GSMA

India Market Insight: The 6 GHz Band

5.925–7.125 GHz

May 2024

GSMA

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Executive summary

6 GHz mobile spectrum can play a central role in delivering sustainable industrial development in India but partnership between government and the mobile sector is required to deliver commercialisation of the band.

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 has undergone trials for the past two years in countries across the world, reaching peak speeds of 12 Gbps. The first prototype handset using 6 GHz was tested in late-2023 by Ericsson and MediaTek. Following on from this period of commercial activity, The World Radiocommunication Conference 2023 (WRC-23) defined the harmonisation of this spectrum and support at WRC-23 from countries representing 60% of the global population already guarantees its scale.

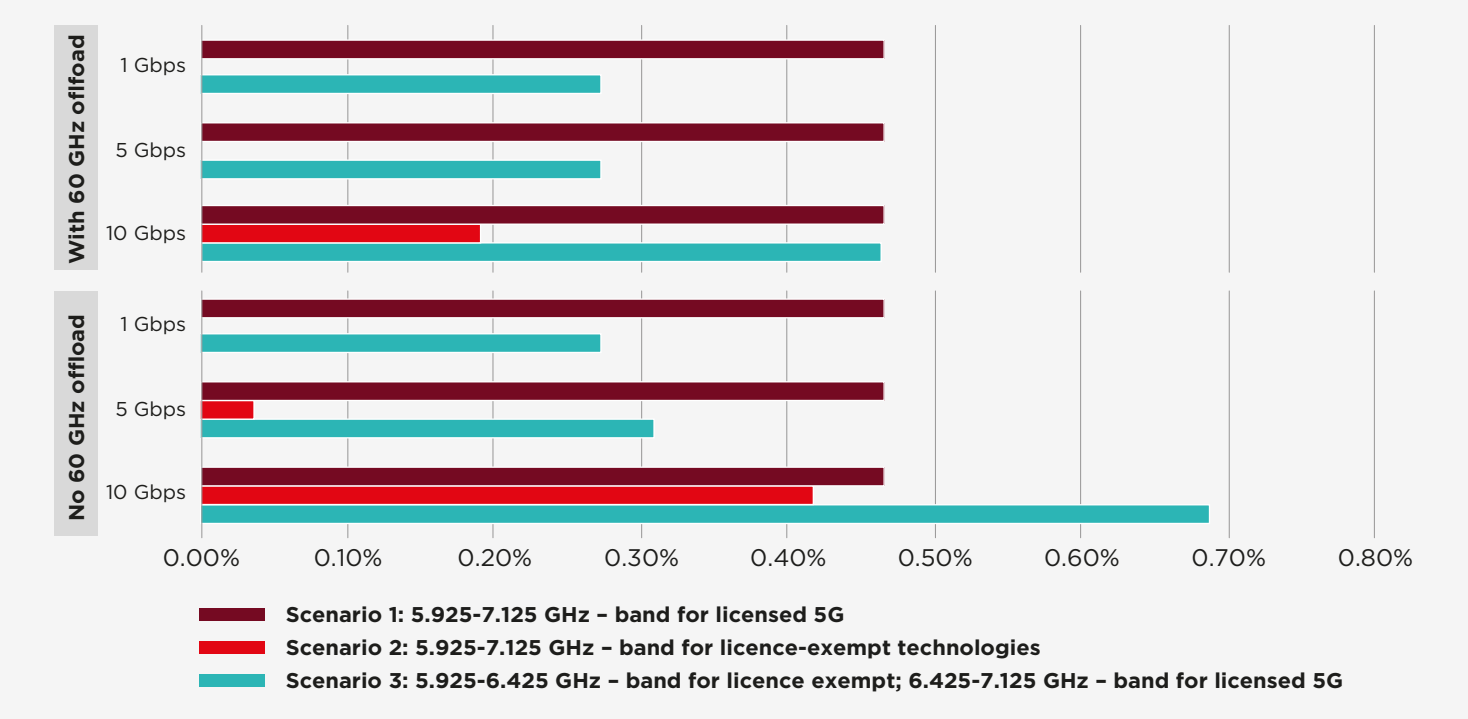
Without the 6 GHz band, Indian mobile operators do not have clarity on expansion of mid-band spectrum capacity beyond 370 MHz in 3.5 GHz band that was auctioned in 2022 and the unsold been put to auction scheduled in June 2024. This risks network densification, higher carbon emissions, increased capex and higher consumer tariffs. Without access to 6 GHz capacity, 5G networks will be slower while consumers will pay more and commerce that relies on Industry 4.0 capabilities of 5G will be less competitive. The benefit for the Indian economy and tax revenue that the Indian government will receive from 5G and beyond will be lower.

The economic benefits of 5G are shown in Section 4 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 its impact on global GDP in 2030 will be reduced to 0.42%.

Meanwhile, the economic benefits of additional licence exempt / Wi-Fi spectrum are tied to the capability of fixed line connectivity speeds. GSMA 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 India remain under 10 Gbps. This speed should be compared to a current average fixed broadband speed in India of 62 Mbps, meaning speeds will need to increase even greater than 150x.

Impact of licensed 5G vs licence-exempt use of 6 GHz in India

GDP impact of 6 GHz choices in India – 2035



Source: GSMA Intelligence

The graph shows the potential economic benefits of 6 GHz spectrum as a percentage 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 using the full 6 GHz band to licence-exempt technologies in India. With significant improvement in fibre capacity and its availability to all Indian households, there is only some potential benefit of allowing 5.925-6.425 GHz 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 2 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 in the lower part of the band and licensed 5G, operating in the band 6.425-7.125 GHz, become feasible.

Mobile take-up can soften the economic divide in India

Analysis of the Indian 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 Wi-Fi spectrum – will be the highest in those sections of the society who already have access to all resources of connectivity.

Study of the overall socio-economic benefit from 5G, shown in section 4 demonstrates how much will be lost, including in countries like India, if no additional mid-band spectrum is assigned. Finally, in section 5, we look at spectrum needs of 5G and the impact of such needs on the Indian situation.

Spectrum constraints will harm the global environment

Spectrum policy has an important role to play in the race to net zero and efficient spectrum use reduces carbon emissions while simultaneously generating benefits for society. The enabling effect of mobile in impacting carbon emissions reductions in other sectors can be enhanced by ensuring that sufficient spectrum, such as the 6 GHz band, is made available to licensed mobile.

GSMA research[1] shows that an 800-1000 MHz spectrum shortfall in Mumbai would lead to a need for 195,785 additional small cells. This would see power consumption increasing by 2.9x, on top of the relative increase in total network costs of 4.3x.

Considering both the enabling effect, and the impact on mobile's own emissions, a 100 MHz reduction in 5G spectrum is associated with a 15 $MtCO_2e$ increase in emissions in a high-income country over a ten-year period, or 2 $MtCO_2e$ in a low-income country[2]. With less spectrum, more base stations are needed to meet demand for mobile data, which means more energy and a higher carbon impact through their manufacture through the supply chain.

5G in India is at a crossroads. One road sees it restricted and constrained by limited spectrum assignment, and its economic value to the people of India repressed. The other opportunity will see industry work together with the Indian government and 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 2030 – Mid-Band Spectrum Needs
2 GSMA: Spectrum: the Climate Connection

1. GSMA vision for the 6 GHz band in India

6 GHz spectrum can help support the next wave of connectivity in India, enhancing the lives of consumers, the competitiveness of businesses and the sustainability of industry. 6 GHz mobile is maturing: the mobile industry has carried out equipment development, while international agreements have been reached at the International Telecommunication Union (ITU). National adoption and commercialisation of 6 GHz in India are the next phase of this spectrum's development.

The ITU's World Radiocommunication Conference 2023 (WRC-23) opened the doors to a new era of connectivity for all services and laid the foundation for mobile to progress into 5G-Advanced and 6G. India can now take advantage of the harmonisation of the 6 GHz band that was achieved at WRC-23 and begin national plans to commercialise the upper 6 GHz band (6.425-7.125 GHz). WRC-23 decisions saw upper 6 GHz identified for mobile use by countries in every ITU Region – EMEA / CIS, the Americas, and the Asia Pacific (APAC), and conditions for its use have been agreed in the ITU's Radio Regulations.

6 GHz represents the largest remaining single block of mid-band spectrum that can be allocated to licensed mobile services in the foreseeable future. With this comes an opportunity for India to finalise its own plans for 6 GHz and align with other major markets in APAC.

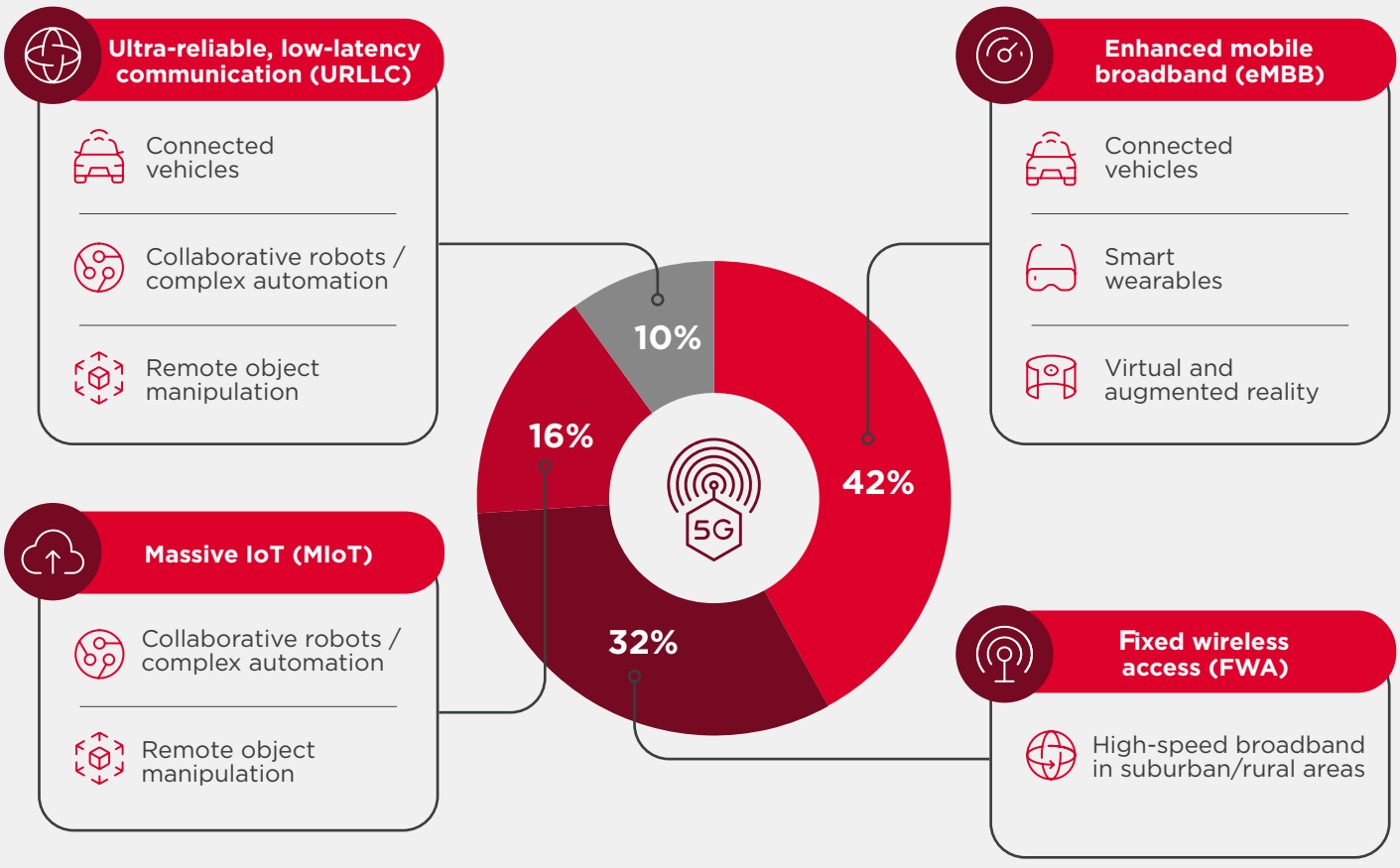
Enhanced mobile connectivity and capacity enabled by the 6 GHz band will lay the foundations for inclusive and technology-driven progress envisioned by Indian government initiatives. India remains amongst the fastest growing 5G markets globally and has witnessed a massive growth in mobile download speeds, making it into the top 50 of the Speedtest Global Index list. As the demand for 5G grows, 6 GHz capacity will be critical to support the rapid growth and to foster innovation, affordable connectivity, and economic growth across the rest of this decade. With the conclusion of WRC-23, it is important for policymakers and national regulators to update their spectrum strategies and to incorporate the 6 GHz band into their IMT spectrum roadmaps to support future growth of mobile.

