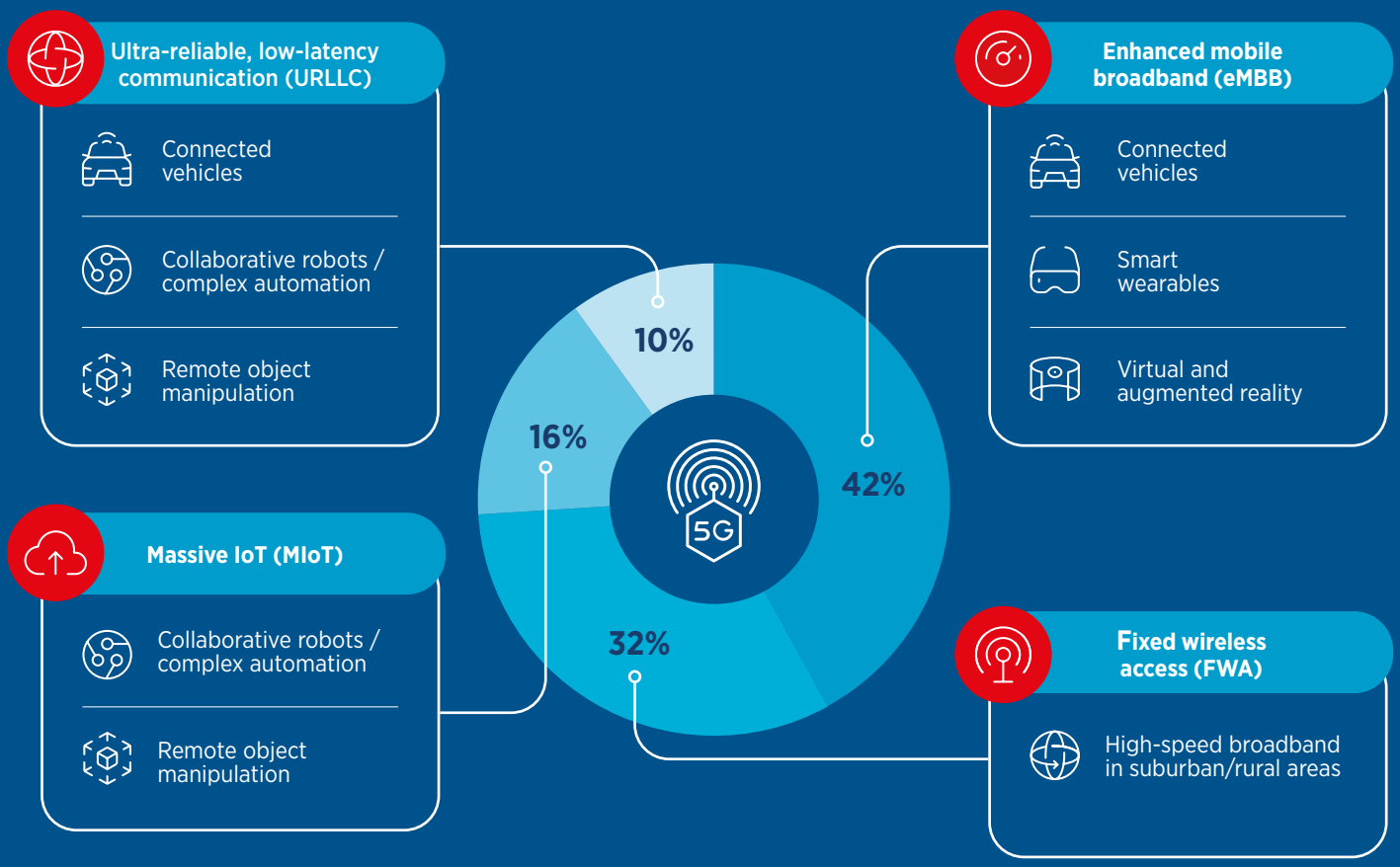
Governments around the world need to make a carefully considered decision as to what the most efficient use of 6 GHz spectrum will be. It represents the largest remaining single block of mid-band spectrum that can be allocated to licensed mobile or unlicensed services in the foreseeable future.

6 GHz spectrum can ensure that affordable 5G capacity is available to drive Brazilian industrial and economic competitiveness in the sustainable, digitised markets of the future.

The GSMA vision suggests that Brazil:

- **Analyses the cost-benefit of the 6 GHz range and looks at the impact of reduced 5G performance and penetration against any perceived benefits of more Wi-Fi access spectrum**
- **Updates its decision to assign 1200 MHz of new spectrum for licence-exempt technologies, limiting to the 5925-6425 MHz range**
- **Considers the future of the 6425-7125 band after WRC-23, based on international decisions as well as fibre capacity and penetration developments in Brazil**

Mid-band spectrum capacity division between 5G use cases



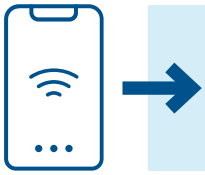
Source: GSMA Intelligence

2. Cost-Benefit Analysis of the 6 GHz Band

Background: Brazil Mobile Data

Brazil leads the LatAm region in number of subscribers, smartphone adoption and 4G penetration[1]. This trend is expected to continue for the years to come, with 20% of connections in 5G, the region's highest subscription growth by 2025. 13 million more Brazilians will have begun using the mobile internet by 2025 – again the fastest mobile growth in Latin America.

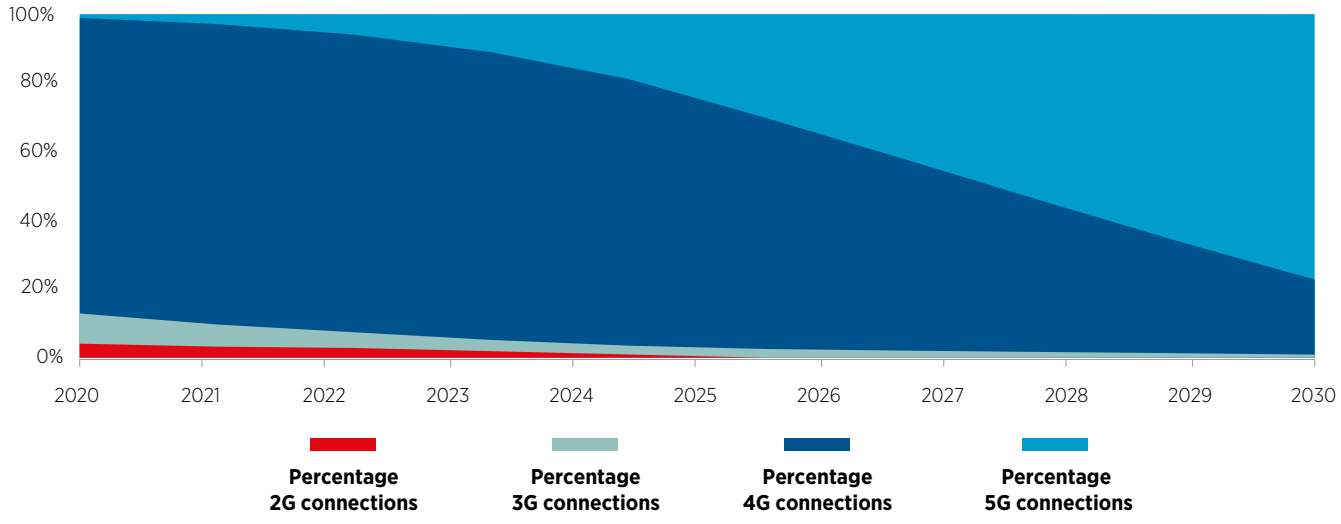
% Mobile Internet Market Penetration, Brazil



2020	2025	2030
61.8%	68.3%	74.8%

1. https://www.gsma.com/mobileeconomy/wp-content/uploads/2021/11/GSMA_ME_LATAM_2021.pdf

% of Mobile Users by Technology, Brazil



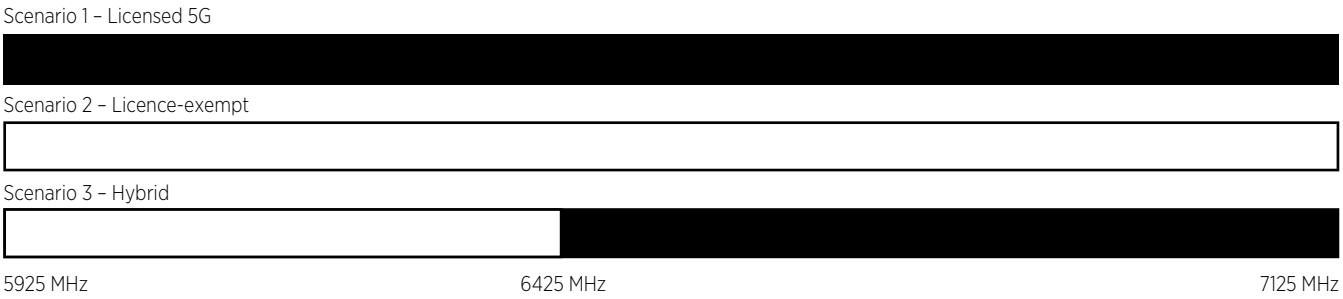
36% of homes are connected to fibre today and the quality of the fixed connection is another important metric. Wi-Fi average speeds in Brazil are currently at 90 Mbps downlink and 46 Mbps uplink[2] - well within the window of Wi-Fi 5 technology capabilities which provide up to 7 Gbps. The bottleneck of Wi-Fi quality does not lie on the amount of spectrum, but on the availability of fixed infrastructure. Fibre is currently in 36% of Brazilian households, mostly present in higher-income areas of large cities[3].

