GSMA

Socio-Economic Benefits of 5G
The importance of low-band spectrum

March 2023

GSMA

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Executive summary

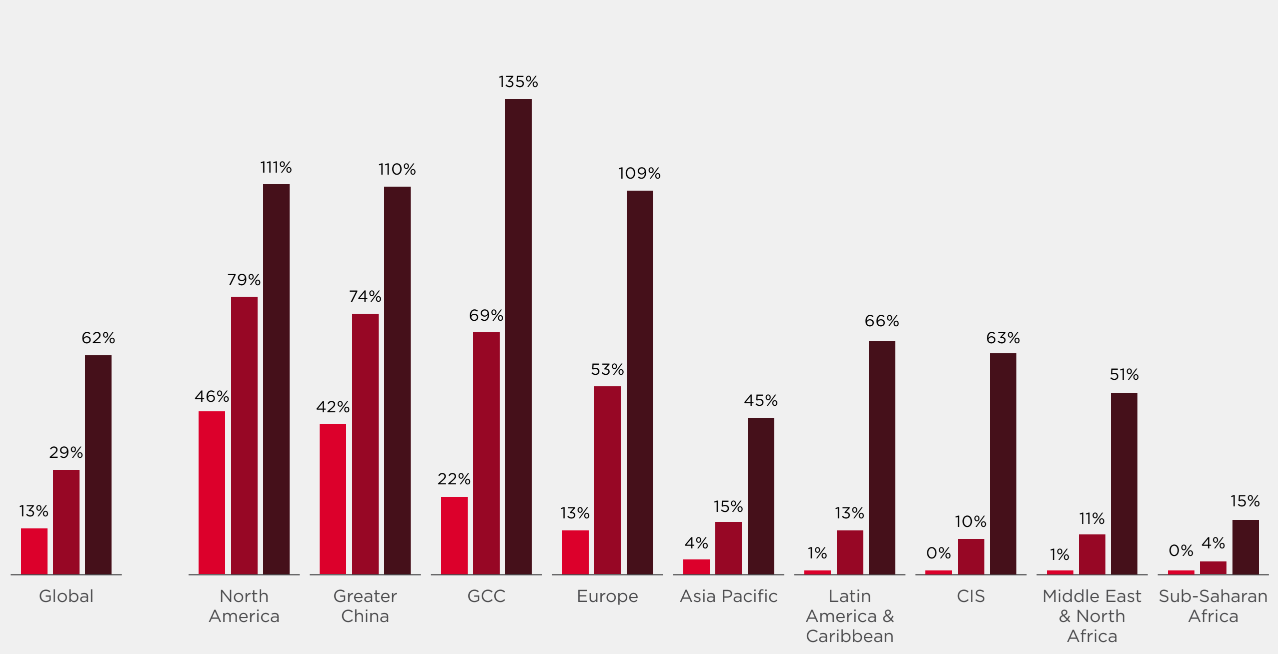
The digital divide widens without sufficient low-band spectrum

Low-band spectrum is a driver of digital equality, reducing the gap between urban and rural areas and delivering affordable connectivity. Without sufficient low-band spectrum, the digital divide is likely to widen, and those living in rural areas will be excluded from the latest digital technologies.

At the end of 2022, there were already 252 commercial 5G networks in 86 countries around the world, serving more than 1 billion 5G connections. By 2030, more than 5 billion 5G connections are forecast worldwide, driving almost $1 trillion in GDP growth. While 5G is forecast to reach maturity by 2030 in North America, Europe, China and the GCC countries, it will continue to grow in many low- and middle-income countries (LMICs) well into the 2030s.

Figure 1

5G market penetration by region, 2022–2030



Note: 5G penetration is calculated as the number of 5G connections as a percentage of total population. Connections differ from subscribers in that a unique subscriber can have multiple connections. Penetration can therefore be greater than 100%.

Source: GSMA Intelligence

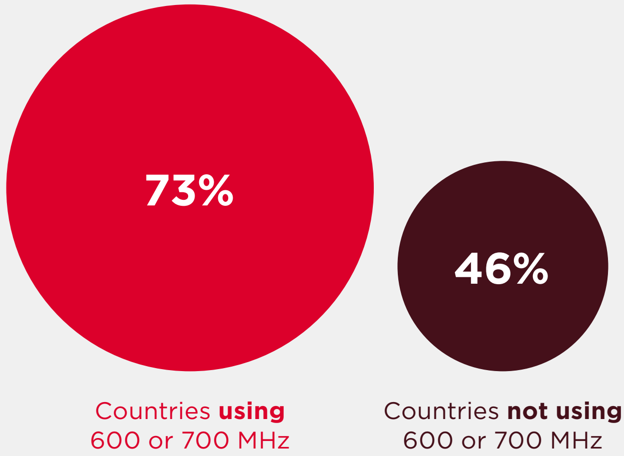
Low bands play an important role in achieving the social goals of widespread connectivity by serving two key requirements:

- Their superior propagation characteristics make them particularly suitable for providing coverage in rural and remote areas, which is important in low- and middle-income countries that have large rural populations.
- They have superior in-building penetration, providing 'deep' indoor coverage as well as capacity in urban areas.

In most countries, the main low bands currently used for 5G are in the 600 MHz and 700 MHz frequencies, while 800 and 900 MHz are used for previous generations. At the end of 2022, operators in almost half the countries where 5G had been launched were utilising the 600 or 700 MHz bands for 5G. Those countries have achieved significantly higher levels of coverage, as well as better 5G availability and indoor quality of service, than those not using 600/700 MHz.

Figure 2

Average 5G network population coverage (Q4 2022)



Source: GSMA Intelligence

Low-band 5G is set to generate $130 billion in GDP in 2030

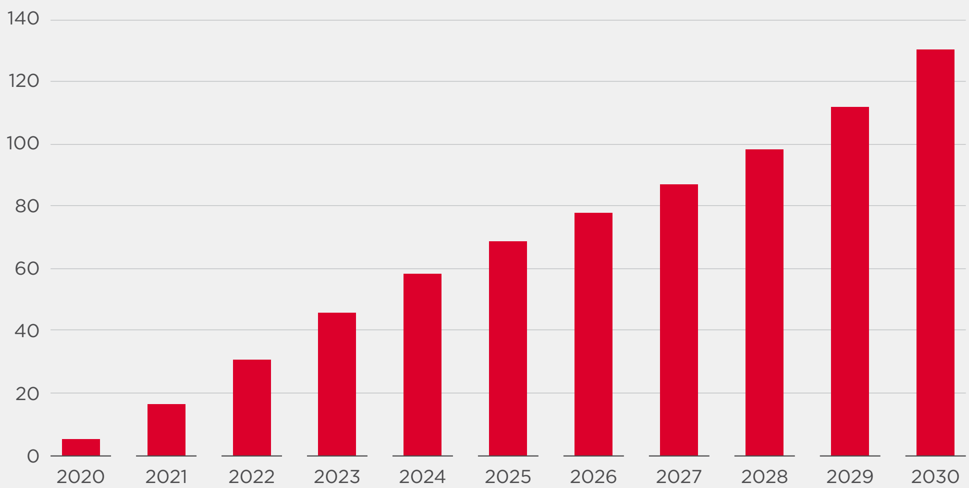
Low-band 5G is expected to drive around $130 billion in economic value in 2030. Half of the impact will come from massive IoT (mIoT). Many existing and future IoT use cases require wide area coverage, in addition to population coverage, which low-band spectrum is best suited to provide. MIoT applications are set to play an important role in digital transformation across a range of economic sectors, including manufacturing, transport, smart cities and agriculture.