The results of recent 6 GHz field trials, involving vendors, operators, academia and chipset-makers, provide further evidence on the ability of this band to provide an effective layer for 5G expansion.

The GSMA suggests that India:

- 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 competing uses for the upper 6 GHz band.
- Includes 6.425-7.125 GHz in its spectrum roadmap/table of allocations to ensure that the band is commercialised in India.

Mid-band spectrum capacity division between 5G use cases



Source: GSMA Intelligence

2. Cost-benefit analysis of the 6 GHz band

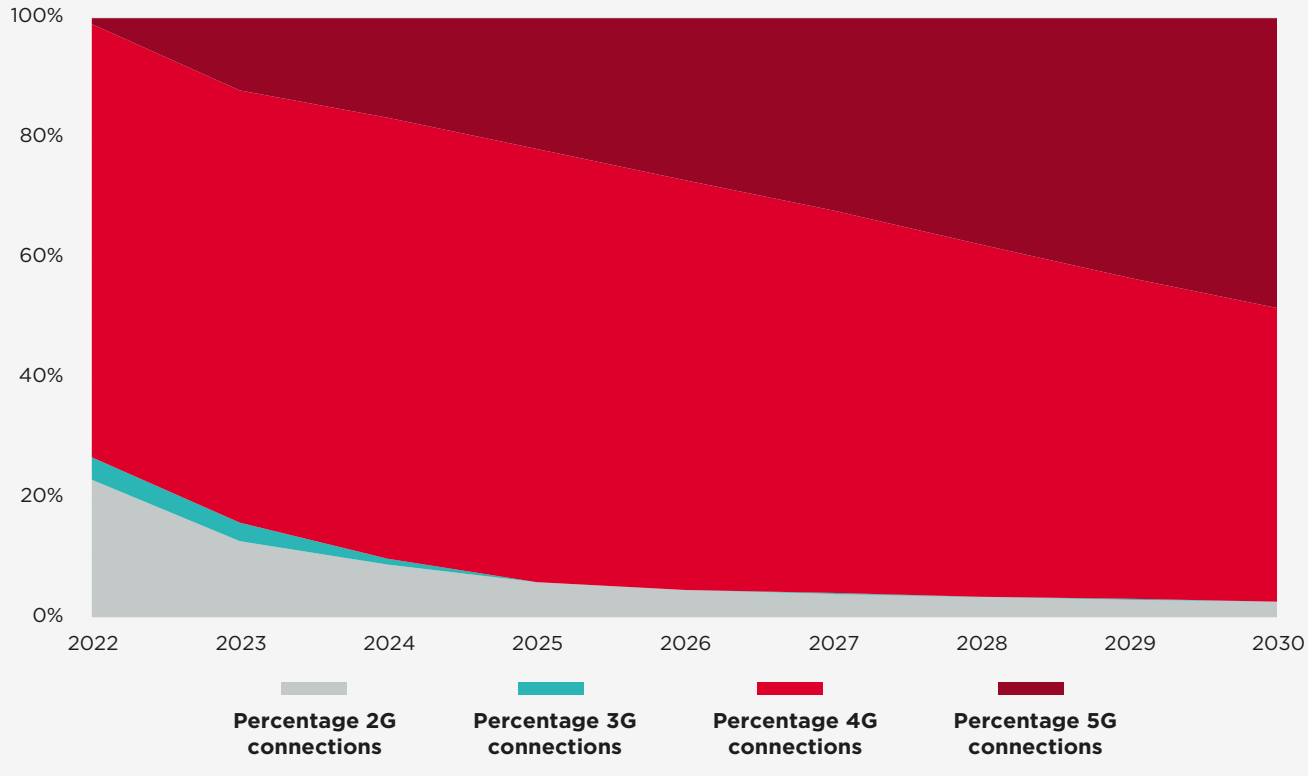
Background: India mobile data

The Asia Pacific (APAC) region has some of the fastest growing 5G markets today, notably India, which has almost 175 million 5G connections at the end of Mar 2024. India is one of the leading markets in the Asia Pacific in number of 5G subscribers, smartphone adoption and 4G penetration[3]. This trend is expected to continue for the years to come, with almost 48% of connections in 5G, one of the region's highest subscription growth by 2030.

Top three smartphone markets in Asia Pacific (smartphone connections, 2030)

Source: GSMA Intelligence

% of Mobile users by technology, India



Source: GSMA Intelligence

3 https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-economy/wp-content/uploads/2023/07/Mobile-Economy-Report-Asia-Pacific-2023.pdf

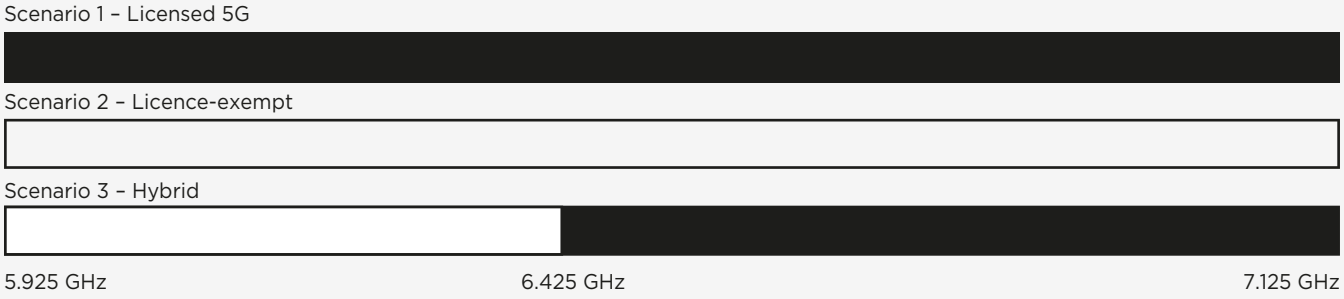
5G adoption was initially driven by early adopters and consumer use cases, but this trend is now changing. Within Asia Pacific, future growth is expected to come from key markets such as India[4], which launched 5G networks in 2022 with the expansion of services from Airtel and Jio in 2023. Meanwhile, some countries in the region, including India, Japan and South Korea, have begun setting their 6G vision, with plans to implement the technology around the end of this decade.

Mobile will play a critical role in the development of connectivity in India. TRAI[5] data shows that wireline broadband subscribers in India stand at 39.46 million i.e. 4% of the total 916.77 million broadband subscribers in the country. The quality of the wireline broadband connection is another important metric. Fixed broadband speeds in India are currently at 62 Mbps downlink and 54 Mbps uplink[6]. which indicates that the bottleneck of Wi-Fi quality does not lie on the amount of spectrum, but on the availability of fixed infrastructure. Fixed speeds would need to be over 100 x faster to justify significant new assignment of unlicensed spectrum.

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 upon the fixed broadband capability.

6 GHz scenario analysis



4 Second wave of 5G: 30 countries to launch services in 2023", GSMA, February 2023
5 https://trai.gov.in/sites/default/files/PR_No.18of2024.pdf
6 https://www.speedtest.net/global-index/india

GSMA Intelligence undertook a cost-benefit analysis of the 6 GHz band in 24 countries around the world, including India. 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).

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:

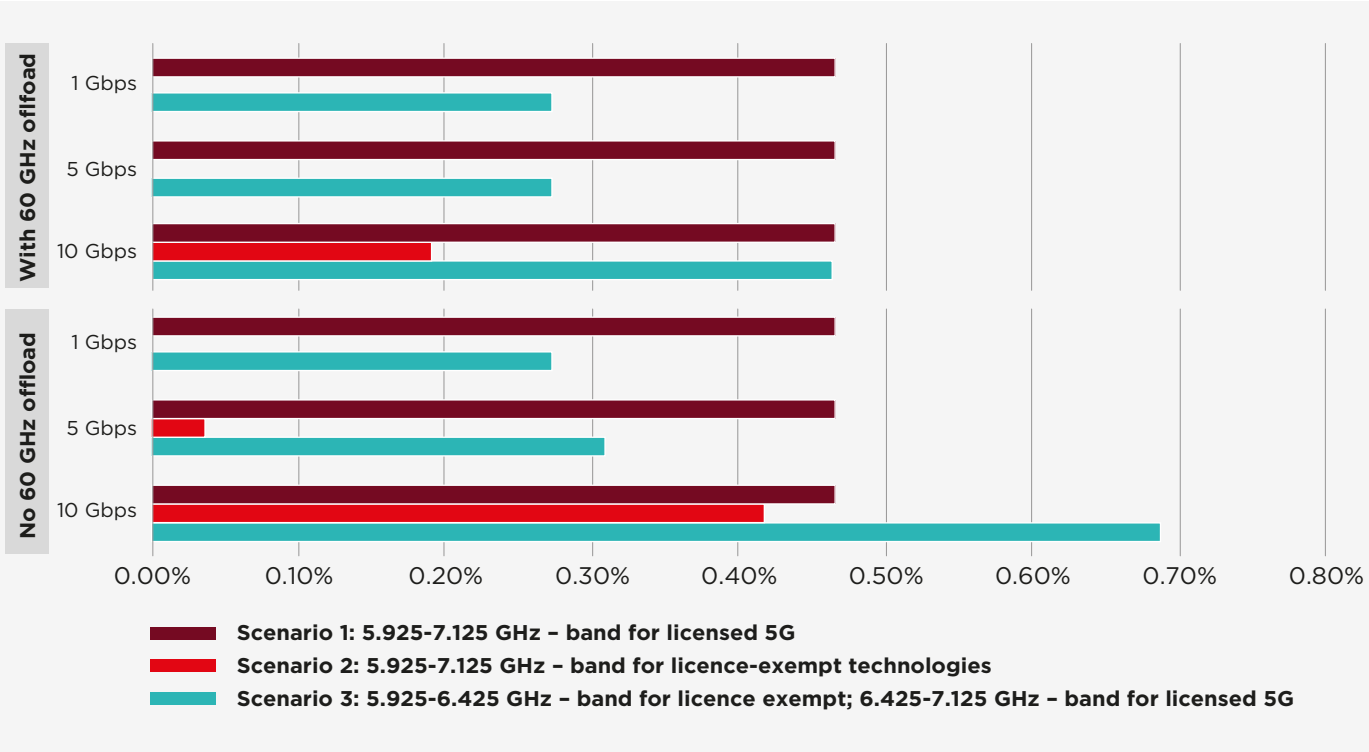
- If fixed broadband does not allow the majority of users to have speeds faster than 1 Gbps then Scenario 1 (assigning 5.925-7.125 GHz for licensed) will deliver the greatest benefit across all countries as existing unlicensed / Wi-Fi spectrum is sufficient to provide this already. This is also the case 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