2. https://www.speedtest.net/global-index/brazil
3. https://informacoes.anatel.gov.br/paineis/acessos/telefonia-movel

Drivers of Connectivity

The capacity supply of a mobile network depends on the amount of spectrum that operators have access to – more spectrum enables greater throughput and higher data rates. If there is not enough spectrum to meet demand, then network congestion will reduce the quality of service experienced by the device or end user. The capacity of a Wi-Fi network depends on the fixed broadband capability and amount of spectrum Wi-Fi has access to. Given enough fixed broadband speed, additional unlicensed spectrum enables greater throughput and higher data rates.

6 GHz scenario analysis



Baseline refers to no allocation of either licensed or unlicensed use. In some countries (e.g. within CEPT), the lower frequency boundry is 5945 MHz.
Source: GSMA Intelligence

GSMA Intelligence has recently undertaken a cost-benefit analysis of the 6 GHz band in 24 countries around the world, including Brazil. The analysis looked at the economic benefits of allocating all of the 6 GHz band to licensed (Scenario 1); all of the 6 GHz band to unlicensed (Scenario 2); and the lower part of the band for unlicensed use and the upper part of the band for licensed (Scenario 3).

Phase 2 of this report is due for release in Q2 2022, including the Brazilian data included here. However more information about the model can be found in Phase 1 of the report, which has already been released.

The full report can be found here.

Based on the amount of spectrum available and the spectral efficiencies enabled by 5G and Wi-Fi 6, the GSMA Intelligence study assesses whether there is sufficient capacity to meet demand for both services over a 15-year period for each of the policy scenarios highlighted above. It considers these three scenarios against theoretical FTTP speed availability of 1 Gbps, 5 Gbps and 10 Gbps, both with or without 60 GHz Wi-Fi.

For all countries studied, there is never a scenario where the allocation of the full 6 GHz band to unlicensed use (Scenario 2) generates the greatest benefit to society.

On a global basis it found that:

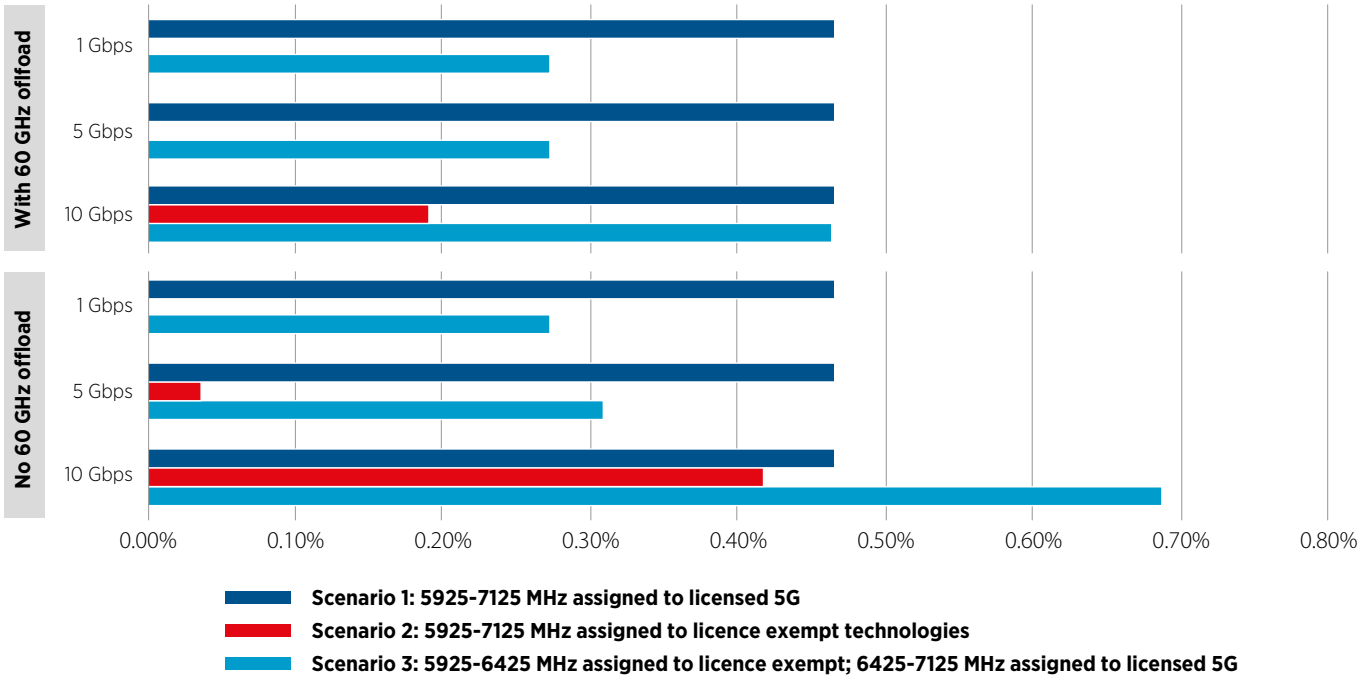
- If fixed broadband does not allow the majority of users to have speeds faster than 1 Gbps then Scenario 1 (assigning 5925–7125 MHz for licensed) will deliver the greatest benefit across all countries as existing unlicensed / Wi-Fi spectrum is sufficient to provide this already. This is also the case if fixed broadband enables speeds up to 5 Gbps for all countries and if the 60 GHz band can be utilised for up to 30% of Wi-Fi traffic.
- If 60 GHz spectrum is not used for Wi-Fi and if fixed broadband speeds are able to reach 5 Gbps, then Scenario 1 still drives the greatest benefit in most countries.
- In countries with very high Wi-Fi demand, allocating an additional 500 MHz of spectrum for unlicensed use in the 6 GHz band (Scenario 3) is sufficient to meet expected demand.

Report Highlight 1:
Socio-Economic Impact of Licensed / Unlicensed 6 GHz

Brazil is one of the countries where the analysis carried out shows that a fully licensed approach is most beneficial. This is the case unless fixed broadband to the premises speeds reach 10 Gbps and there is limited use of 60 GHz Wi-Fi, at which point having the lower band for unlicensed and upper band for licensed is most beneficial.

There is no point at which having the full band available for licence-exempt / Wi-Fi technologies will bring the highest benefits to the Brazilian people.

GDP IMPACT IN 2035

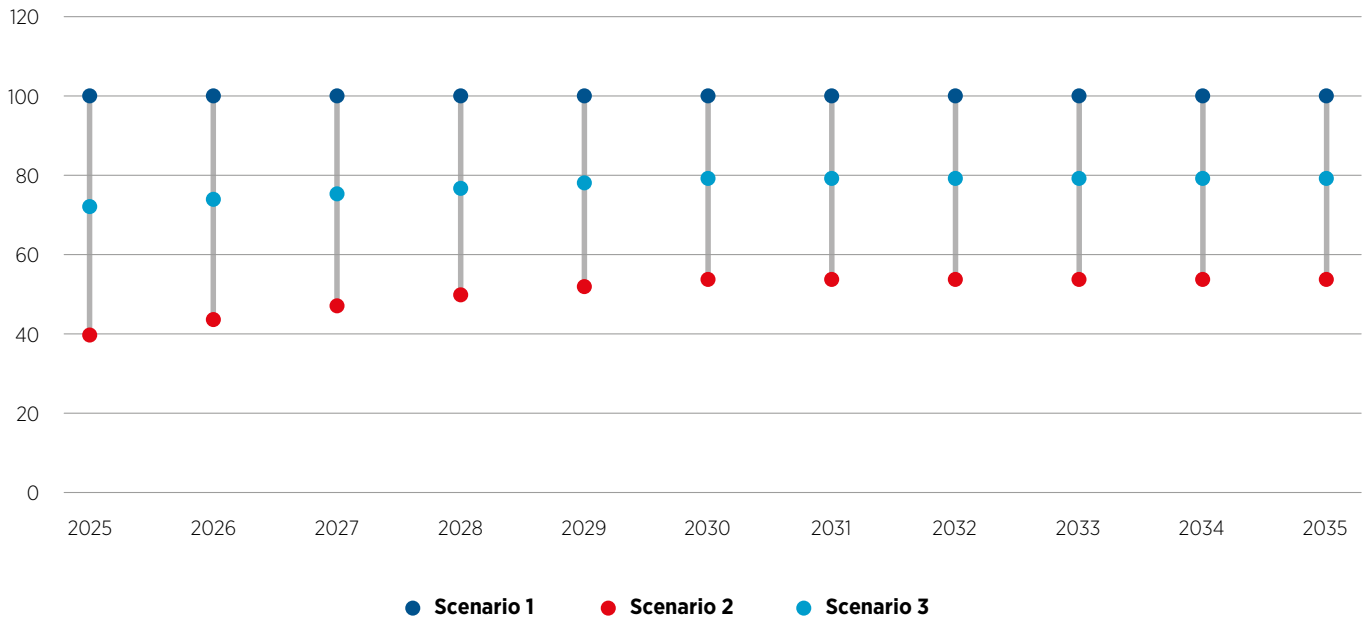


Source: GSMA Intelligence

Report Highlight 2:
5G Speed Reduction with Constrained 6 GHz

The analysis also looked at the impact of reducing the availability of the 6 GHz band on average 5G download speeds. It found that under the full licence-exempt 'Scenario 2', 5G speeds would be constrained to around half their values if all 6 GHz is made available for licensed 5G. If the upper portion of the band is made available to 5G, average download speeds will reach around 80%.