The rest of the economic impact will be driven by enhanced mobile broadband (eMBB) and fixed wireless access (FWA), as low bands will play a critical role in delivering high-speed broadband connectivity in areas underserved by fixed networks.

Figure 3

Estimated global impact of low-band 5G on GDP

$ billion

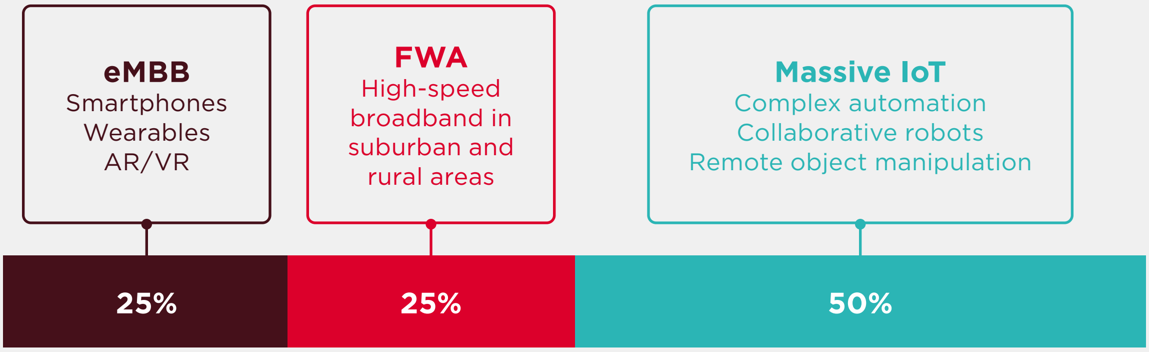


Source: GSMA Intelligence

Figure 4

Distribution of 5G low-band benefits by use case

Percentage of total GDP impact in 2030

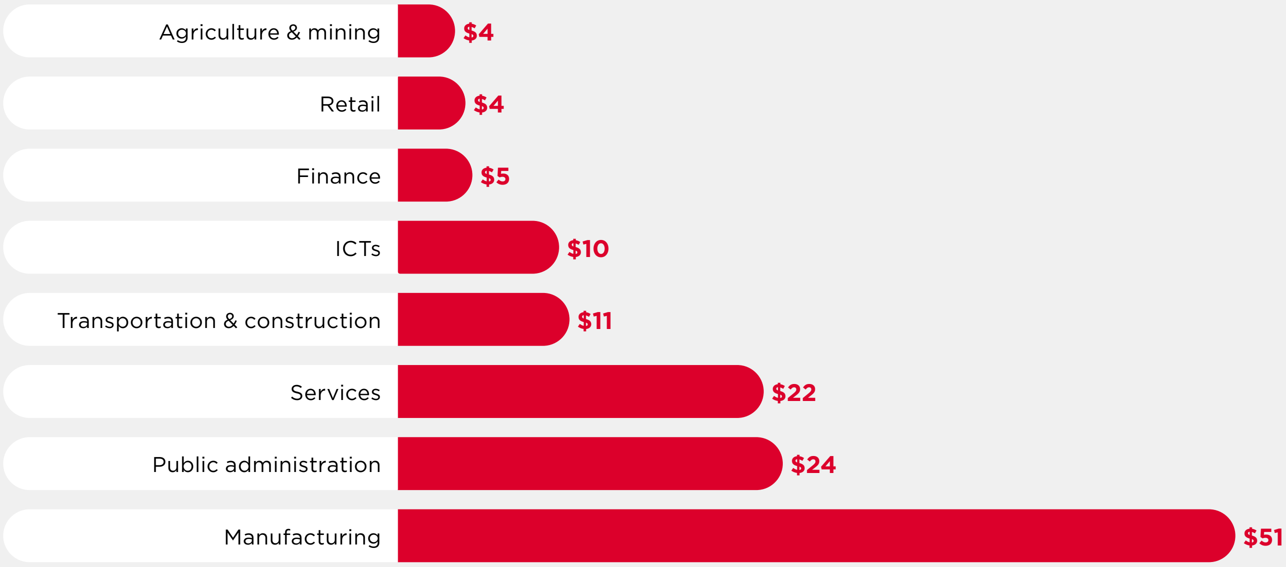


Source: GSMA Intelligence

Figure 5

Estimated global contribution of low-band 5G spectrum to GDP, by sector, 2030

$ billion



Source: GSMA Intelligence

In addition to the macroeconomic impacts, low-band 5G applications will enhance the social and environmental benefits driven by mobile technology. This includes poverty reduction; improved well-being; access to health, education and financial services; and enabling reductions in greenhouse gas emissions. This is especially important for rural populations most impacted by these challenges but who, in low- and middle-income countries, are 33% less likely to access mobile internet and who experience lower network performance than urban residents. Without adequate amounts of low-band spectrum, increasing capacity to deliver 5G-based use cases will be unaffordable in many rural areas.

Regional impacts: GDP contribution generated by low-band 5G, 2030

North America

GDP contribution
$26bn

Percentage of GDP
0.07%

Latin America and the Caribbean

GDP contribution
$9bn

Percentage of GDP
0.11%

Asia Pacific

GDP contribution
$62bn

Percentage of GDP
0.11%

Europe

GDP contribution
$26bn

Percentage of GDP
0.08%

RCC*

GDP contribution
$3bn

Percentage of GDP
0.11%

Middle East and North Africa

GDP contribution
$4bn

Percentage of GDP
0.08%

Sub-Saharan Africa

GDP contribution
$3bn

Percentage of GDP
0.08%

Source: GSMA Intelligence
*Regional Commonwealth in the Field of Communications, which includes 11 countries from the former Soviet Union.

Use of more UHF spectrum for mobile will provide greater value than maintaining it for broadcasting