India is one of the countries where the analysis carried out shows that a fully licensed approach is most beneficial to 2035 GDP. 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 Indian citizens.

GDP impact in 2035

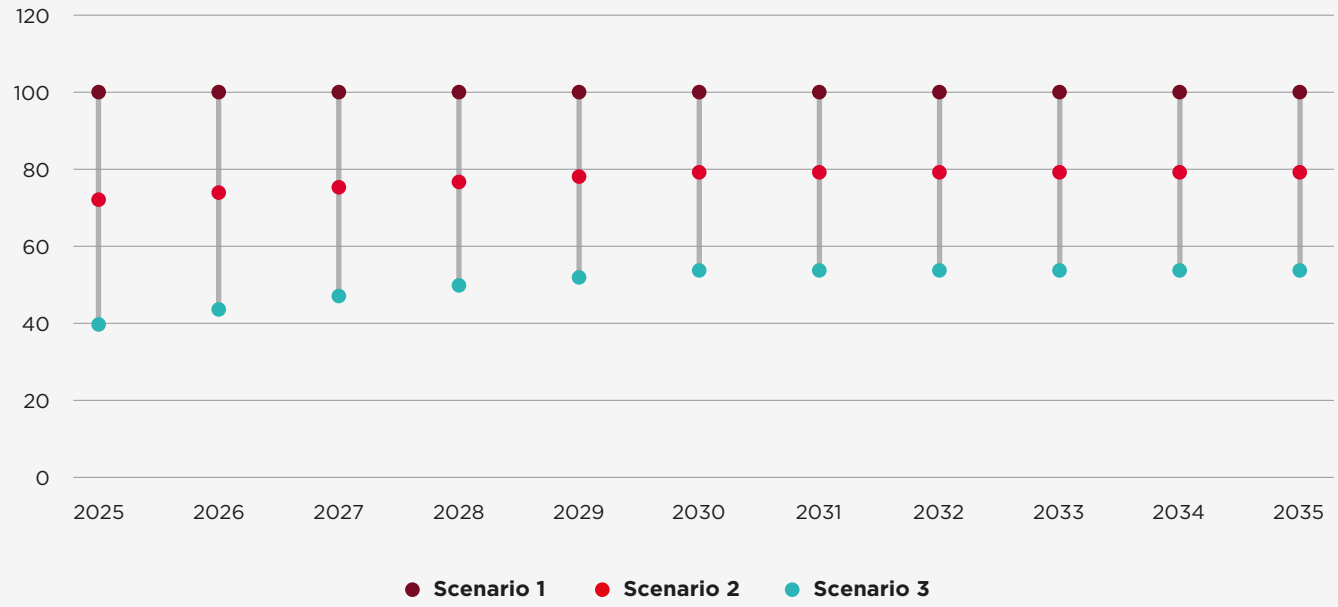


Source: GSMA Intelligence

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)

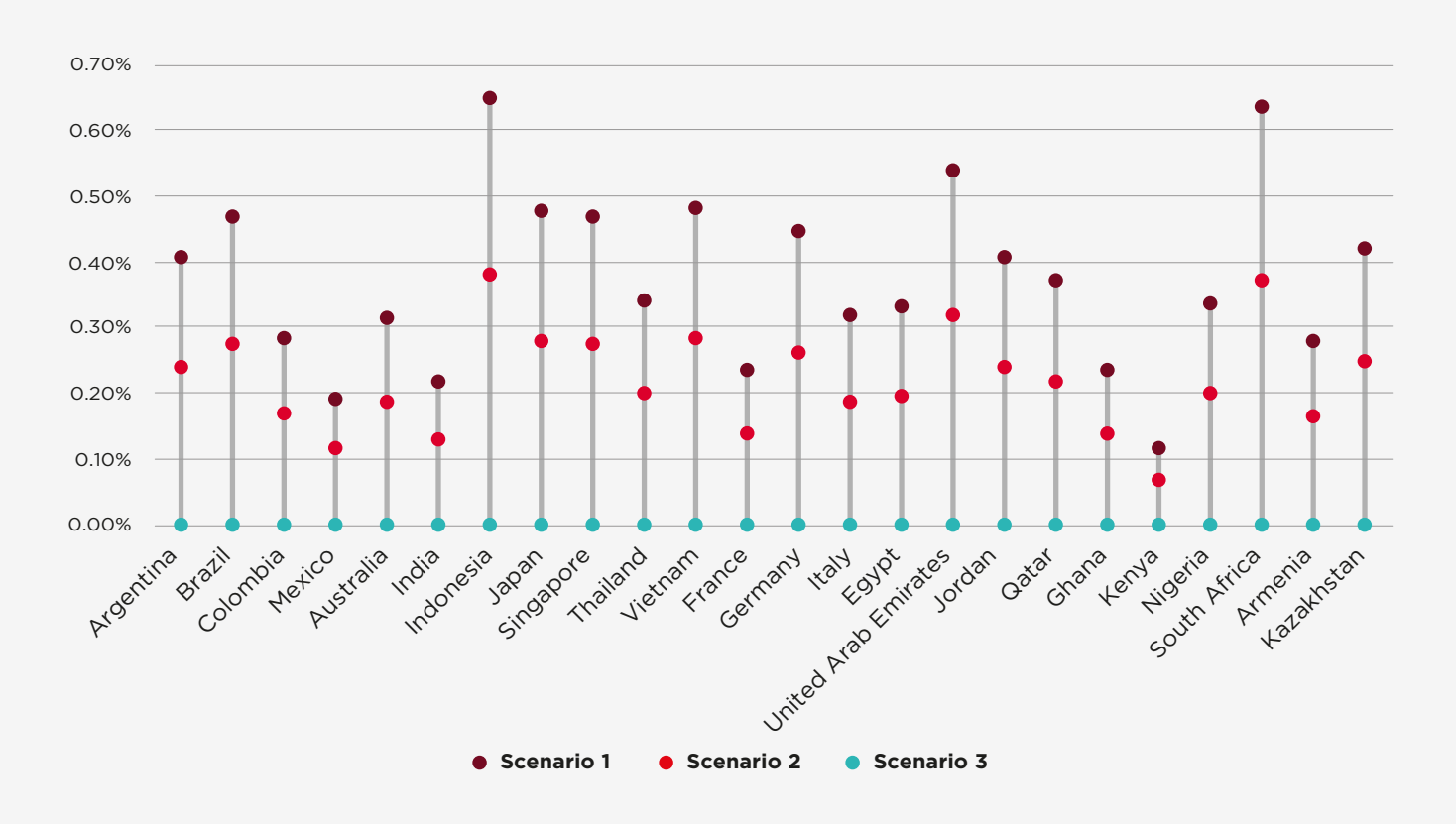


Source: GSMA Intelligence

Global picture: economic impact of 6 GHz scenarios in 24 countries

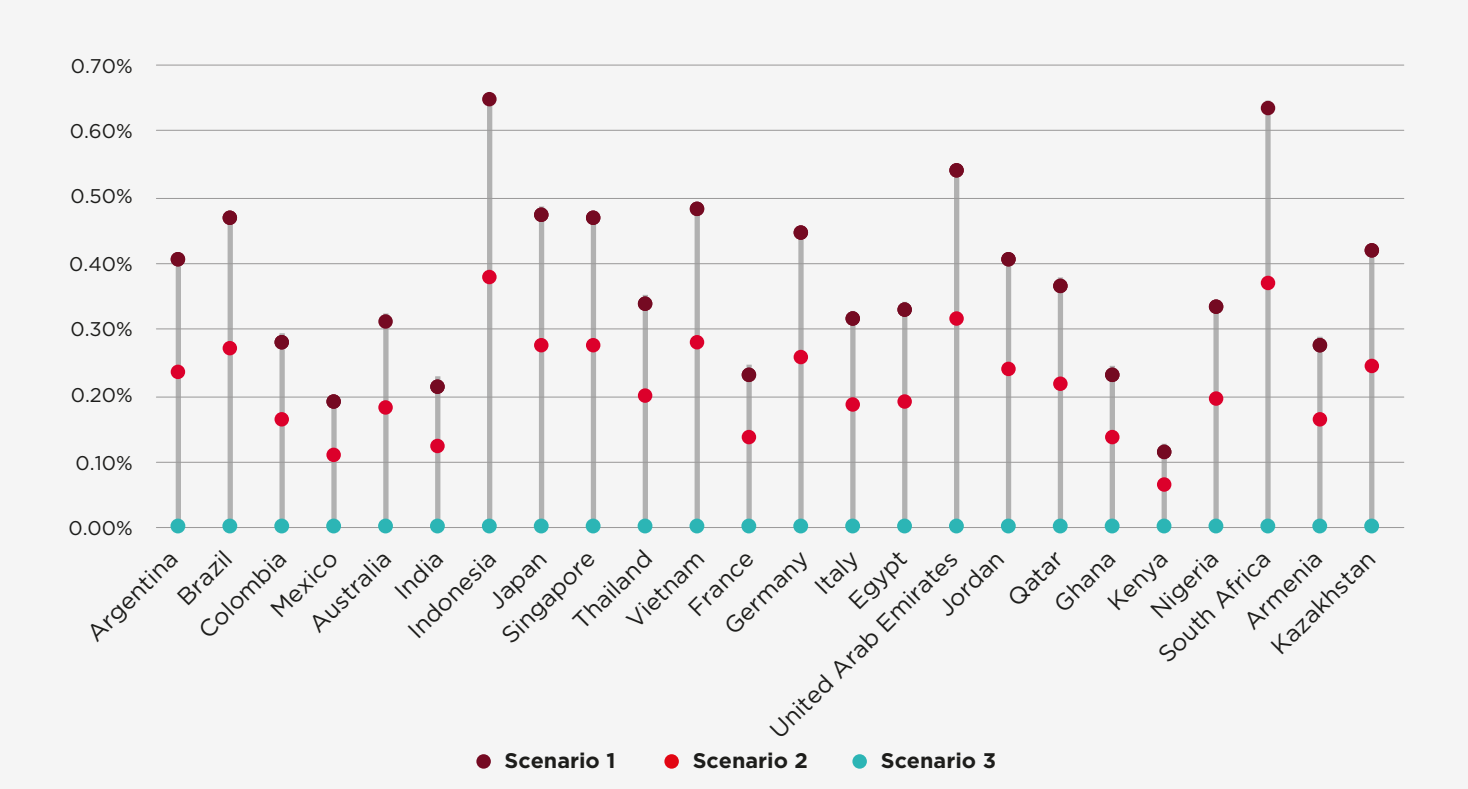
GSMA Intelligence studied a total of 24 countries in its study of the benefits of 6 GHz spectrum. India's results are typical for upper middle countries in showing lower economic benefit to any licence-exempt assignment with FTTP speeds of less than 10 Gbps. Subsequently, it is also typical of many upper-middle income countries that some benefit appears in assigning the lower band (5.925-6.425 GHz to licence exempt with FTTP of 10 Gbps and over.