AVERAGE DOWNLOAD SPEEDS IN SCENARIOS 1, 2 AND 3 (Mbps)



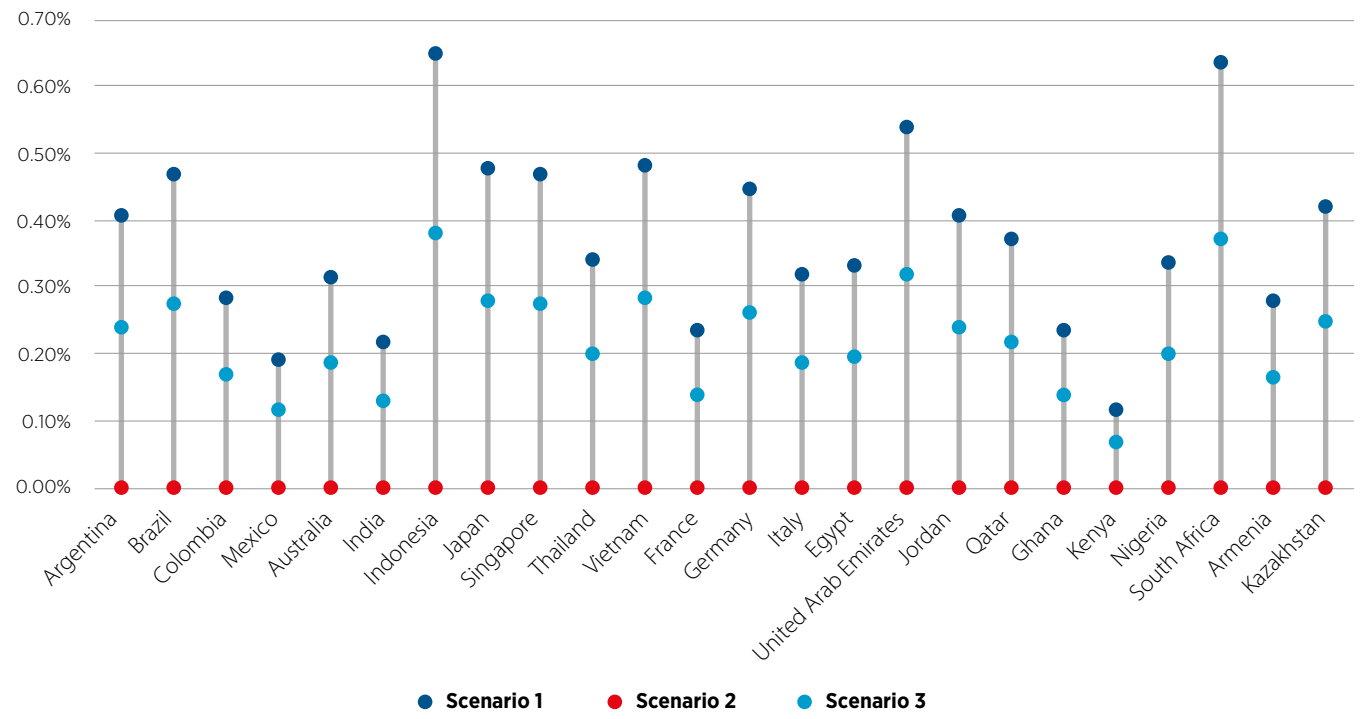
Source: GSMA Intelligence

Global Picture: Economic Impact of 6 GHz Scenarios in 24 Countries

GSMA Intelligence studied a total of 24 countries in its study of the benefits of 6 GHz spectrum. Brazil's results are typical for upper middle countries in showing lower economic benefit to any licence-exempt assignment with FTTP speeds of less than 10 Gbps. Subsequently, it is also typical of many upper-middle income countries that some benefit appears in assigning the lower band (5925-6425 MHz) to licence exempt with FTTP of 10 Gbps and over.

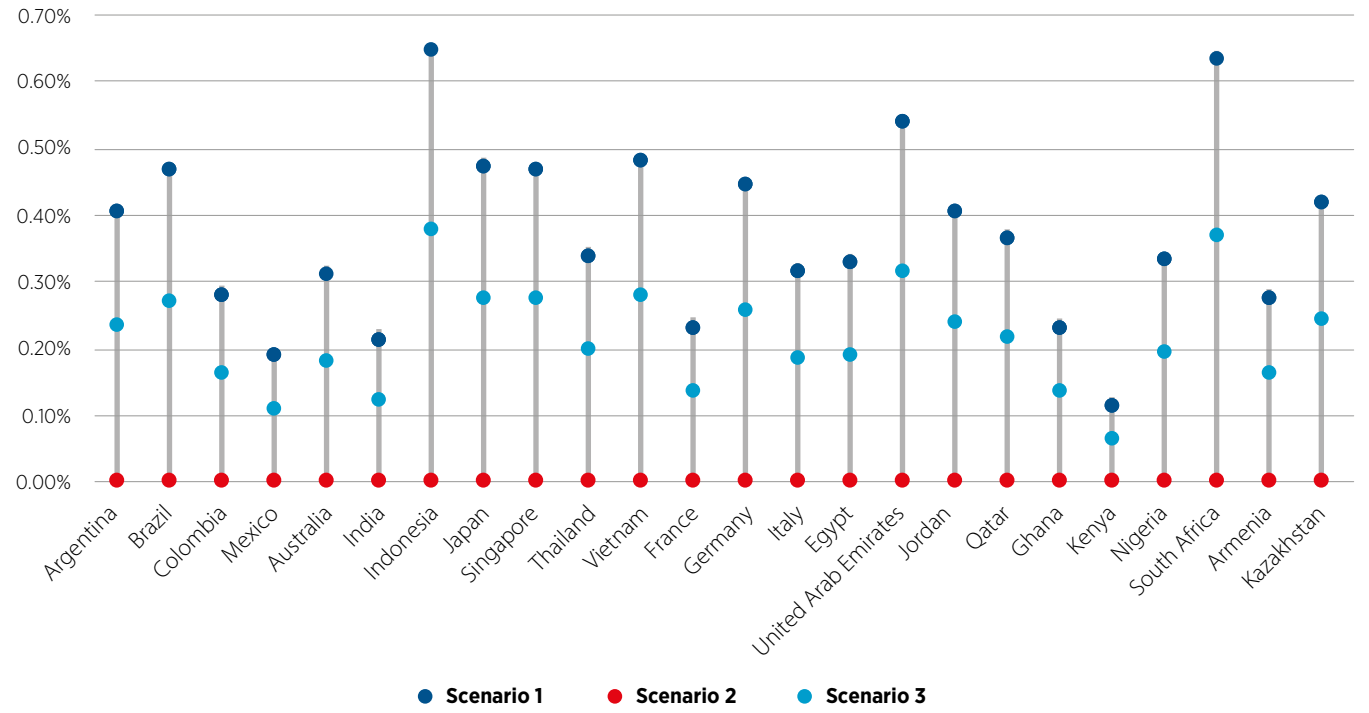
Other than Brazil and Colombia, none of the other countries surveyed have plans to use the full 6 GHz band for licence-exempt technologies at the time of writing.