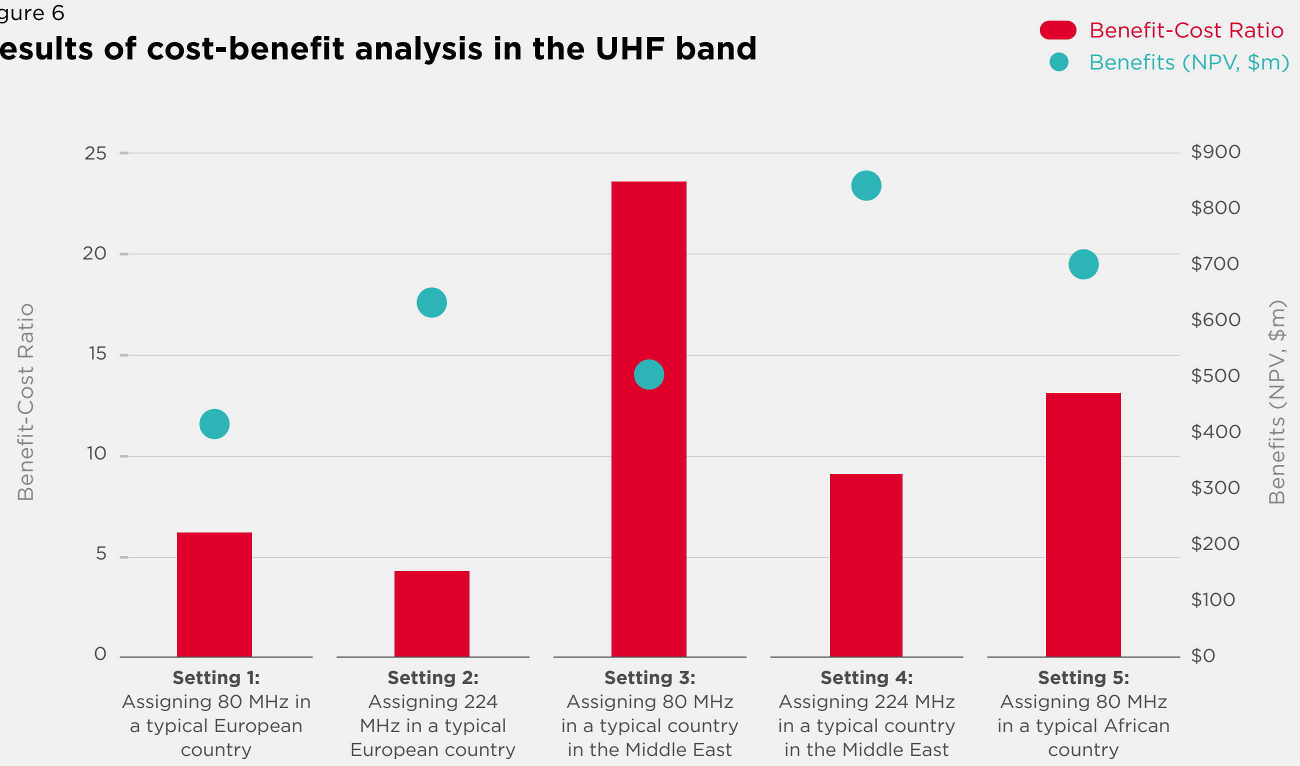
In many countries, ensuring that operators have sufficient access to low-band spectrum is likely to require additional frequencies below the 700 MHz band – frequencies currently used for broadcasting. This study presents the results of a cost-benefit analysis of assigning parts of the UHF band in ITU Region 1 (470–694 MHz) for mobile use.

For a typical country in Europe, the Middle East and Africa, the benefits from assigning 80 MHz of UHF spectrum to mobile would be 6–24× greater than the costs incurred by the broadcasting sector to maintain the existing number of digital terrestrial television (DTT) programmes. In a scenario where the full 470–694 MHz band is assigned to mobile, the benefits are 4–9× greater for a typical country in Europe and the Middle East.

This reflects the growing demand for 5G bandwidth and the general decline in DTT, driven in significant part by the rise of IPTV and on-demand viewing. The results therefore show that the utilisation of more UHF spectrum for mobile use will provide greater value to society than maintaining it for broadcasting. They also highlight the importance of avoiding a uniform approach to low-band spectrum. National governments should pursue the policies that generate the most economic and social value for their citizens.

Figure 6

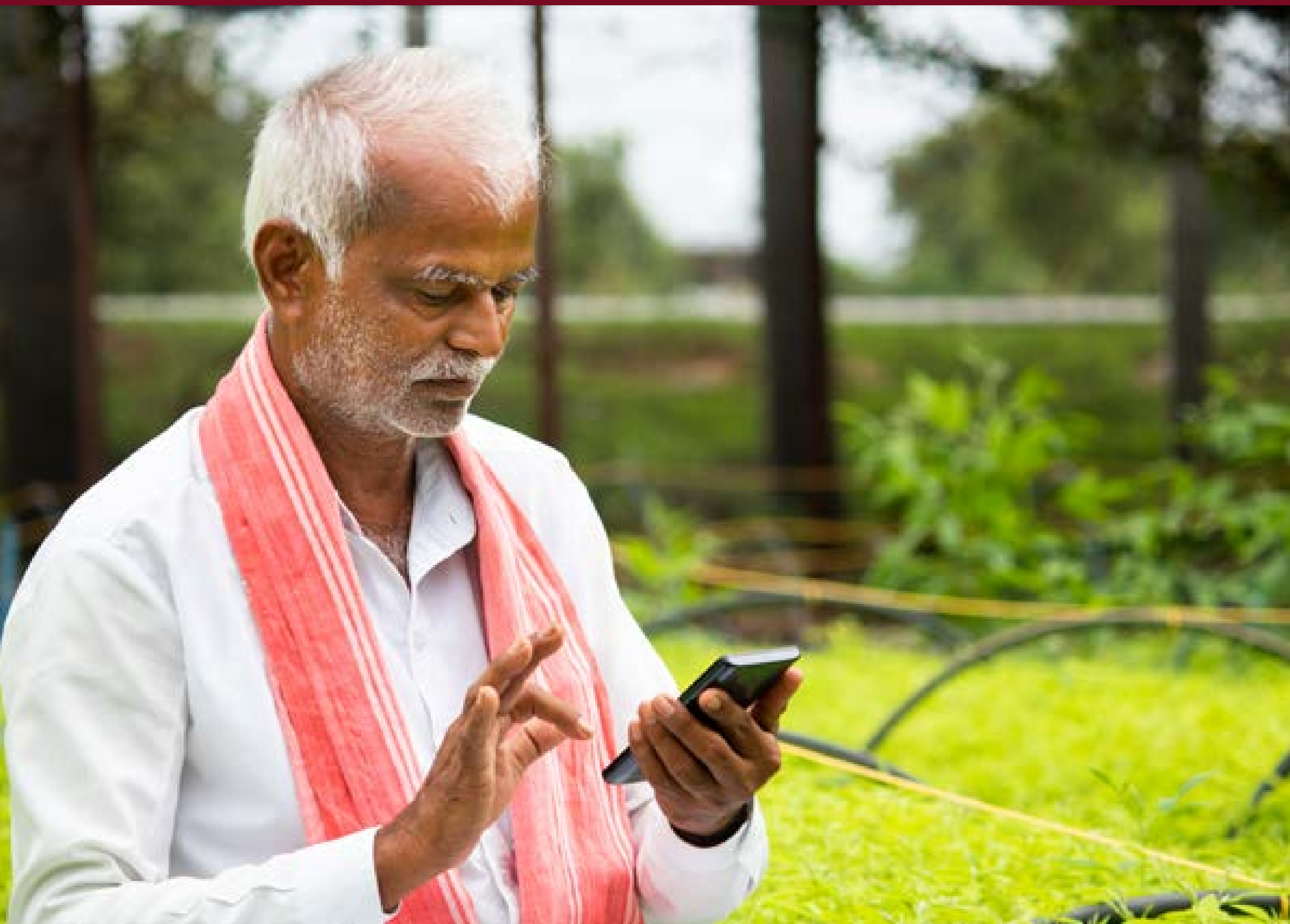
Results of cost-benefit analysis in the UHF band



Source: GSMA Intelligence

An appendix containing all details of the modelling used in this report can be found at: **www.gsma.com/spectrum**