Maximum available FBB speed of 1 gbps – with or without wi-fi offload to 60 GHz



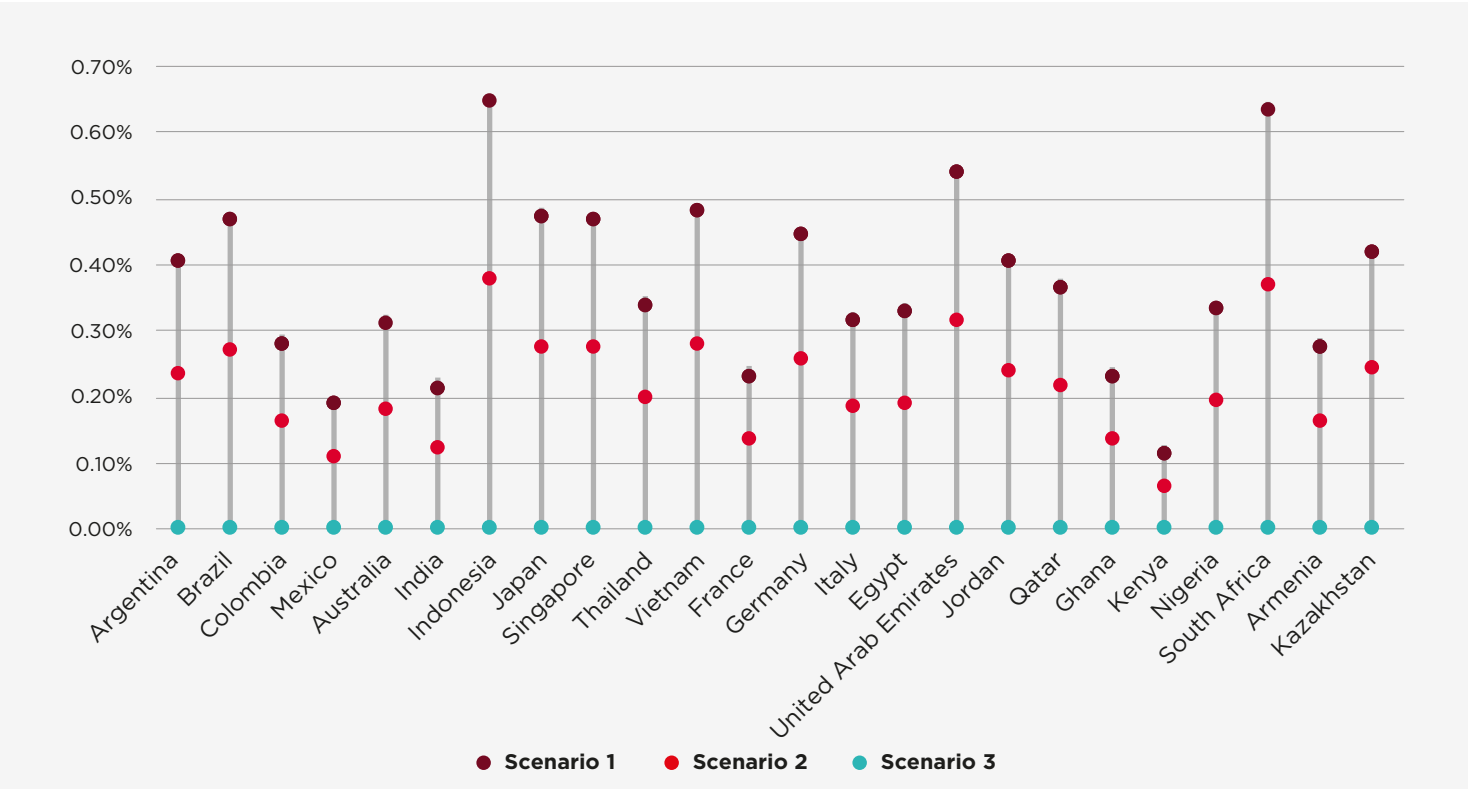
Source: GSMA Intelligence

Maximum available FBB speed of 5 gbps – up to 30% wi-fi offload to 60 GHz



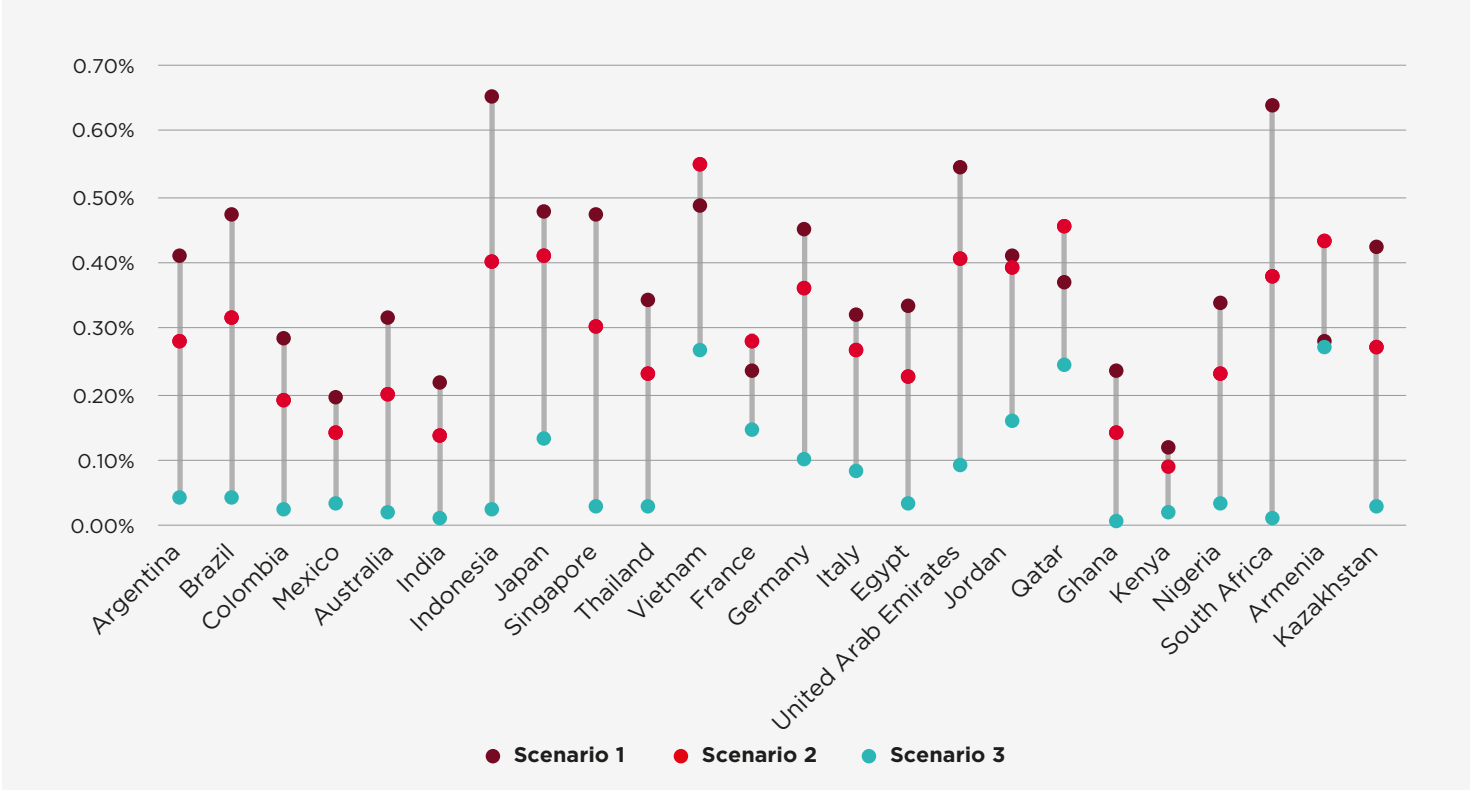
Source: GSMA Intelligence

Maximum available FBB speed of 10 gbps – up to 30% wi-fi offload to 60 GHz



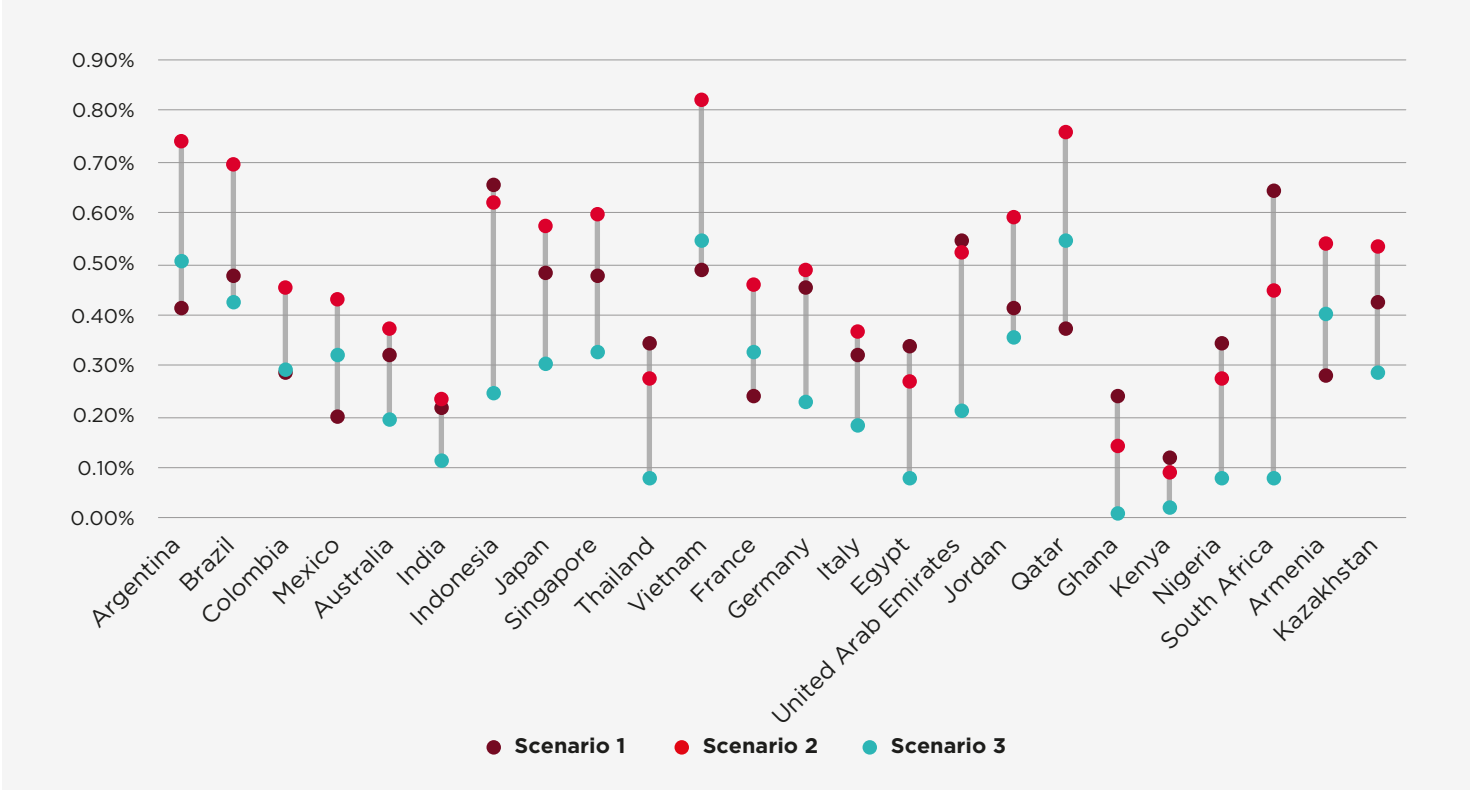
Source: GSMA Intelligence

Maximum available FBB speed of 5 gbps – no wi-fi offload to 60 GHz



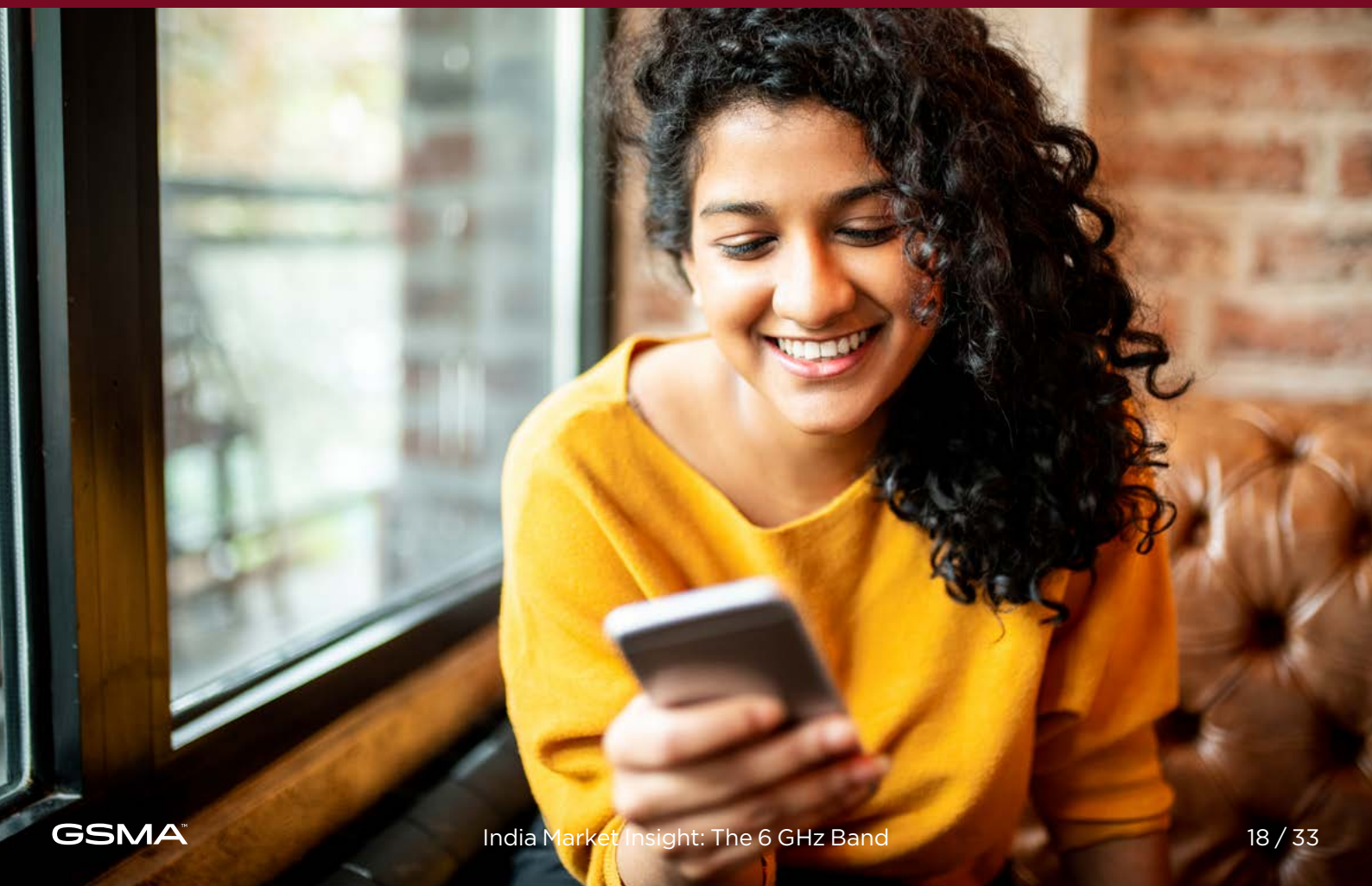
Source: GSMA Intelligence

Maximum available FBB speed of 10 gbps – no wi-fi offload to 60 GHz



Source: GSMA Intelligence

3. India market analysis



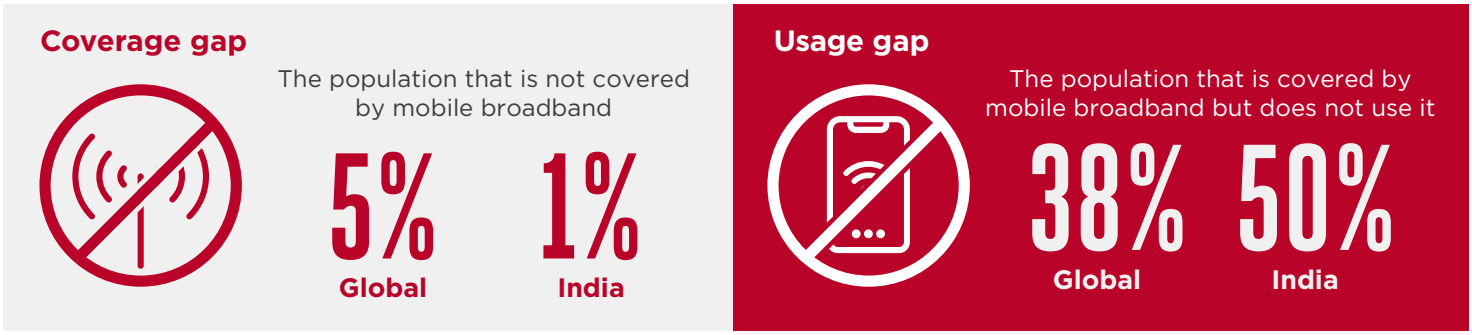
Background: usage gap