MAXIMUM AVAILABLE FBB SPEED OF 1 Gbps – WITH OR WITHOUT WI-FI OFFLOAD TO 60 GHz



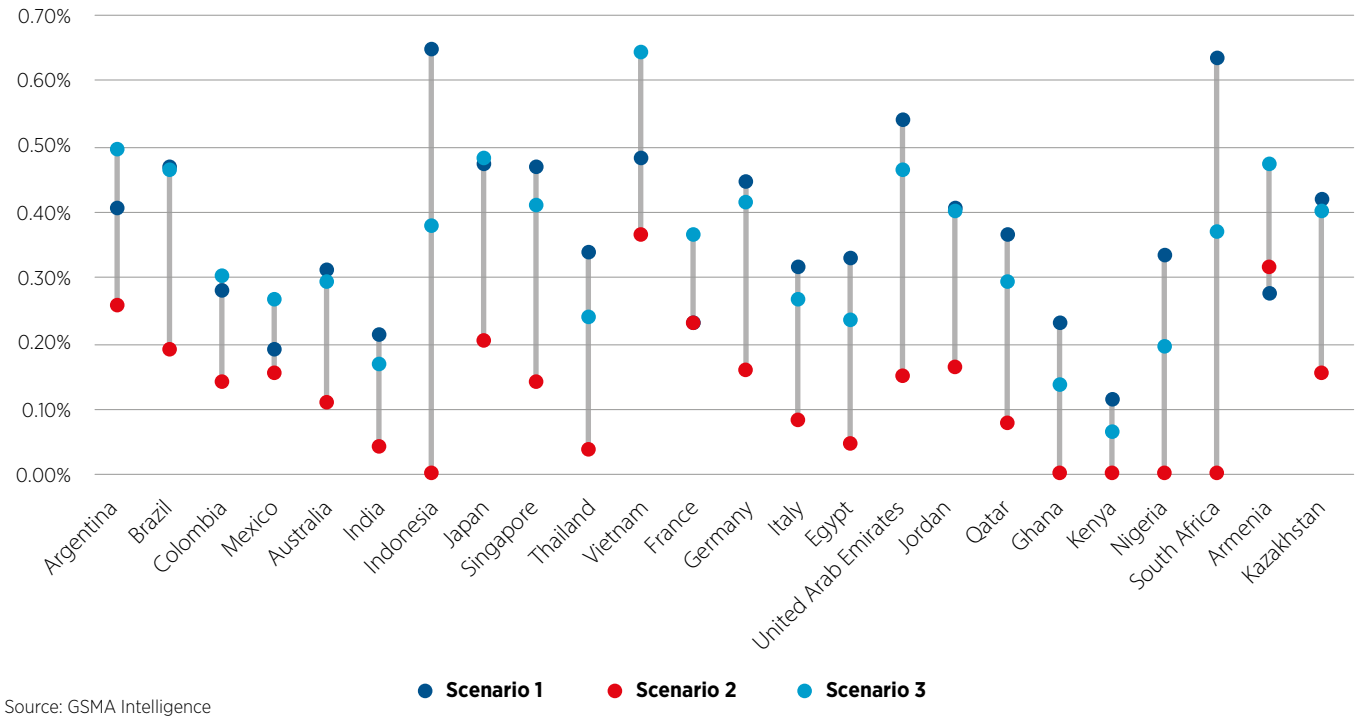
Source: GSMA Intelligence

MAXIMUM AVAILABLE FBB SPEED OF 5 Gbps – UP TO 30% WI-FI OFFLOAD TO 60GHz



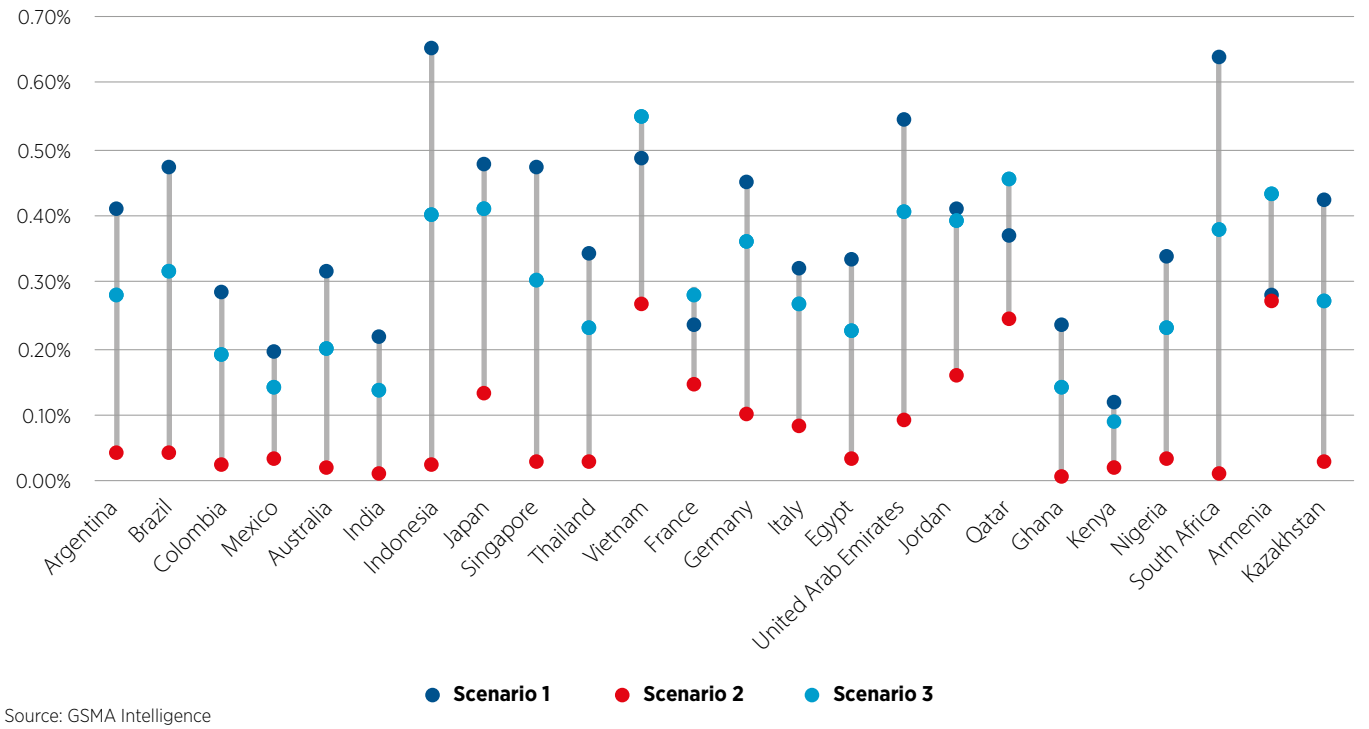
Source: GSMA Intelligence

MAXIMUM AVAILABLE FBB SPEED OF 10 Gbps – UP TO 30% WI-FI OFFLOAD TO 60 GHz



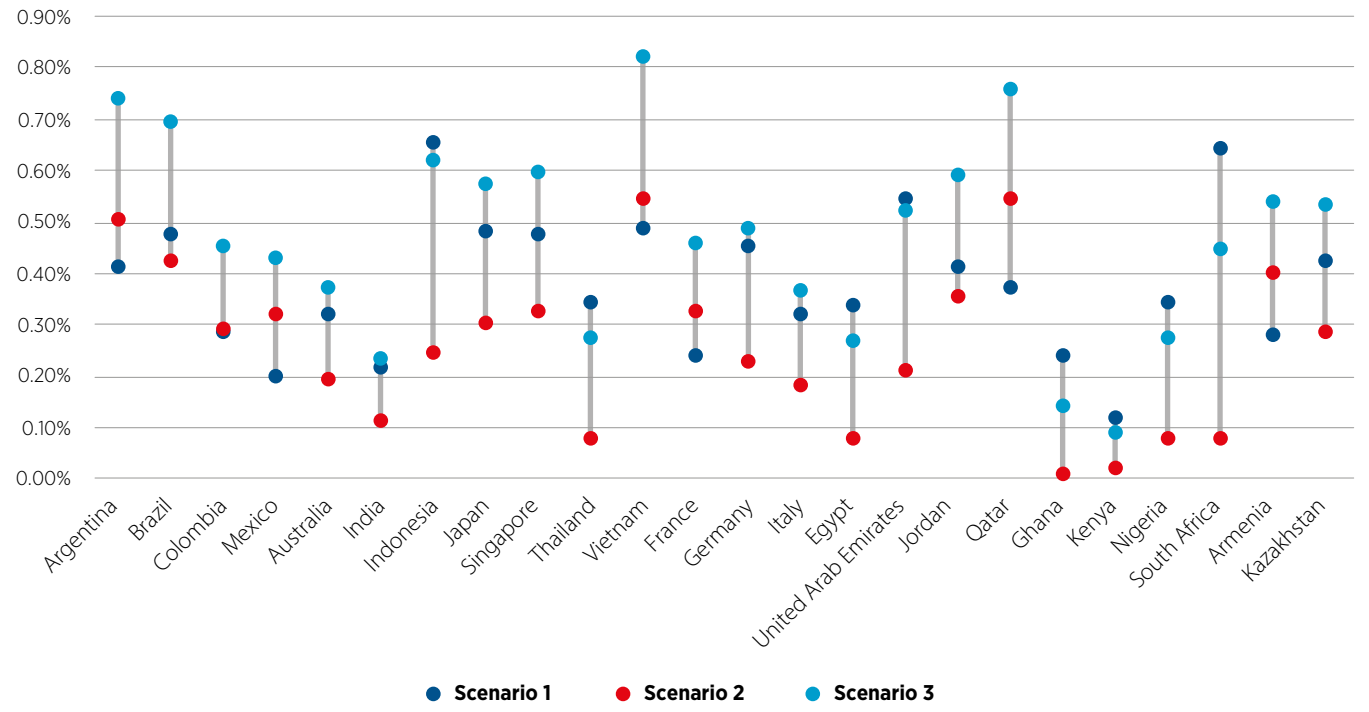
Source: GSMA Intelligence

MAXIMUM AVAILABLE FBB SPEED OF 5 Gbps – NO WI-FI OFFLOAD TO 60 GHz



Source: GSMA Intelligence

MAXIMUM AVAILABLE FBB SPEED OF 10 Gbps – NO WI-FI OFFLOAD TO 60 GHz



Source: GSMA Intelligence

3. Brazil Market Analysis

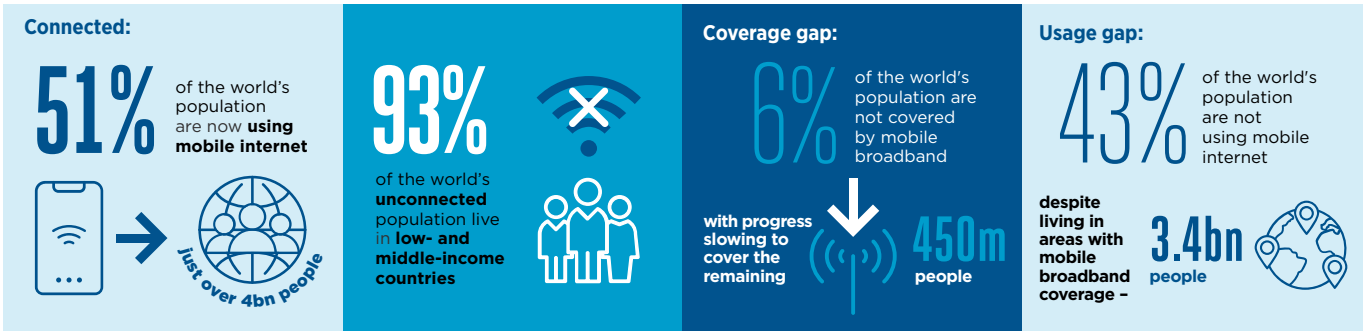
Background: Usage Gap

The GSMA releases figures each year explaining the factors behind non-adoption of mobile services. This looks at the main barriers to internet adoption and use and lays out analysis of:

a) The coverage gap – those who live outside mobile coverage and cannot receive service

b) The usage gap – those who live within mobile coverage but nevertheless do not use it

On a global basis the coverage gap is 6% of the world's population while in Latin America the figure is just 4%. However, in both cases the usage gap of those who could potentially use mobile internet but do not is much higher. Globally, the usage gap is 43% while in Latin America as a whole the usage gap is 40%.