01 The role of low-band spectrum in deploying 5G networks



Low-band spectrum will be a key enabler of digital equality

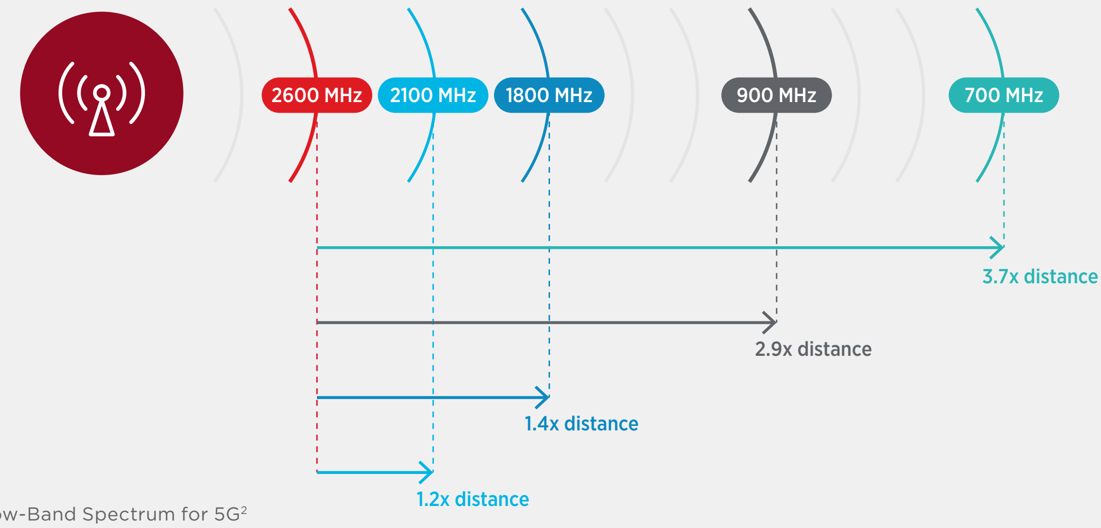
Low-band spectrum serves two key requirements for 5G deployments:

— Its superior propagation characteristics make it particularly suitable for providing coverage in rural and remote areas (see Figure 7). This is especially important in low- and middle-income countries that have large populations living in rural and sparsely populated areas, as network deployments here are much less economically sustainable. Without sufficient low-band spectrum, rural citizens can be excluded from the latest digital technologies.

— It is better able to penetrate buildings and serve built-up areas, providing 'deep' indoor coverage as well as capacity in urban areas, including locations where people live and work. Depending on the location and residence type, indoor traffic can account for 30–70% of total mobile traffic.[1] Low bands therefore often account for a greater proportion of traffic than they do capacity (see Figure 8). Assigning sufficient low-band spectrum is critical to addressing long-term demand for 5G in urban as well as rural areas.

Figure 7

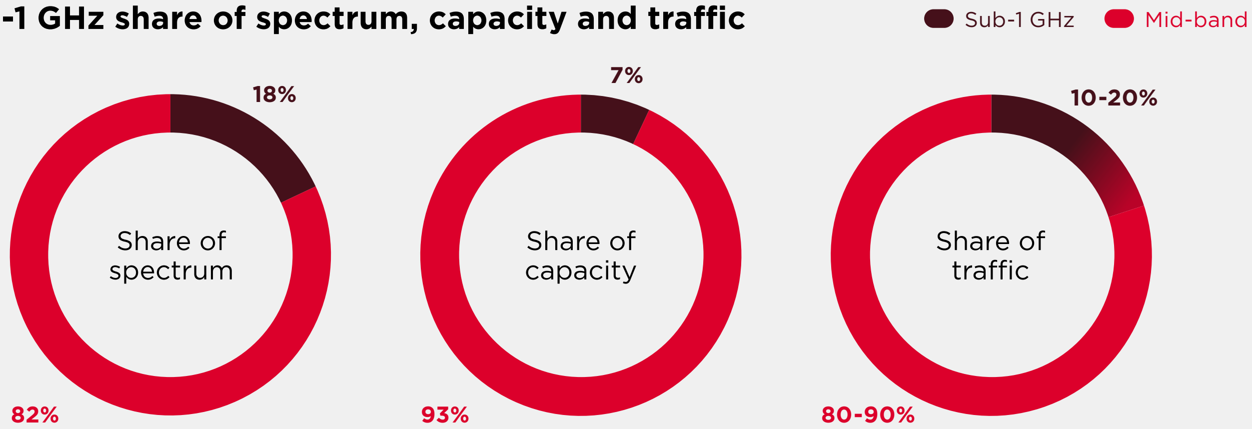
Coverage comparison by band



Source: Low-Band Spectrum for 5G[2]

Figure 8

Sub-1 GHz share of spectrum, capacity and traffic



Source: Low-Band Spectrum for 5G[3]

1 See Planning in-building coverage for 5G: from rules of thumb to statistics and AI, Ericsson, 2021; Better Indoor Coverage, Better 5G Networks, Huawei
2 Low-Band Spectrum for 5G, Coleago, 2022
3 Low-Band Spectrum for 5G, Coleago, 2022

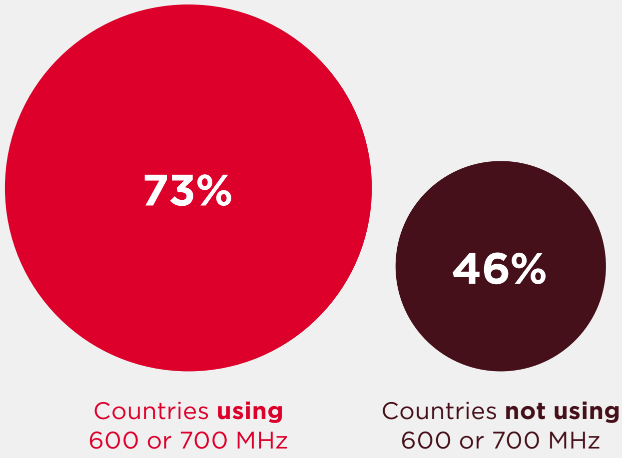
Countries utilising the 600 and/or 700 MHz band for 5G have achieved faster rollout

The 700 MHz frequency band has been the most commonly used low band for 5G – with the exception of North America, where the 600 MHz band is used. Other bands, such as 800, 850 and 900 MHz, are expected to be refarmed for 5G, but in most countries these are still being used for 2G, 3G and/or 4G.[4]

As shown in Figure 9, at the end of 2022, either 600 or 700 MHz was being used for 5G by mobile operators in almost half the countries where 5G has been launched. Figure 10 highlights the importance of assigning these low bands for 5G use. Countries that have deployed 5G using the 600 or 700 MHz bands have achieved significantly higher levels of population coverage than those that have not.