The GSMA releases data[7] 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 5% of the world's population while in India the gap is just 1%. 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 38% while in India the usage gap is 50%.



Source: GSMA Intelligence

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.

Fixed internet penetration in India

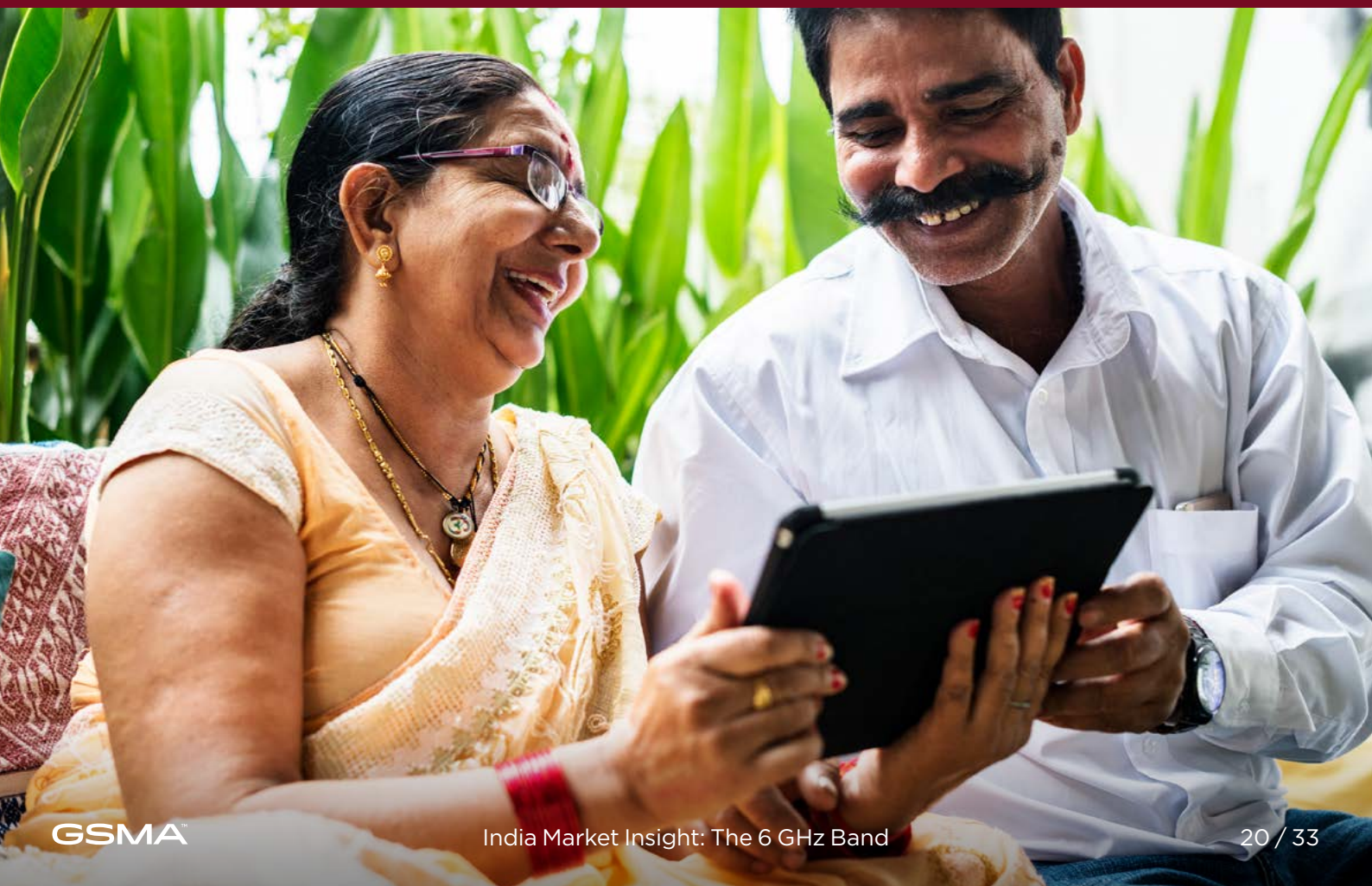
51 million households in India[8] have a fixed broadband connection, 13% of the total households in India, at the end of March 2024. It is also important to note that there has been an improvement of only 8% (increased from 4.8% to 13%) in terms of households having fibre broadband connections in the past 10 years (since 2015). By contrast, 89% of total mobile connections in India are mobile broadband connections and 4G alone represents 73% share, followed by 5G at roughly 13%.