There are two major causes of the usage gap. The first is digital literacy and skills while the second, which can be directly impacted through spectrum policy, is affordability. On a global basis, those without access to connectivity are not just poorer but are also less educated, meaning that lack of affordable connectivity can create a downward spiral and those most in need lack access to smart education and other services.

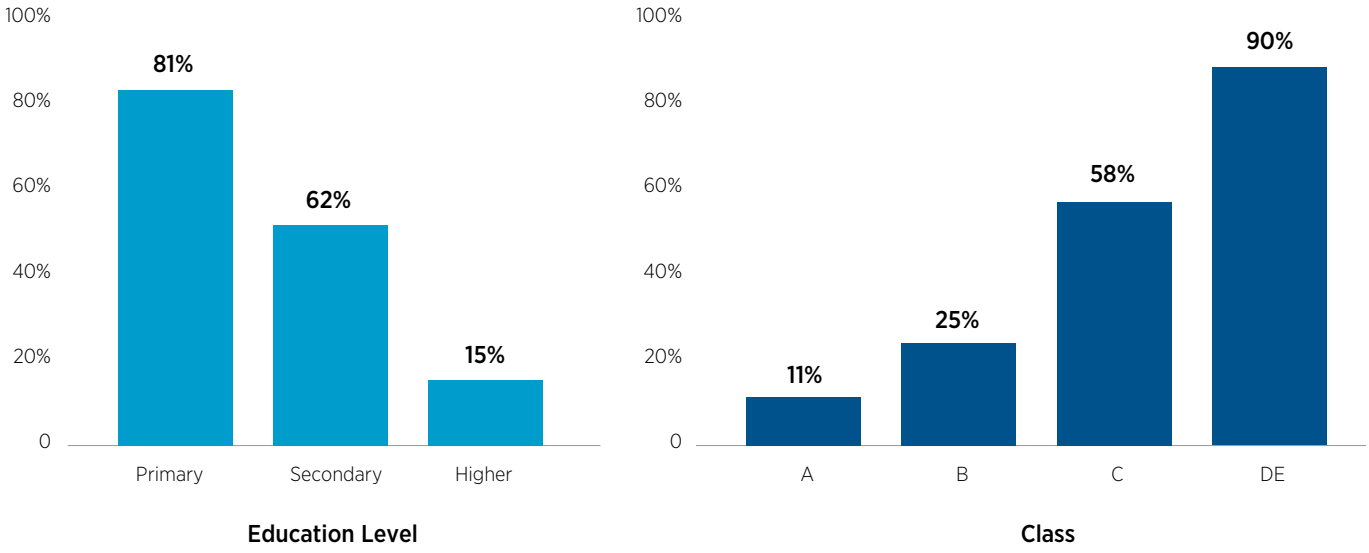
Brazil Analysis

As shown above in Section 3, additional Wi-Fi spectrum benefits only those with access to very high throughput fibre while raising the cost and lowering the quality and throughput of 5G.

Better and affordable mobile connectivity is essential for lower income families in Brazil. This is laid out very clearly by internet data statistics which show the percentage of people relying on their mobile as their access point increases if:

1. They are poorer
2. They are less educated
3. They are from the Nordeste or Norte regions

PERCENTAGE OF PEOPLE OF WHO MOBILE IS THE EXCLUSIVE INTERNET ACCESS POINT:[4]



This means that 90% of the DE class are either reliant on the cost, quality and capacity of the mobile network, or they must seek Wi-Fi connectivity through a third party or the purchase of additional equipment. Affordable mobile connectivity – not additional Wi-Fi capacity – is crucial to bringing these groups into digital equality.

The social impact of this was made clear by further data from CGI: 77% of health-related online research in 2020 – at the peak of the COVID-19 pandemic – was carried out using mobile broadband.

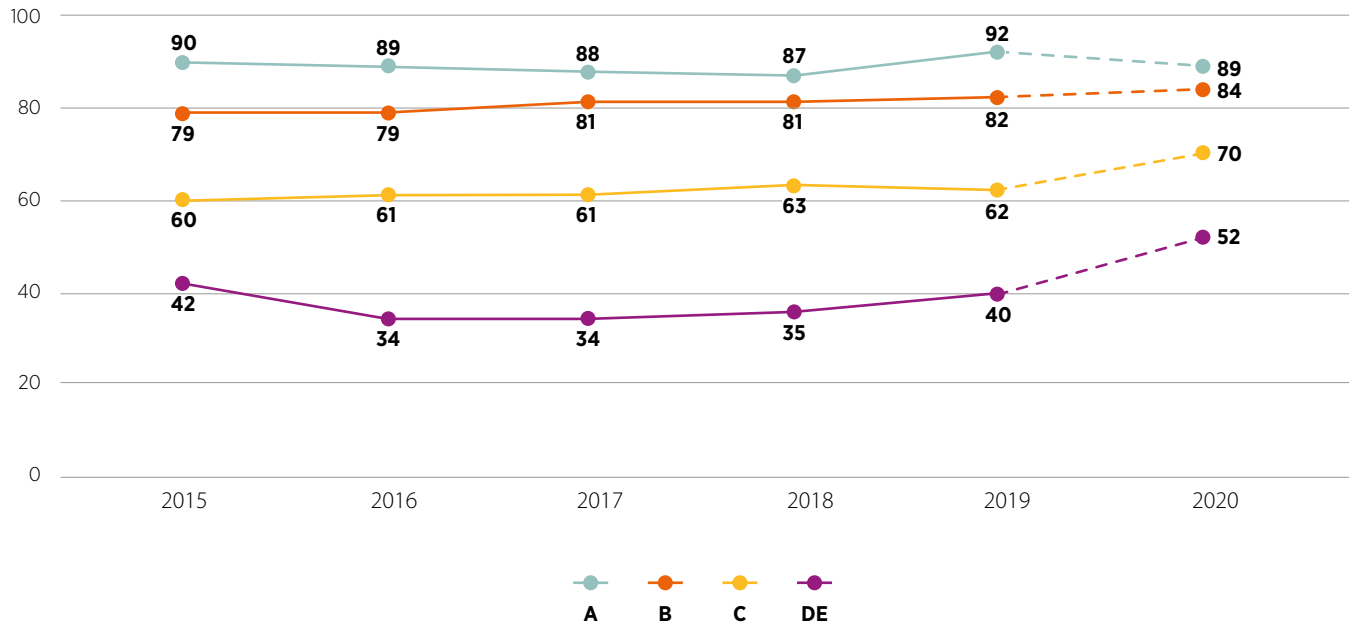
4. TIC Domicilios 2020: https://www.cgi.br/media/docs/publicacoes/2/20211124201233/tic_domicilios_2020_livro_eletronico.pdf

Fixed Internet Penetration in Brazil

Anatel's figures[5] show that 40 million premises have fixed internet in Brazil, or around 57.8%, however only 61.5% of these are connected to fibre, making a total of 36% premises are connected to fibre in Brazil. By contrast, 77.5% of mobile connections are 4G with total connections over 100%. As we show below, the vast majority of fixed connections are in the wealthiest regions in the South / South East whereas mobile connectivity is used by all. Improving fibre connectivity in all Brazilian regions will clearly benefit its citizens but such projects are decades-long and the 5G era will long be over by the time all Brazilians benefit from such fixed infrastructure development.

Currently, there is a clear link between wealth and fixed internet access in Brazil, with only 52% of Class DE households having access compared to 89% of Class A.