Figure 10

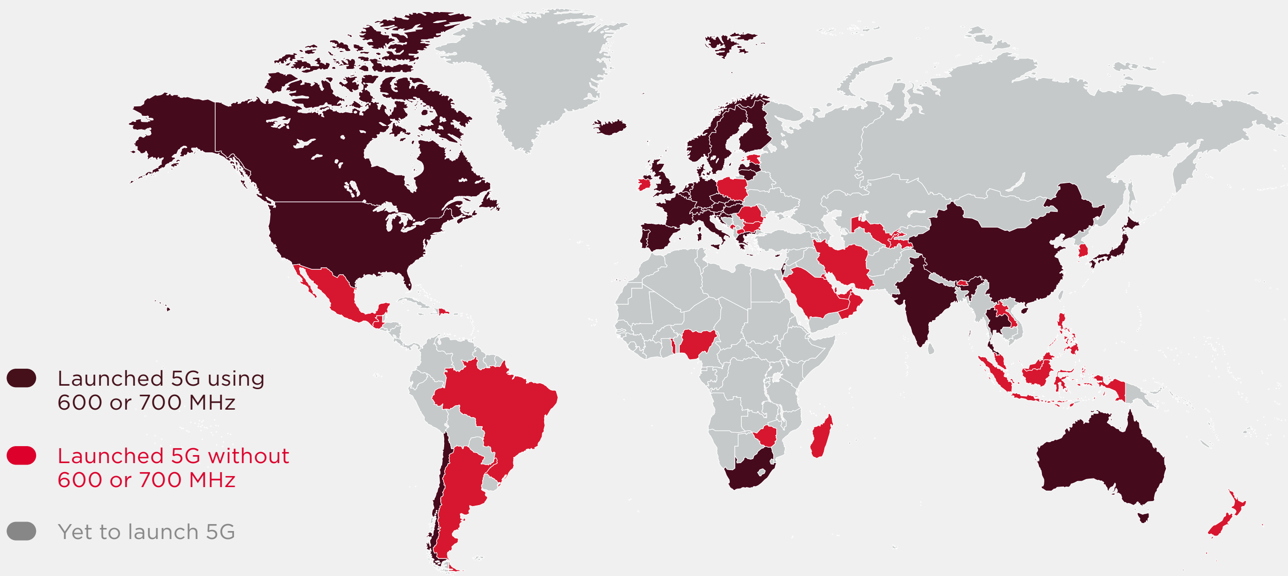
Average 5G network population coverage (Q4 2022)



Source: GSMA Intelligence

Figure 9

Countries with 5G networks that utilise the 600 or 700 MHz bands (Q4 2022)



Note; analysis is based on at least one operator actively utilising 600 or 700 MHz frequencies to deliver 5G (whether or not it has been identified or assigned for IMT).

Source: GSMA Intelligence

4 For further discussion of the specific bands available by region, see Low-band spectrum for 5G, Coleago, 2022

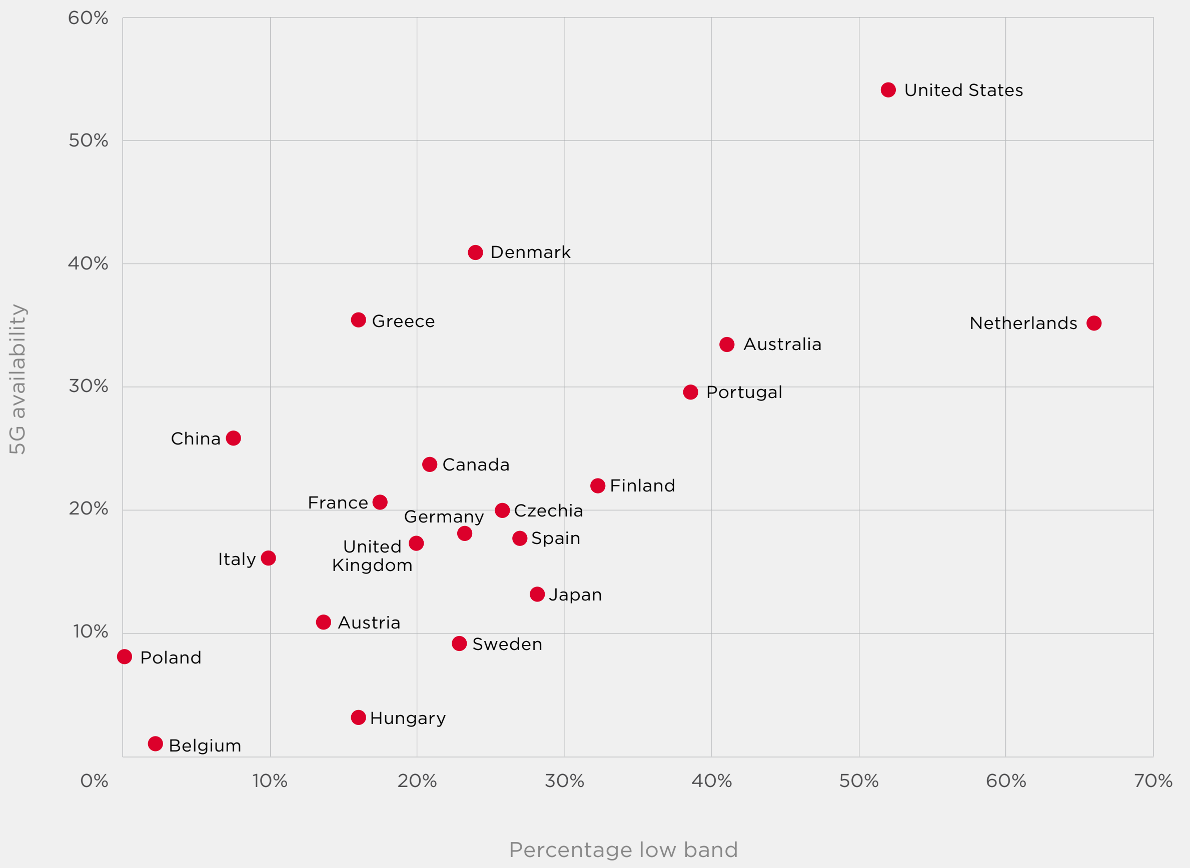
Low bands enable consumers to benefit from a better 5G experience

The importance of low-band spectrum for 5G availability is illustrated in Figure 11, which shows that the countries where consumers are more likely to access a 5G signal are also those where they are more likely to connect using low-band frequencies.

The analysis highlights in particular the strong performance of the US in terms of 5G availability. Consumers in the US that have a 5G-capable device are more likely to spend most of their time on a 5G network than those in any other country. One reason for this is that operators can use the 600 MHz band.

Figure 11

5G availability and the use of low-band spectrum, Q3 2022



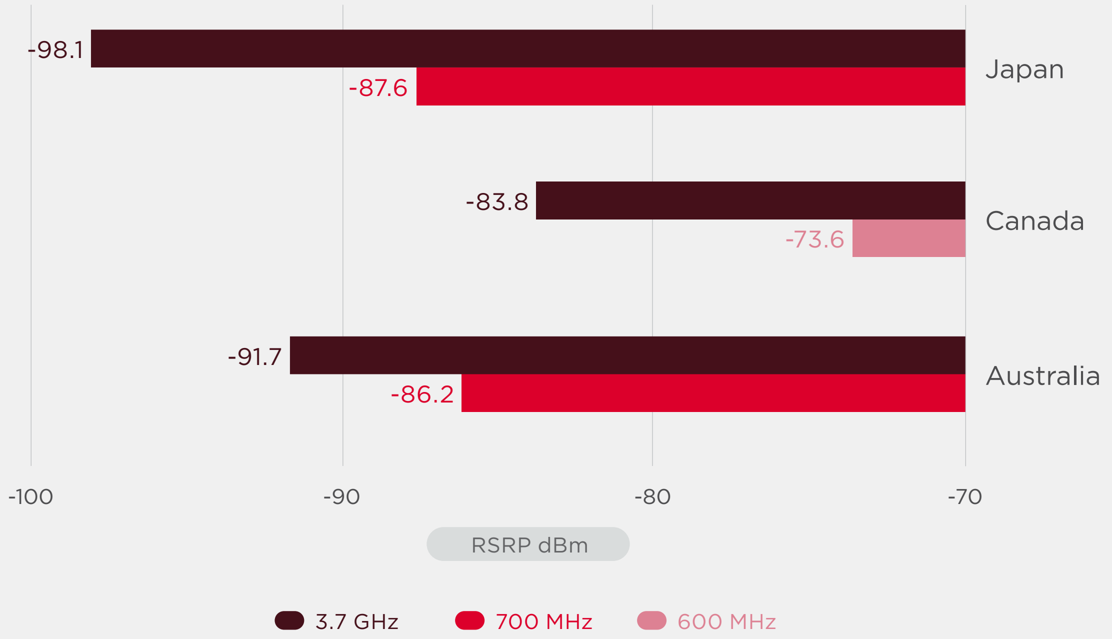
Note: '5G availability' is the proportion of users on 5G-capable devices who spent the majority of their time on a 5G network on their subscriber (SIM) network in Q3 2022. 'Percentage low band' is the proportion of device scans that are carried out using low-band spectrum (in the 600, 700, 800, 850 or 900 MHz frequencies).