Mobile connectivity is the primary and preferred mode of broadband access in India covering all sections of society and bridging the rural-urban divide. The faster rollout and expansion abilities of mobile technologies such as 4G/5G and constant improvement in devices affordability have helped make mobile a crucial tool for digital inclusion in India.

7 https://www.gsma.com/r/wp-content/uploads/2023/10/State-of-Mobile-Internet-Connectivity-2023-Global.pdf

8 GSMA intelligence

4. Socio-economic benefits of mid-band spectrum

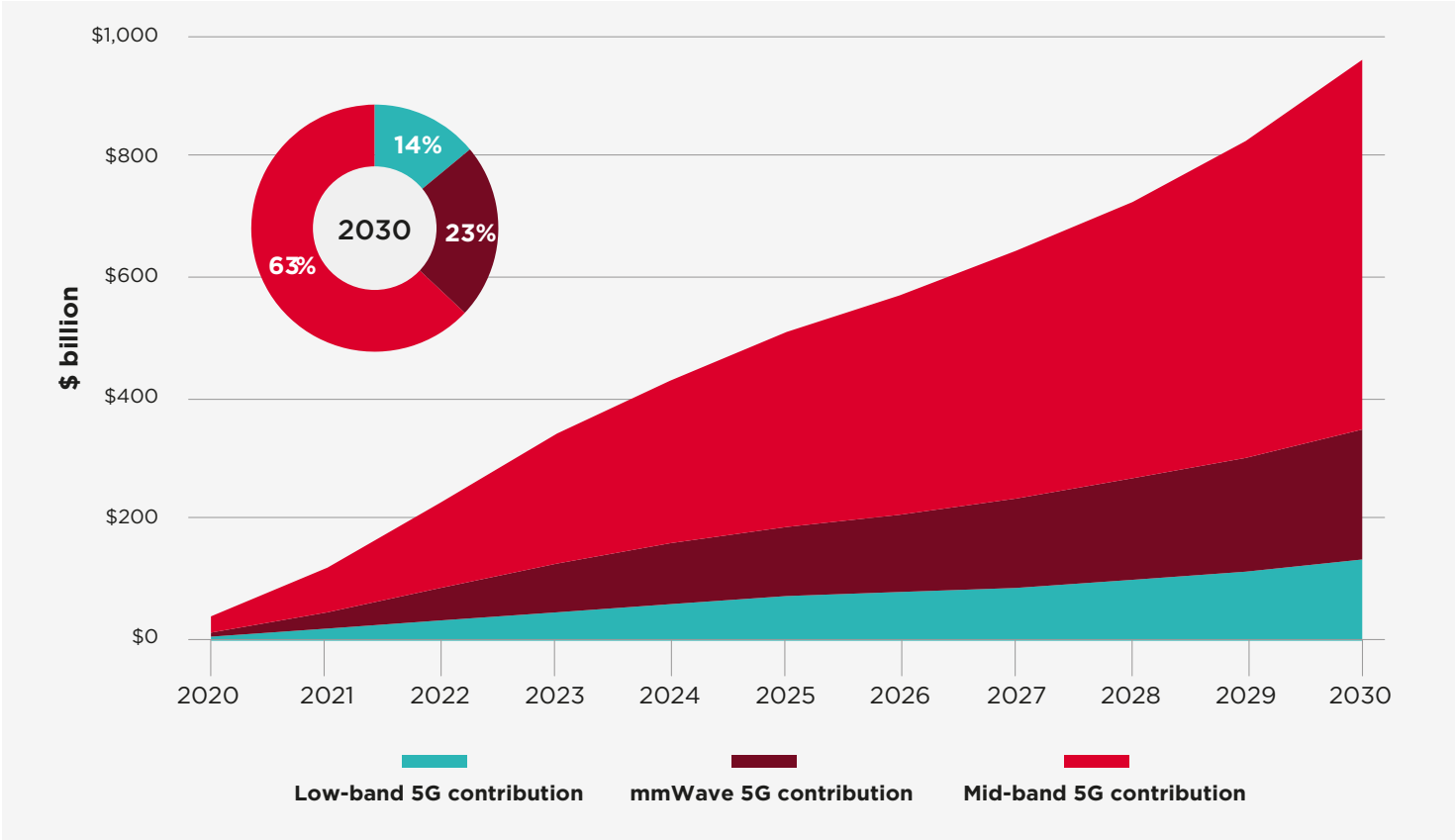


The GSMA's study on the socio-economic benefit of the mid-band spectrum[9] show the importance of this range in developing the global economy.

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.

GDP contribution by spectrum range

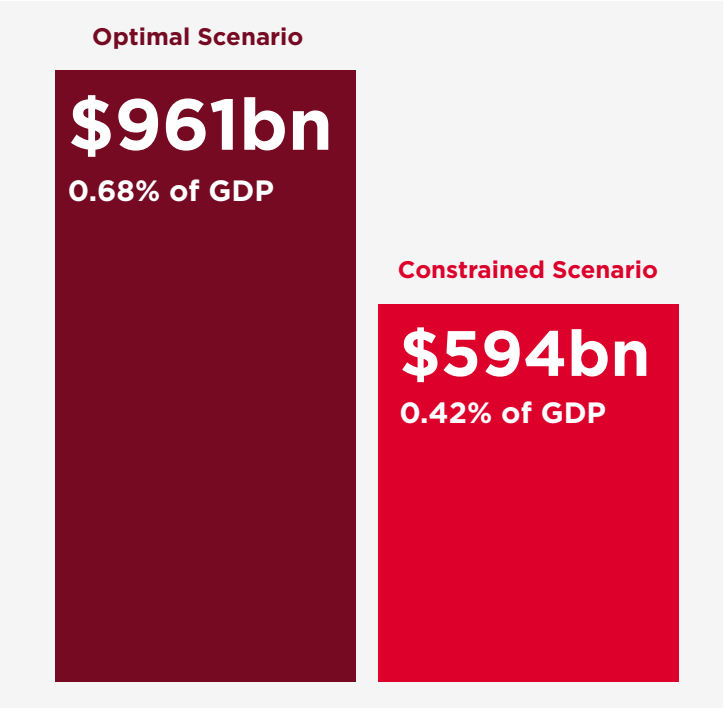


Source: GSMA Intelligence

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

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.

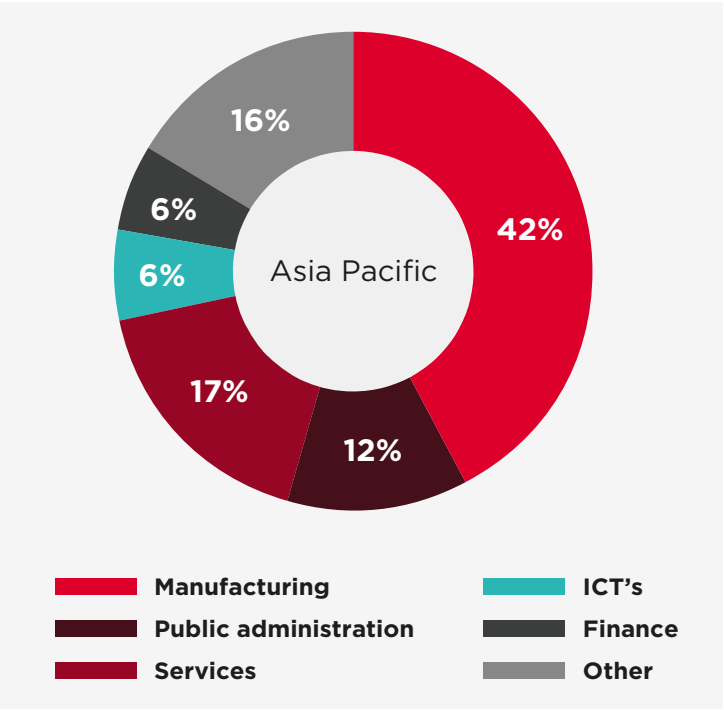


Source: GSMA Intelligence

India and Asia-Pacific data

On a regional level, unconstrained 5G is expected to impact Asia Pacific as a high percentage of GDP.