HOUSEHOLDS WITH FIXED BROADBAND, BY CLASS (2015-2020)



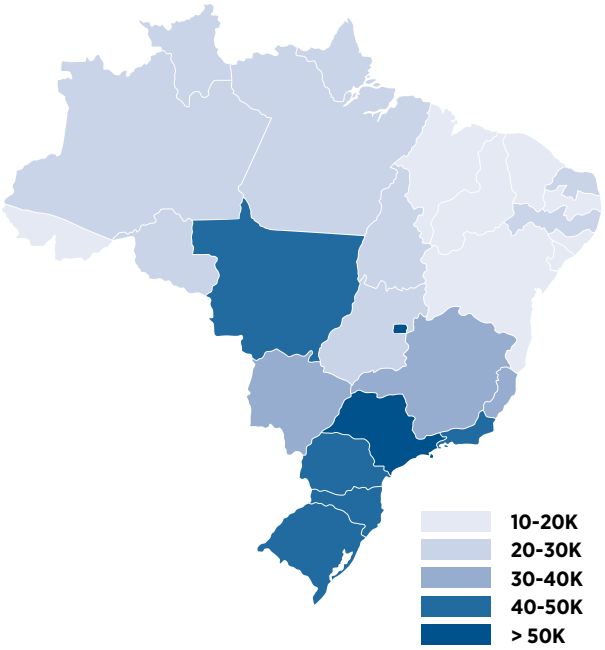
Fixed Internet Access vs Income Levels

Brazilian government data clearly shows the link between fixed penetration and wealth. As shown above, additional licence-exempt spectrum will only benefit areas advanced FTTP systems. There is thus a direct link between how wealthy a state is and how much it will benefit from additional Wi-Fi spectrum.

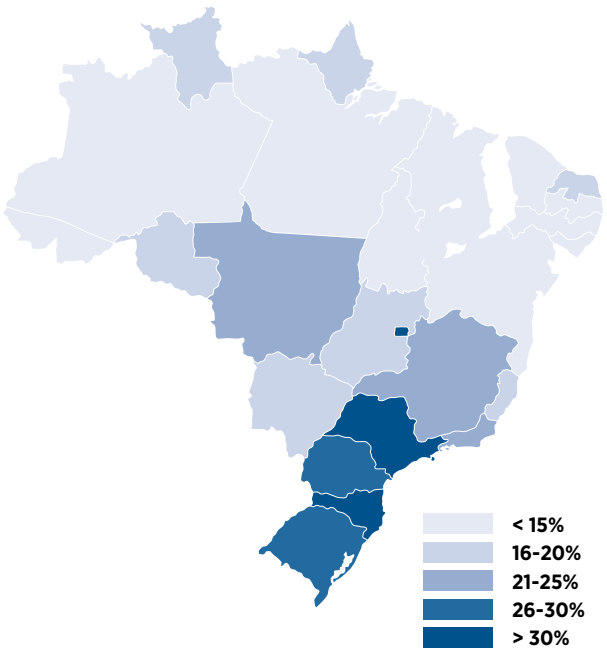
The charts below show that, rather than enhancing digital inclusion, a continuation of the decision to use all 6 GHz spectrum for Wi-Fi will exaggerate digital division, ensuring the poorest states are left entirely behind in an era of 5G fast-broadband speeds.

5. Anatel Dados Painel de Acessos https://informacoes.anatel.gov.br/paineis/acessos

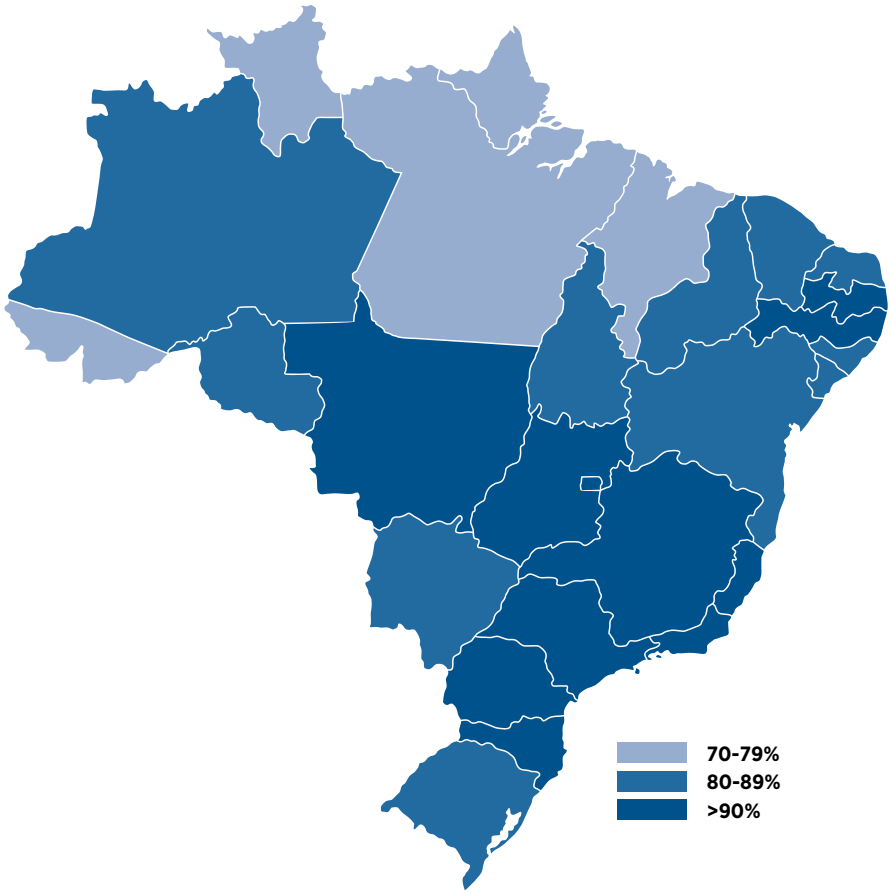
2019 GDP PER CAPITA (R$)



2021 FIXED BROADBAND PENETRATION



2021 MOBILE BROADBAND PENETRATION



4. Socio-Economic Benefits of Mid-Band Spectrum

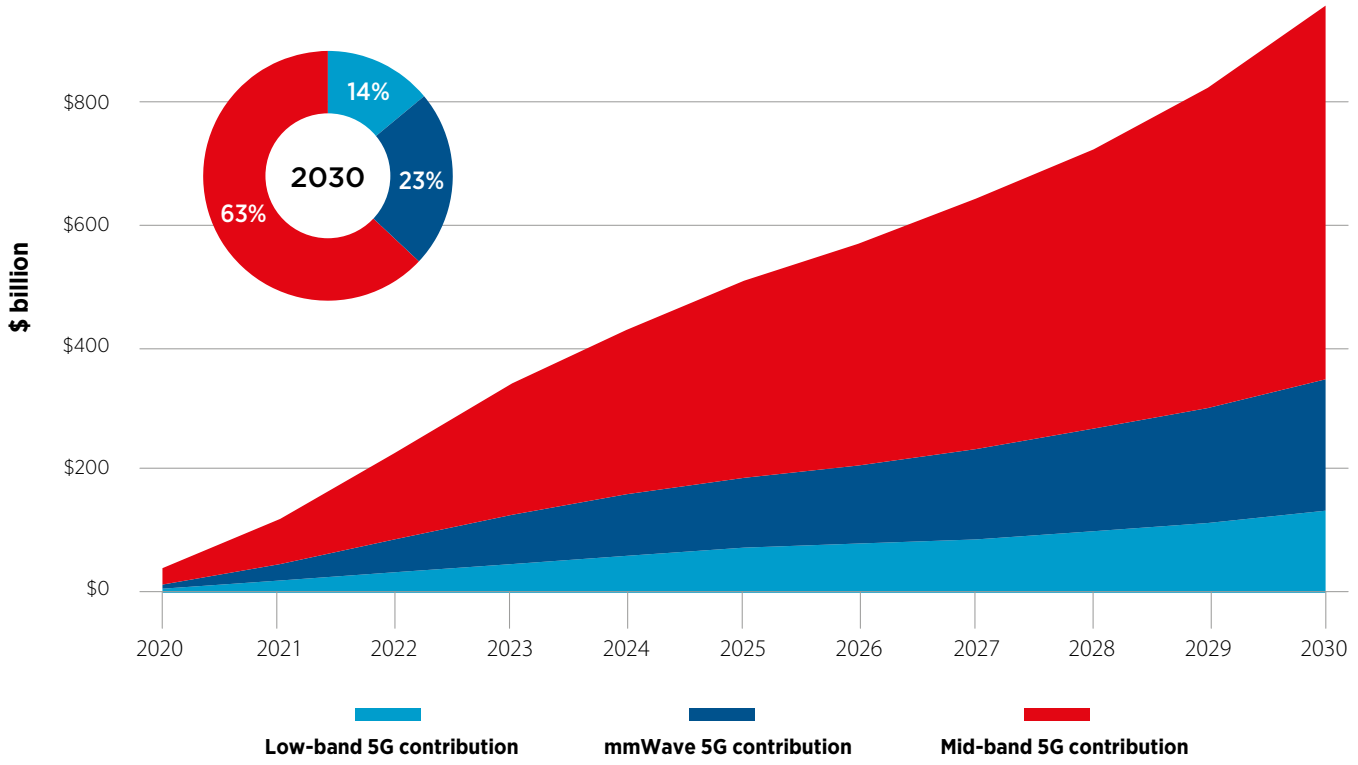
In February 2022, the GSMA released a study into the socio-economic benefit of the mid-band spectrum.[6]

Global Data

Based on the conservative assumption that the socio-economic growth generated by 5G would only be as much as 4G, the report's global findings were that, by 2030, 5G can contribute $961bn to global GDP, or around 0.68% of total GDP, if mid-band spectrum is not constrained. Mid-band would be responsible for almost 65% of the overall socio-economic value of 5G spectrum or around $610bn of global GDP in 2030.