Source: Ookla Speedtest Intelligence®

Evidence also shows that low-band frequencies improve user experience, particularly indoors. Figure 12 compares indoor 5G signal strength in the largest cities in Australia, Canada and Japan. Consumers connected using the 700 MHz band in Australia and Japan, and the 600 MHz band in the case of Canada, had a better quality indoor signal than those connecting in the mid-bands.

Figure 12

Indoor signal strength using low- and mid-band spectrum, Q3 2022



Note: analysis based on weighted average Reference Signal Received Power (RSRP) for all consumer scans in Q3 2022 by frequency band in in-building locations in downtown areas in Sydney (Australia), Toronto (Canada) and Tokyo (Japan).

Source: Ookla Speedtest Intelligence®

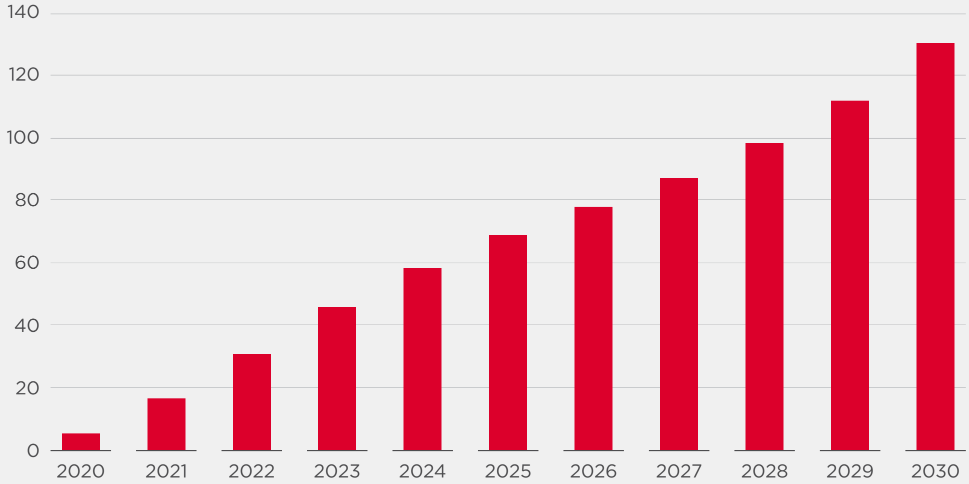
02 The socio-economic benefits of low-band 5G

Low bands to account for around $130 billion of economic value in 2030, with 5G expected to drive almost $1 trillion in additional GDP

Figure 13

Estimated global impact of low-band 5G on GDP

$ billion



Source: GSMA Intelligence

The economic benefits of mobile have been quantified in a number of studies. GSMA Intelligence research showed that over the period 2000–2017, a 10% increase in mobile adoption increased GDP by between 0.5% and 1.2%. Furthermore, the subsequent rollout of 3G and 4G networks drove increasing impacts, with the economic effect increasing by 15% when 2G connections were upgraded to 3G and by 25% when 2G connections were upgraded to 4G.[5]

Based on this evidence, 5G is expected to yield more than $950 billion in additional GDP to the global economy, or approximately 0.7% of forecast global GDP, in 2030. The contributions from the three broad spectrum bands are as follows:

- low-band 5G is expected to account for $130 billion (14% of the total 5G benefit)
- mid-band 5G will account for a $610 billion uplift to global GDP (63% of the total 5G benefit)
- high-band 5G adds another $220 billion of GDP uplift (23% of the total 5G benefit).

Further information on the methodology used can be found in the Appendix.

5 Mobile technology: two decades driving economic growth, GSMA Intelligence, 2020

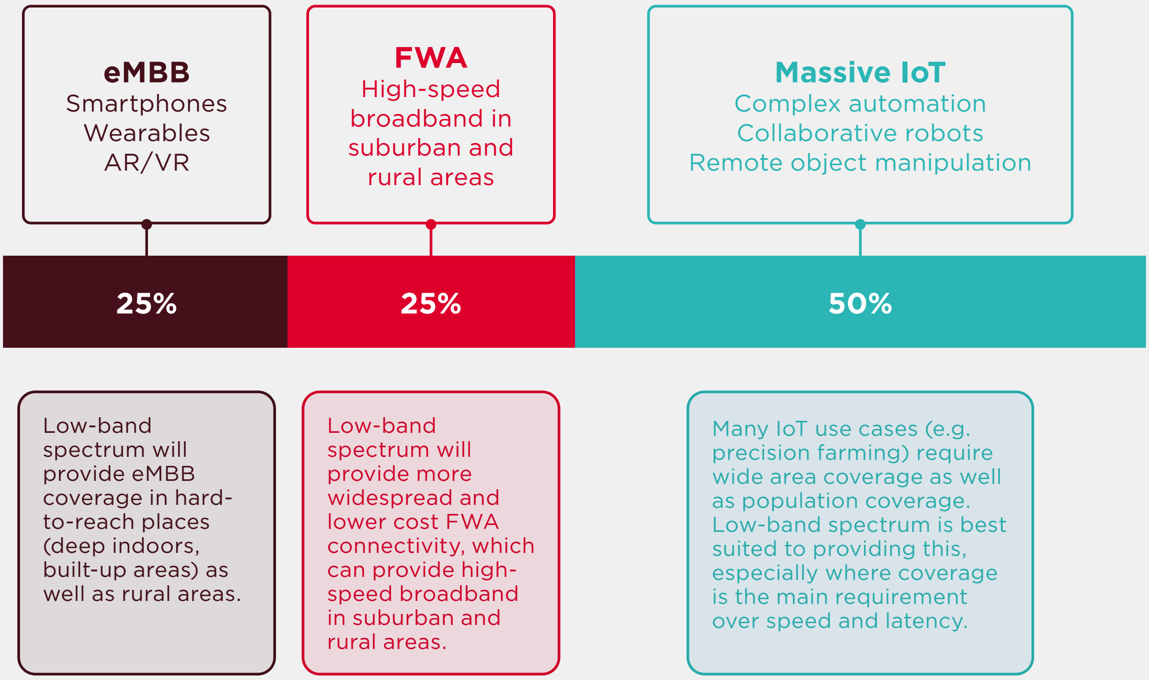
Half of the economic impact of low band will be driven by massive IoT (mIoT)

Low bands are expected to enable three core 5G use cases. Figure 14 shows that half of the economic impact will materialise through effects on massive IoT (mIoT). Many existing and future IoT use cases require wide area coverage, in addition to population coverage, which low-band spectrum is best suited to provide. MIoT applications are expected to play an important role in digital transformation across a range of economic sectors, including manufacturing, transport, smart cities and agriculture, by increasing productivity and reducing costs. The rest of the economic impact will be driven by enhanced mobile broadband (eMBB) and fixed wireless access (FWA).