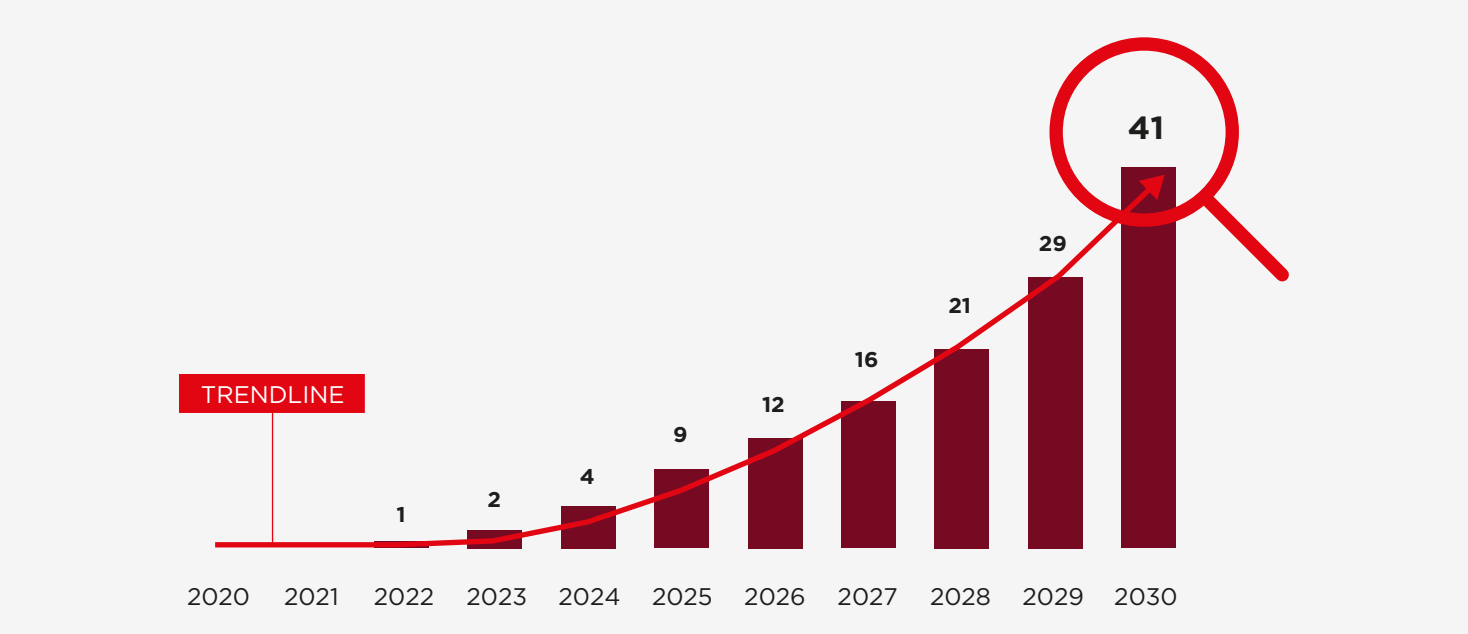
Mid-band applications will mostly be used to benefit the manufacturing, public administration and services, ICT, and retail sectors across Asia Pacific as a whole. The manufacturing sector, in particular, is expected to benefit from 5G, as the region presents a rich environment of high-tech manufacturing companies that will rapidly integrate new 5G applications into their businesses.



Source: GSMA Intelligence

Growth of socio-economic benefit of 5G 2020-2030

Meanwhile, the overall impact of unconstrained 5G will be $285 bn in APAC by 2030. In the South Asia region, this GDP contribution will be around $32 bn, of which India will be responsible for almost 84%.

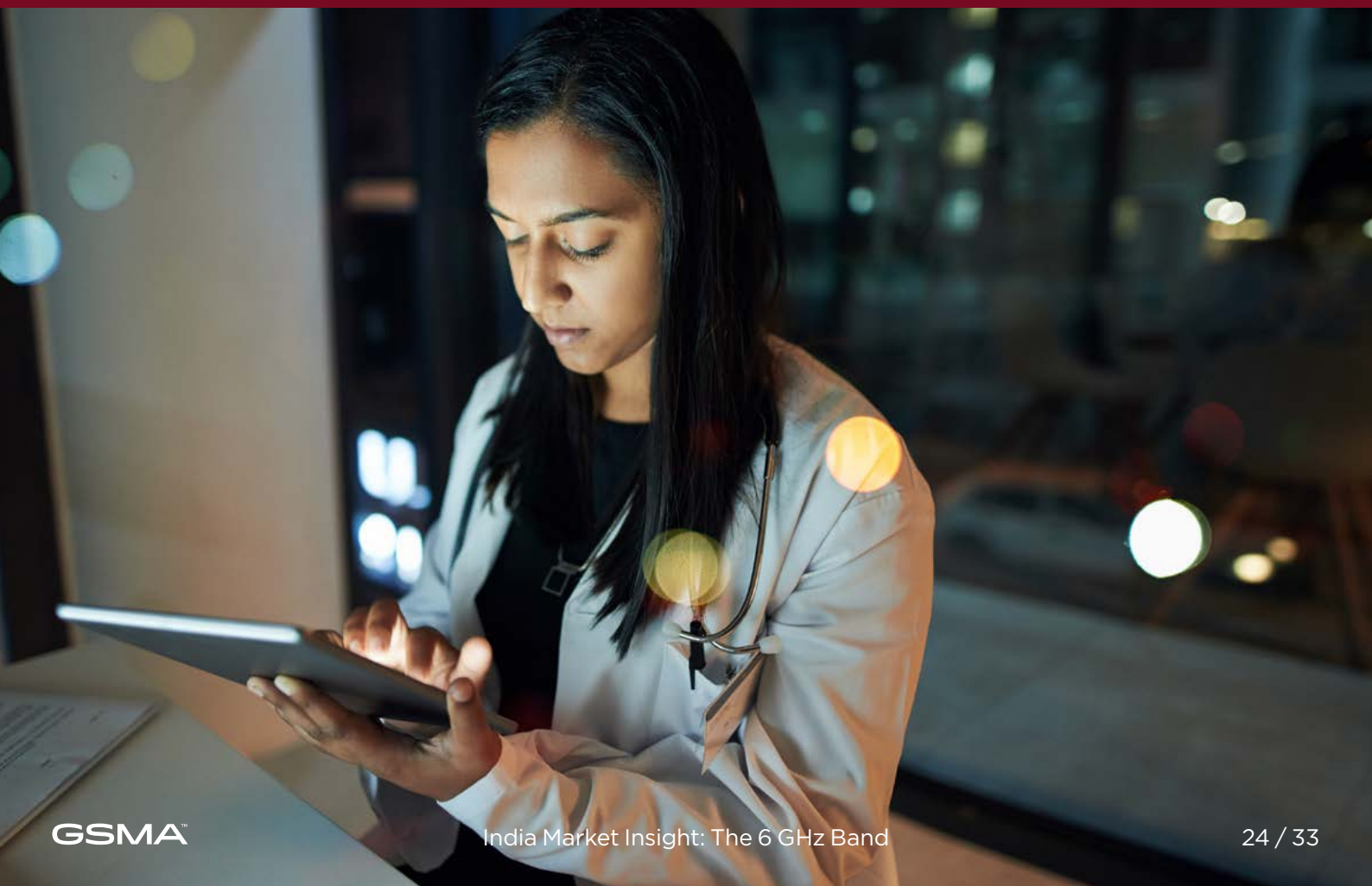


Source: GSMA Intelligence

Percentage of total sub-regional contribution

Source: GSMA Intelligence

5. Mid-band spectrum needs of 5G



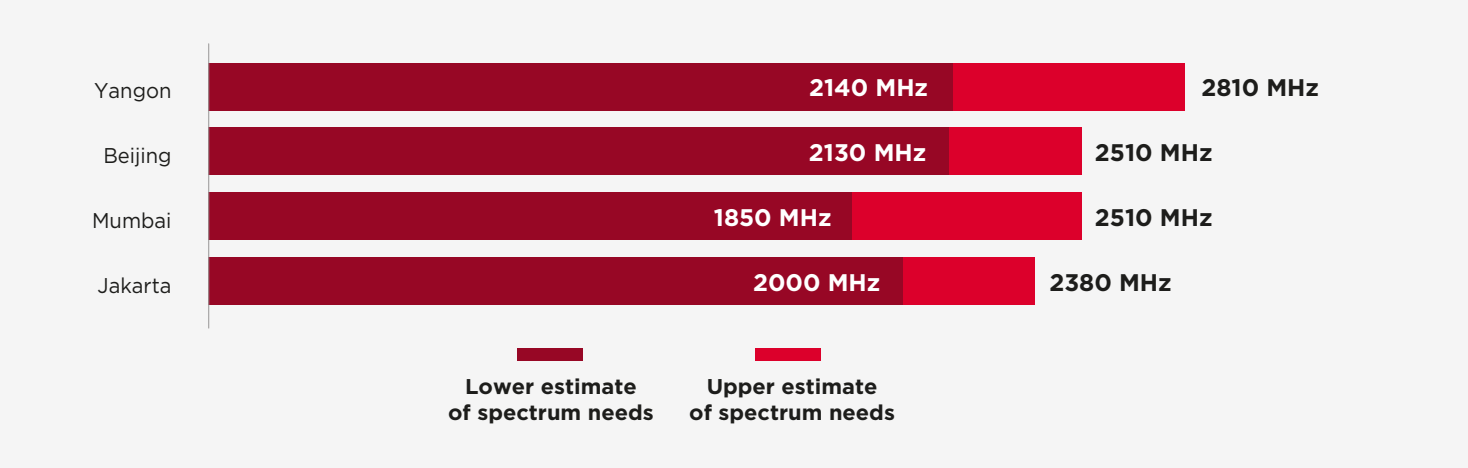
Global data

GSMA analysis[10] of the spectrum needs of 5G by 2030 presents its 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.

Mid-band needs in Asia Pacific

The global research analysed the mid-band spectrum needs for 5G in 36 large cities around the world. The sample group included four cities from Asia Pacific, one of which was Mumbai in India and shows the upper and lower limits of mid-band spectrum needs, depending on 5G usage at any given time.



Source: GSMA Intelligence

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

Environmental impact

If there is a shortfall in the amount of spectrum available, where possible, mobile operators will be required to densify their networks by deploying more small cells.

However, this imposes additional costs, which are ultimately borne by mobile operators' customers. Such a densification may not even be feasible for other reasons (e.g., interference scenario, site availability, restrictive electromagnetic field rules), while large numbers of cells will also increase the overall power consumption as well as having an aesthetical impact.

Densification alone will not solve the lack of spectrum and high levels of densification would not be physically possible in some of these cities and after a certain level of densification, interference between sites would also trigger the need for additional spectrum.

Densification, with its extra costs, also carries with it an energy impact. Below is analysis of the increased energy consumption required to power a highly-dense network in Mumbai that is required in a constrained spectrum environment.