6. https://www.gsma.com/spectrum/resources/mid-band-5g-spectrum-benefits/

GDP CONTRIBUTION BY SPECTRUM RANGE



Impact of constrained mid-band on GDP

However, the study also found that if mid-band spectrum was constrained to today's levels, the GDP benefit of 5G would reduce significantly. On a global basis the GDP impact of 5G in 2030 would reduce from $961bn (0.68% of global GDP) to $594bn (0.42% of GDP) without further assignment of harmonised mid-band spectrum in ranges such as 3.5 GHz and 6 GHz.

Optimal Scenario

$961bn

0.68% of GDP

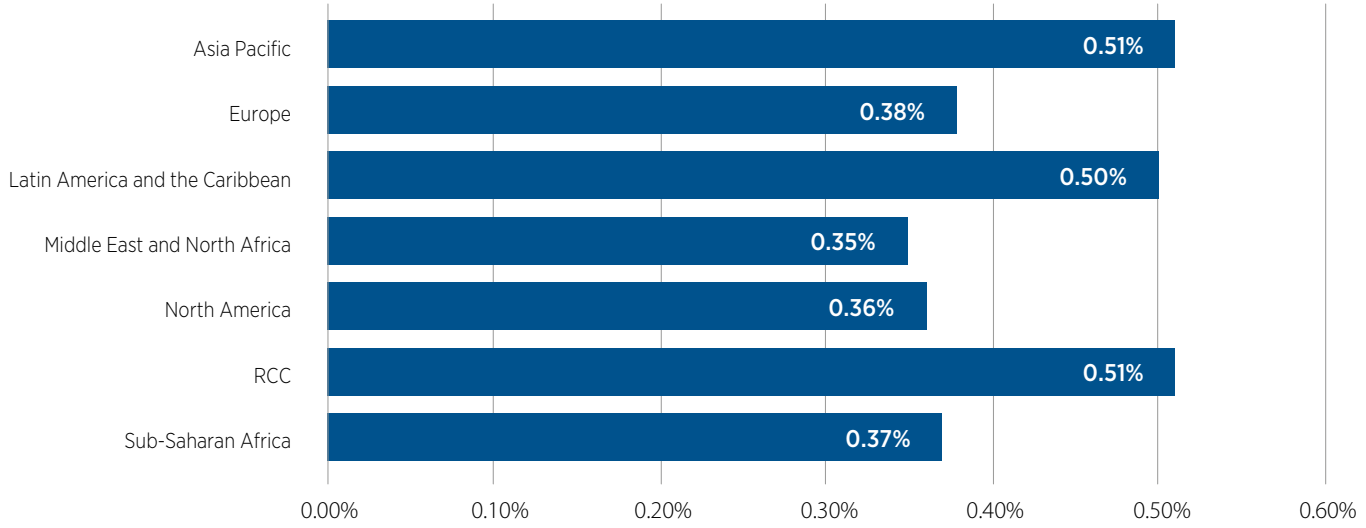
Constrained Scenario

$594bn

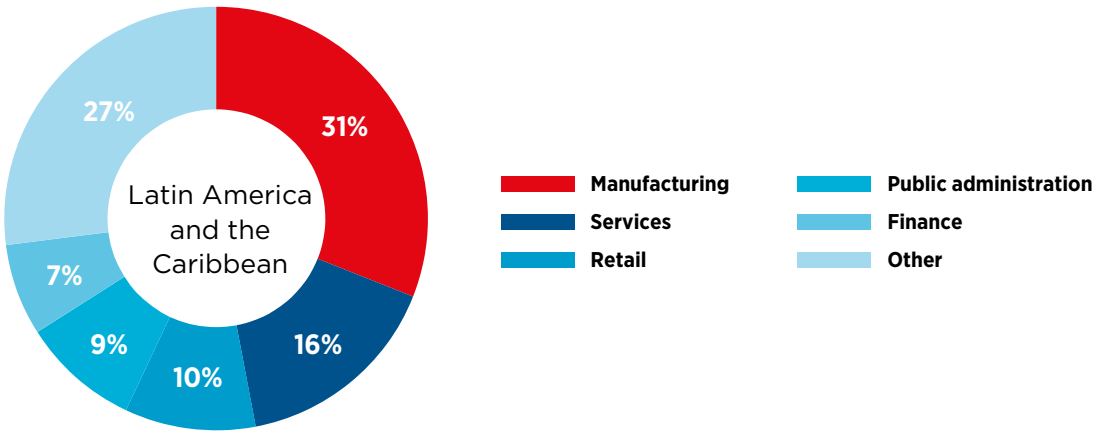
0.42% of GDP

Brazil and Latin America Data

On a regional level, unconstrained 5G is expected to impact Latin America and the Caribbean as a high percentage of GDP.

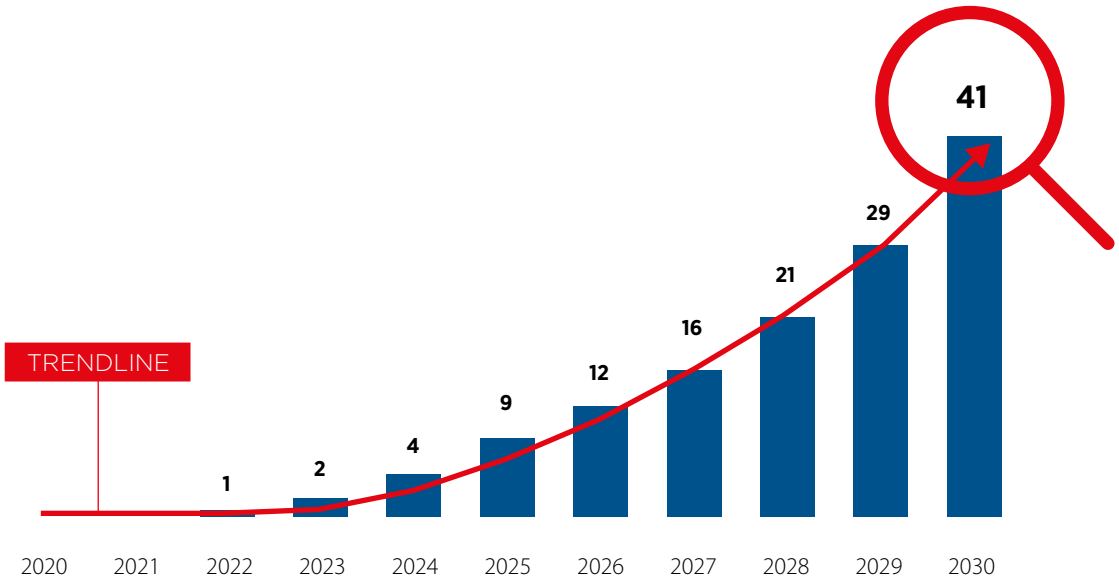


Mid-band applications will mostly be used to benefit the manufacturing, services, retail and finance sectors in the LatAm region as a whole. While manufacturing dominates, the retail sector will account for a significant proportion of benefits in LAC due to applications such as VR/AR and smart devices, which are expected to increase productivity in retail outlets and create new revenue streams.



Growth of Socio-Economic Benefit of 5G 2020-2030

Meanwhile, the overall impact of unconstrained 5G will be $41bn in LatAm by 2030, of which Brazil will be responsible for 43%.



PERCENTAGE OF TOTAL SUB-REGIONAL CONTRIBUTION

Brazil
43%

Mexico
15%

Argentina
9%

5. Mid-Band Spectrum Needs of 5G

Global Data

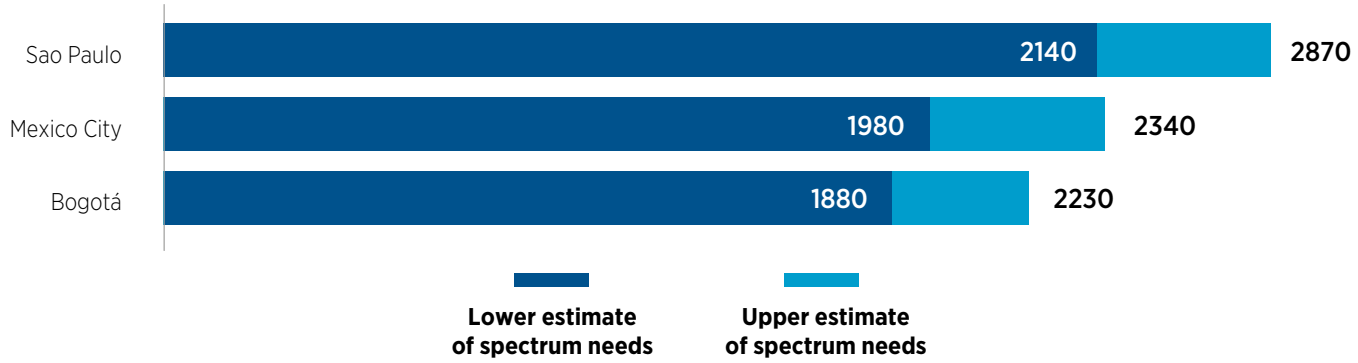
In mid-2021, the GSMA released a report analysing the spectrum needs of 5G between by 2030[7]. This presents the GSMA's vision for how much mid-band spectrum mobile operators will require between 2025 and 2030 in order to meet ITU requirements of 100 Mbps DL and 50 Mbps UL in busy periods. The analysis looks at how much mid-band spectrum 5G networks will need for reliable high-speed mobile broadband services in heavily populated urban areas, including delivering FWA.