Figure 14

Low-band 5G benefits by use case

Percentage of total GDP impact in 2030



Source: GSMA Intelligence

Case study:

IoT, smart farming and precision agriculture

A key use case for low-band 5G will be IoT, including in agriculture. The use of precision farming can help maximise resources, optimise crop and livestock yields, reduce costs and preserve the environment. Many applications will require wide area coverage as well as population coverage, making sub-1 GHz spectrum a critical enabler of use cases. Furthermore, the larger the area over which 5G speeds can be provided, the more useful the applications for smart agriculture.

For example, in 2022, Thai operator Dtac announced a major breakthrough in the quest to farm Lingzhi mushrooms in Thailand using 5G networks on 700 MHz spectrum equipped with internet of things (IoT) and machine learning (ML) technology. The collaboration enables researchers to collect key data on cultivation factors and record high-resolution multispectral images for crop inspection. The resulting knowledge and expertise can be passed on to farmers in cold-weather areas, sustainably raising their quality of life and revenue.[6]

In the US, 5G is expected to enable precision agriculture that can perform a range of time- and labour-intensive farming and ranching activities in real-time and, if necessary, in harsh conditions, with little to no human involvement. Examples include unmanned tractors plowing farmland, autonomous ground robots regulating cattle movement, and minimising fruit decay and spillage. The use of 5G not only provides the speeds required to deploy technologies efficiently; it also provides the connectivity at a lower unit cost, making it more sustainable than previous solutions.[7]

Another example of the impact of smart farming is the rollout of smart sensor technology on tractors by John Deere (a provider of agricultural equipment). Sensors can send data to improve productivity, ensuring for example that seeds are planted at the right depth, receive the right amount of water and the right amount of herbicide and pesticide. However, the potential of farm sensors can be hindered by limited coverage and slow speeds. A broader and faster connection using 5G can enable greater real-time farm management to optimise crop output.[8]

6 "dtac, Chaipattana Foundation and NECTEC Reveal Major Breakthrough on Lingzhi Cultivation via 5G on 700 MHz", dtac blog, May 2022
7 "Making the 5G precision agriculture connection", Ericsson, January 2022
8 "John Deere turns to IoT to make smart farming a reality", Internet of Business; and "John Deere thinks rural 5G could help feed the world", Fierce Wireless, June 2021

Case study:

5G FWA

While FWA is not new, 5G is making it a competitive solution by offering speeds more than 10× greater than 4G FWA, which significantly reduces the performance gap compared to fibre and cable broadband. At the end of 2022, 91 fixed broadband service providers had launched commercial 5G-based fixed wireless services across 47 countries, while 17 providers had announced plans to do so. Survey evidence shows that, when asked about different 5G use cases, consumers viewed FWA home broadband as the most appealing 5G proposition.[9]

A key business case for 5G FWA is in areas where there is a lack of fixed broadband access or poor fixed broadband services. These are typically concentrated in peri-urban and rural areas, where the costs of deploying high-speed fixed broadband make it economically unfeasible.[10] In such cases, most deployments have so far used mid-band spectrum, but the use of low bands will enable or improve high-speed FWA provision. In particular, as more sub-1 GHz spectrum is deployed on a single cell tower, more FWA customers can be served, reducing the cost per FWA connection and enhancing the business case for suburban and rural FWA. GSMA Intelligence research has found that there are potential cost savings of between 70% and 80% when using 5G FWA compared to FTTP/B in rural and suburban geographies.[11] Beyond the consumer segment, 5G FWA is also being used to connect small and medium-sized enterprises in underserved areas.

Operators are already starting to utilise different spectrum bands to provide FWA, combining lower-band coverage with mid-band and mmWave performance boosts. For example, in the US, the number of 5G FWA subscriptions reached more than 3 million at the end of 2022 and is forecast to increase to more than 10 million by 2025,[12] with the majority of customers switching due to the offer of a lower price compared to other fixed services. One of the main FWA providers is T-Mobile. More than three quarters of its subscribers are in suburban or rural areas, and the majority receive speeds greater than 100 Mbps.[13] In rural areas, having sufficient low-band spectrum is often the only way to deliver the speeds expected from 5G FWA, especially for households further away from the cell tower.

Other countries seeing increased take-up of 5G FWA include Italy, Australia, Austria, Bahrain and the Philippines. All of these markets are expected to have 5G FWA household penetration of more than 10% by 2025.[14] In India, operators have announced plans to launch commercial 5G FWA services. Reliance Jio, which has acquired spectrum in the 700 MHz band, aims to connect 100 million locations with FWA.[15]

9 FWA leads the way in consumer interest in 5G use cases, GSMA Intelligence, 2022
10 The 5G FWA opportunity: series highlights, GSMA Intelligence, 2022
11 The 5G FWA opportunity: series highlights, GSMA Intelligence, 2022
12 GSMA Intelligence and The State of Fixed Wireless Access 2022, T-Mobile, 2022
13 The State of Fixed Wireless Access 2022, T-Mobile, 2022
14 5G FWA: assessing trends, rollout and adoption, GSMA Intelligence, 2022
15 "Reliance Jio to launch a different kind of fixed wireless access", Fierce Wireless, September 2022

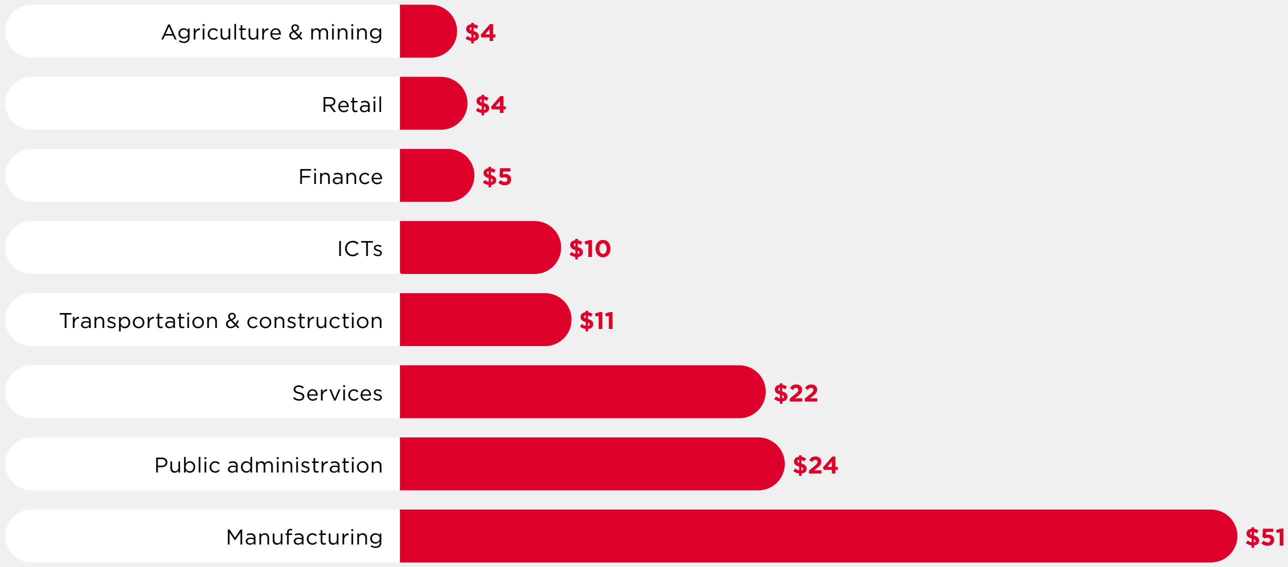
A range of economic sectors will benefit from the low bands

The benefits of low-band spectrum are spread across a range of economic sectors. While manufacturing will benefit the most, at $51 billion or 40% of the low-band benefits, other sectors such as the public sector, the services sector and transport will also account for a significant proportion of the economic benefit. Furthermore, other sectors such as retail and agriculture will drive the majority of low-band benefits in particular regions (see *Low-band socio-economic benefits by region*).