Mumbai comparison: financial and environmental costs with an 800-1000 MHz spectrum shortfall

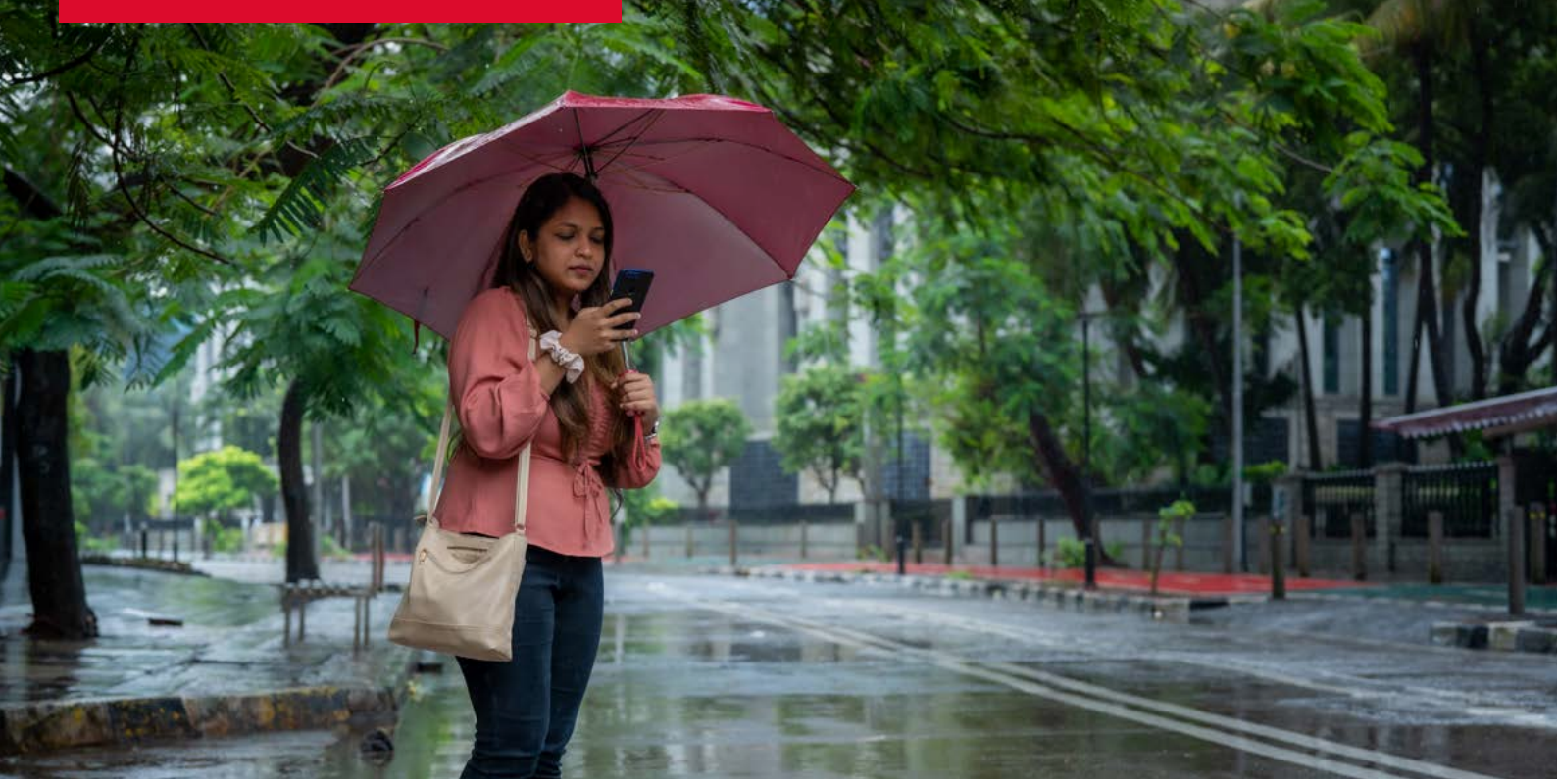
City	# of additional small cells	Cost of additional cells over 10 years	Relative increase in total network costs	Increase in network power consumption
Paris	27,505	$782m	3x	1.8x
Mumbai	195,785	$5bn	4.3x	2.9x
Mexico City	178,236	$5.8bn	4.9x	2.5x

Source: Coleago

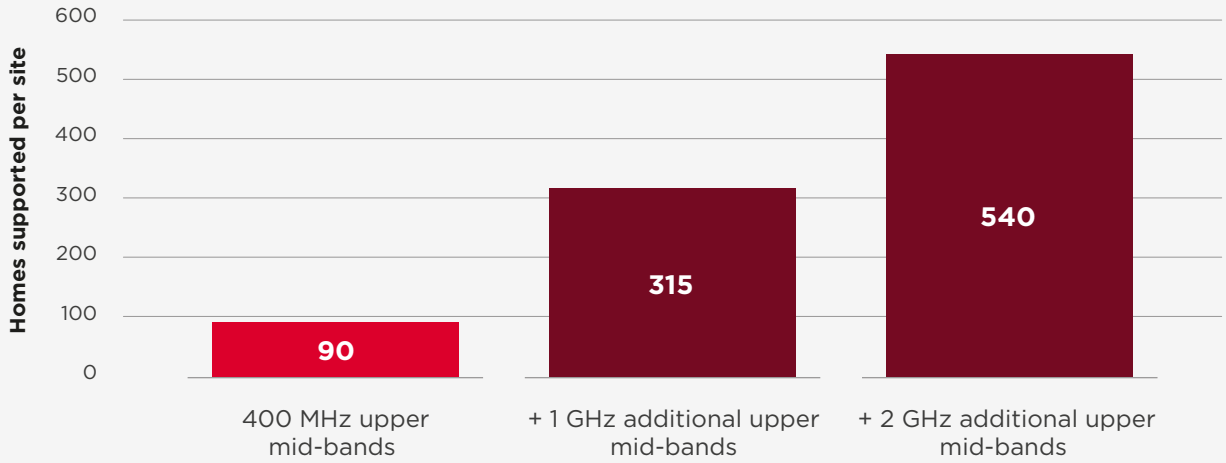
Affordable FWA in non-fibre environments

Many middle-income countries will use the capacity of 5G to provide FWA services to homes and Affordable 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.

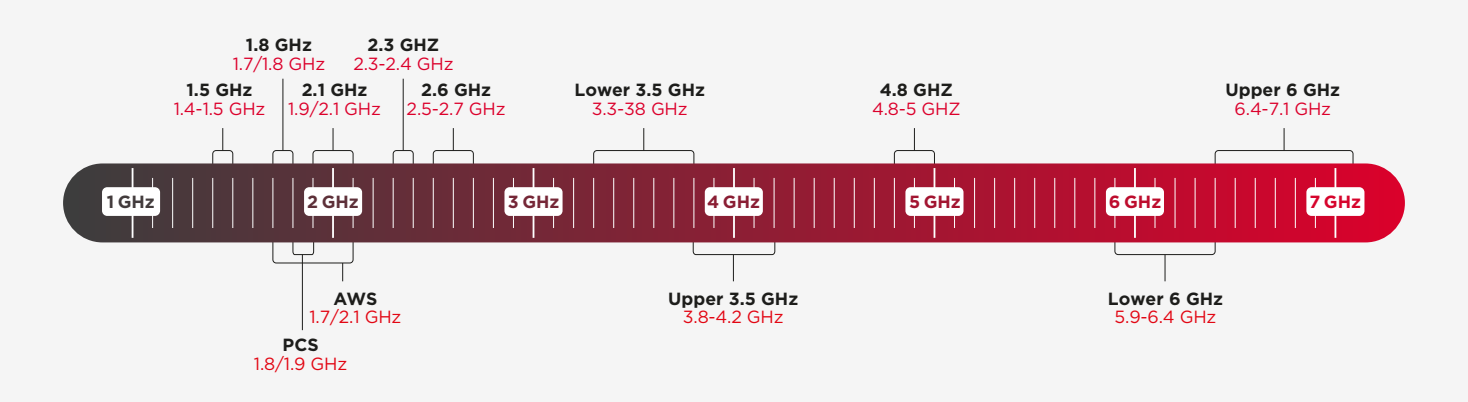


Source: Coleago

6. Mid-band spectrum in India

Mid-band mobile spectrum

Global mid-band options



India's spectrum assignment plans for mobile concluded with the successful multi-band auction in 2022 and the auction in June 2024, mainly for expiring spectrum. These processes are driving the first phase of 5G in India. However, these auctions mark the end of significant mid-band capacity in the India spectrum roadmap for future mobile spectrum before 2030.

India is among the fastest growing 5G markets globally, growth which relied on the timely and strategic actions by the Indian government on various policy fronts, including making available required spectrum in various frequency ranges for 5G rollout. As the demand for 5G grows, there will be need for more spectrum to maintain the desired quality of services and performance without intense network densification.

Mid-band spectrum holdings in India are currently around 700 MHz on average, lower than many advanced 5G markets which have already assigned 1 GHz or more in mid-band range before bringing 6 GHz into play. GSMA statistics show that the next phase of 5G development will be led by APAC, especially India where 5G connections are estimated to grow by 6x and comprise of almost 48% of total mobile connections by 2030. The 6 GHz band is essential to bridge the gap with the leading 5G markets and support the rapid 5G growth in India.

Current mid-band IMT assignments (average) in India

Band	Capacity (MHz)
1.8 GHz	130
2.1 GHz	80
2.3 GHz	80
2.6 GHz	40
3.5 GHz	370
Total	**700**

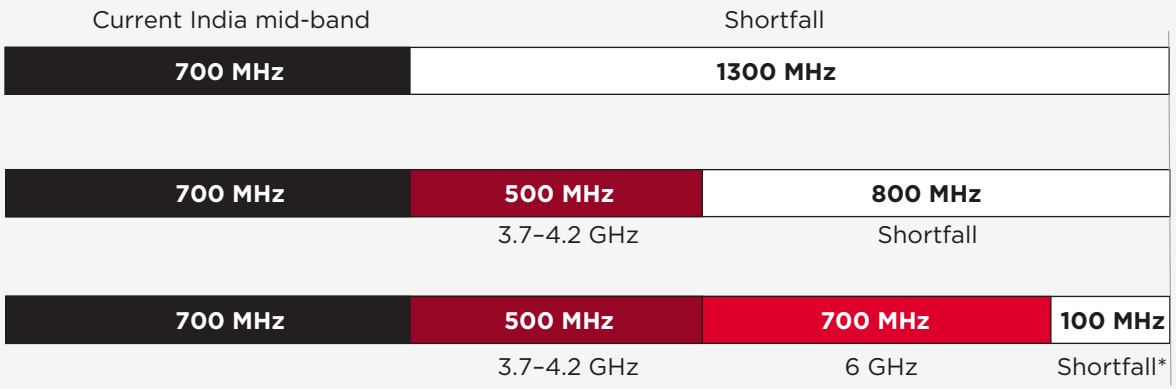
Source: Department of Telecommunications (DoT), India

Countries will require an average of 2 GHz of spectrum in the 2025-2030 timeframe. However, in the densest urban areas such as Delhi, Mumbai and various other cities, more spectrum will be required. This leaves a significant shortfall between average spectrum which is currently assigned and planned for assignment and the amount that will be needed in India in mid-band range.

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 the efforts of the Government to refarm/make available upper 3.5 GHz band from its existing incumbent use, it is impossible to reach 2 GHz without the availability of 6 GHz band.

The below chart serves to illustrate the importance of 6 GHz band in addressing the shortfall of spectrum to meet 2 GHz demand by 2030. Even with the whole of 3.7-4.2 GHz assigned to mobile, there is still a significant shortfall without 6 GHz. If the 700 MHz of upper 6 GHz is brought into play, only 100 MHz of shortfall remains.



* The GSMA recommends consideration of the smaller 1.5 GHz and 4.8 GHz bands to supply additional capacity requirements beyond 6 GHz.

Source: GSMA research

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