1. Densely populated cities need, on average, a total of 2 GHz of mid-band spectrum.
2. IMT-2020 requirements will be at risk with less spectrum, and significantly more base stations would be needed without sufficient assignments.
3. Additional base stations will generate a carbon footprint 1.8-2.9x higher without sufficient spectrum.
4. Affordable fixed wireless access will raise demand. The additional spectrum in mid-bands will allow each cell site to support 3.5-6x more homes with 5G FWA.

7. https://www.gsma.com/spectrum/resources/5g-mid-band-spectrum-needs-vision-2030/

Mid-band needs in Latin America

The global research analysed the mid-band spectrum needs for 5G in 36 large cities around the world. The sample group included three Latin American cities, one of which was São Paulo and shows the upper and lower limits of mid-band spectrum needs, depending on 5G usage at any given time.

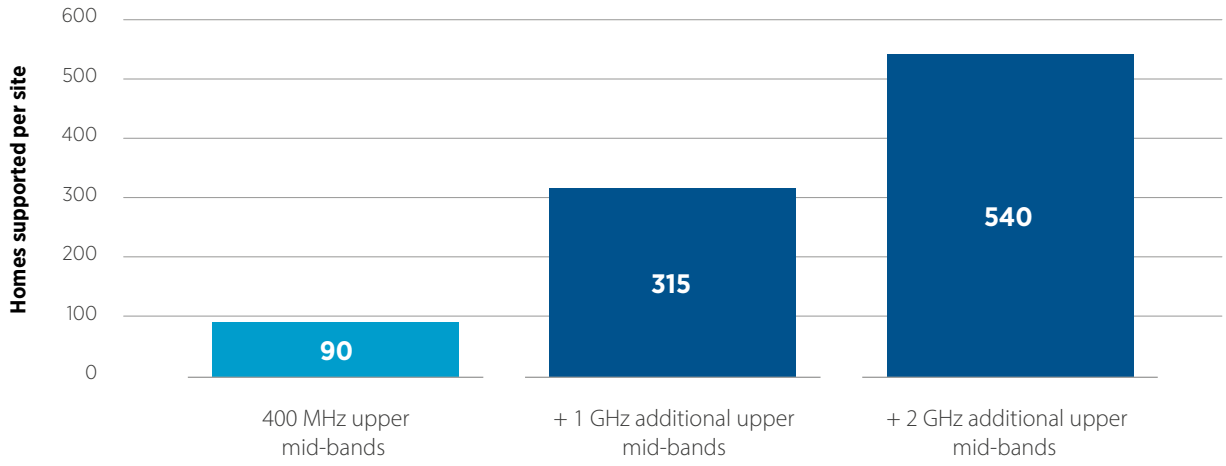


Affordable FWA in non-fibre environments

Many middle-income countries will use the capacity of 5G to provide FWA services to homes and businesses. This allows for vastly accelerated roll-out of high-speed internet compared with digging fibre and comes at a fraction of the cost. Affordable FWA connectivity will thus become an important driver in sustainable development and industrial competitiveness.

FWA connections typically place a much larger capacity burden on mobile networks than a smartphone. Homes or offices can have several concurrent users who often consume large amounts of video, including televisions. To show the economic impact of rolling out FWA in different environments, the GSMA's research analysed how many homes could receive 100 Mbps download and 50 Mbps upload speeds using a single 5G FWA cell site given different amounts of spectrum.

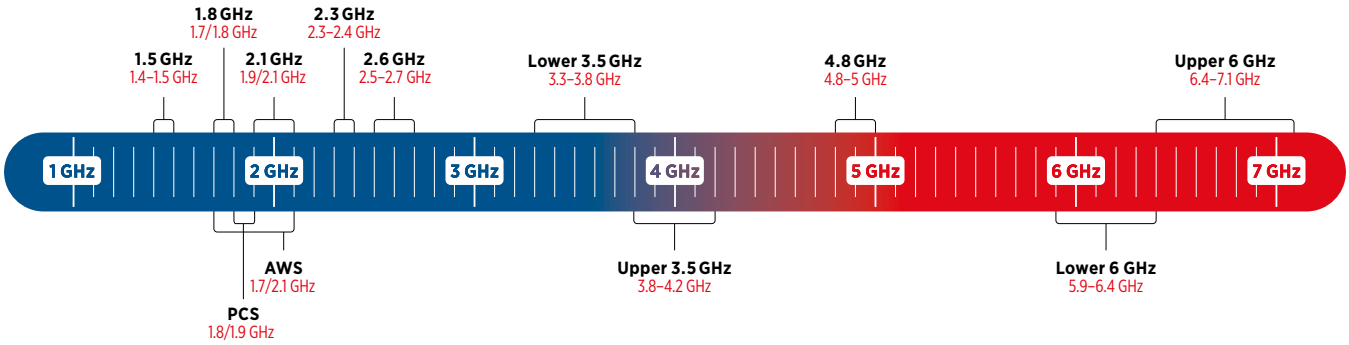
The analysis shows how making sufficient spectrum available for FWA can significantly lower capex in rolling out new services by lowering the need for network densification. Such an environment will create a virtuous circle where roll-out can accelerate, benefits increase as user-experienced data rates rise and as capex is lowered, consumer tariffs can drop.



6. Mid-Band Spectrum in Brazil

Mid-Band Mobile Spectrum

GLOBAL MID-BAND OPTIONS



Brazil's spectrum assignment plans for mobile are now completed with the multi-band auction at the end of 2021. This was a hugely successful auction which will drive the first phase of 5G in Brazil.

However, the GSMA is concerned that this auction marks the end of significant mid-band capacity in the Brazilian roadmap for future mobile spectrum before 2030. Apart from the anticipated development of 1500 MHz, possible development of 4.8 GHz and potential refarming of the limited-capacity lower bands for 5G, the picture is very uncertain. While there is additional potential spectrum in the 3.7-4.2 GHz and 4.8-4.99 GHz bands, the limited capacity is still an issue. 6 GHz is a solution that is not being considered in Brazil at present.

Network densification in some areas will be possible, including mmWaves. However, outside of the most densely populated hot-spots, additional mid-band spectrum combined with low and mmWave bands will be the only answer to avoiding densification and to bring affordable fibre-like FWA services, therefore benefiting every Brazilian – north to south, west to east.

CURRENT SPECTRUM

Band	Capacity (MHz)
1.8 GHz	150
2.1 GHz	120
2.3 GHz	90
2.6 GHz	140
3.5 GHz	400
Total	900

PLANNED SPECTRUM

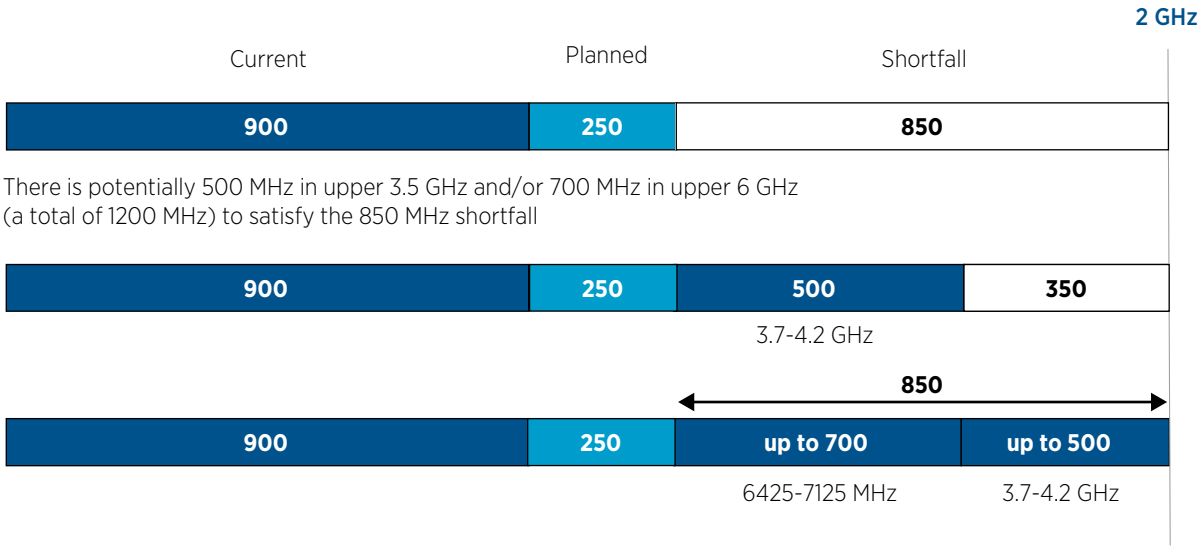
Band	Capacity (MHz)
1.5 GHz	90
4.8 GHz	160
Total	250

Countries will require an average of 2 GHz of spectrum in the 2025-2030 timeframe. However, in the densest urban areas such as São Paulo, more spectrum will be required. This leaves a shortfall between spectrum which is currently assigned and planned for assignment and the amount that will be needed in Brazil.

Shortfall to global 2 GHz requirement:	**850 MHz**
Shortfall to São Paulo lower requirement:	**990 MHz**
Shortfall to São Paulo upper requirement:	**1720 MHz**

MID-BAND SPECTRUM NEED

Assigning enough mid-band spectrum to meet the 2 GHz requirement is a challenge for governments and regulators all over the world and today only the most advanced markets are getting there. The use of the 6 GHz band for mobile presents a unique opportunity to meet spectrum needs but, even with all other harmonised mid-bands assigned, it is impossible to reach 2 GHz without it.



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