Figure 15

Estimated global contribution of low-band 5G spectrum to GDP, by sector, 2030

$ billion



Source: GSMA Intelligence

Enhancing the social impacts of mobile

In addition to macroeconomic impacts, 5G has wider social and environmental benefits that low bands can help deliver to more people. Examples include the following:

Poverty reduction

Mobile broadband reduces poverty. For example, during 2010–2016, mobile helped lift 2.5 million people out of extreme poverty in Nigeria.[16]

Well-being

Mobile ownership combined with internet connectivity is associated with an improvement in peoples' happiness and well-being.[17]

Education

Mobile improves quality of teaching and learning, and facilitates reading and enhanced literacy. In 2021, some 2.5 billion people worldwide used mobile to improve their education or the education of their children.[18]

Health

Mobile phones are linked to improved health outcomes, including lower maternal and child mortality. In 2021, around 2.1 billion people worldwide used mobile to access health information.[19]

Employment

Access to mobile broadband improves labour force participation and wage employment, as it enables more efficient matching between employers and job seekers[20] In 2021, more than 1 billion people worldwide used mobile to look or apply for a job.[21]

Financial inclusion

Mobile has helped reduce the financial exclusion gap in low- and middle-income countries, with more than 1.35 billion registered mobile money accounts at the end of 2021.[22] In Sub-Saharan Africa, one in three adults has a mobile money account.[23]

Environment and climate change

Mobile technologies can enable carbon emissions reductions that are 10× greater than the carbon footprint of mobile networks themselves.[24]

Given that 5G offers an improved user experience (including faster speeds and lower latencies) and a wider set of use cases than previous generations (especially for enterprises), governments can continue to expect these wider social, economic and environmental benefits from the deployment and use of 5G services. However, these will be conditional on operators having adequate access to low-band spectrum, particularly in rural and peri-urban areas. If not, many households and enterprises will not receive the performance requirements needed to realise the full benefits of each use case relevant to them.

16 The poverty reduction effects of mobile broadband in Africa: Evidence from Nigeria, GSMA and World Bank, 2020
17 The Impact of Mobile on People's Happiness and Well-Being, GSMA and Gallup, 2018
18 2022 Mobile Industry Impact Report: Sustainable Development Goals, GSMA, 2022
19 2022 Mobile Industry Impact Report: Sustainable Development Goals, GSMA, 2022
20 See for example Mobile Broadband Internet, Poverty and Labor Outcomes in Tanzania, World Bank Policy Research Working Paper 9749, 2021
21 2022 Mobile Industry Impact Report: Sustainable Development Goals, GSMA, 2022
22 State of the Industry Report on Mobile Money 2022, GSMA, 2022
23 The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19, Demirgüç-Kunt et al, 2022
24 The Enablement Effect: The impact of mobile communications technologies on carbon emission reductions, GSMA, 2019

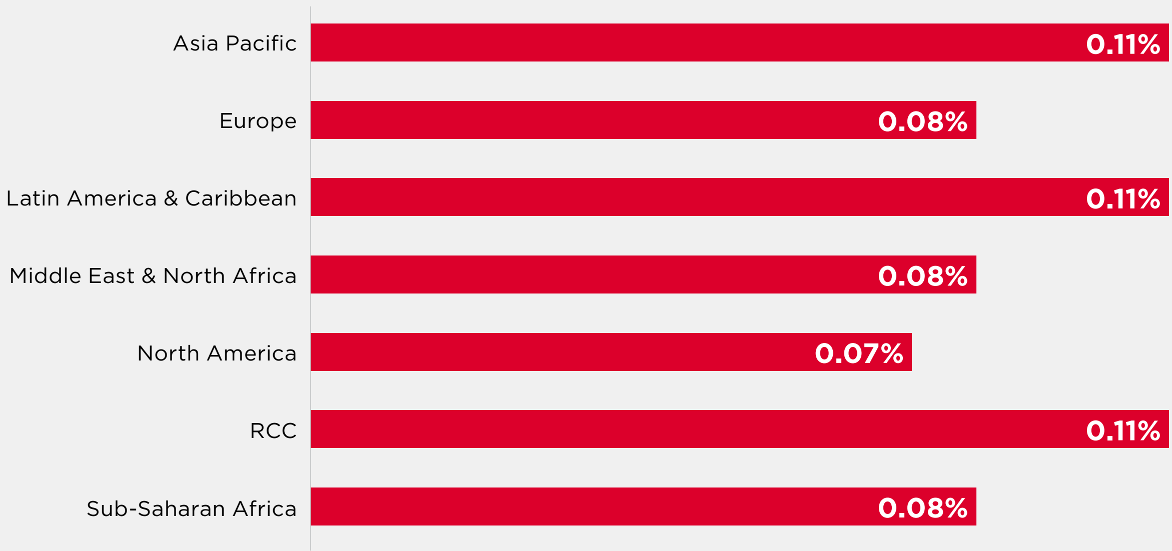
03 Low-band socio-economic benefits by region

The economic impact of the low bands differs by geographic region, according to macroeconomic conditions, the readiness of economies to adopt new technologies and the structure of each country's economy.

While the largest economies will drive the biggest 5G benefits in absolute terms, in relative terms it is expected that low bands will boost GDP more in low- and middle-income countries (LMICs). This reflects the importance of mobile and 5G in their digital transformation, especially where deployment of fibre infrastructure is limited. In LMICs, mobile accounted for around 85% of all broadband subscriptions at the end of 2022 (the proportion was even higher in low-income countries at 98%)[25], highlighting that the majority of internet users in LMICs can only access it via mobile.[26]

Figure 16

Regional breakdown of the GDP contribution generated by low-band 5G in 2030



Source: GSMA Intelligence

25 ITU Facts and Figures 2022
26 For further analysis on this topic, see State of Mobile Internet Connectivity Report 2022, GSMA, 2022

Americas

Low-band 5G will provide a 2030 GDP benefit of around $35 billion in the Americas. Most of this will be accounted for by North America, which is forecast to be a mature 5G market before 2030. However, low-band 5G is expected to increase GDP by more in percentage terms in Latin America and the Caribbean.

Table 1: Americas: GDP contribution generated by low-band 5G, 2030

Region	$ billion	Percentage of GDP
Americas	35	0.08%
— North America	26	0.07%
— Latin America and the Caribbean	9	0.11%

Source: GSMA Intelligence

Low-band 5G will primarily benefit manufacturing, the public sector and the services sector in North America. In Latin America and the Caribbean, the low bands are expected to also be important in the retail sector, as this accounts for a greater proportion of economic activity. 5G connectivity, boosted by low bands, can help optimise supply chains in retail and improve customer experiences.

Figure 17

North America: GDP contribution generated by low-band 5G spectrum, by sector, 2020–2030

Source: GSMA Intelligence

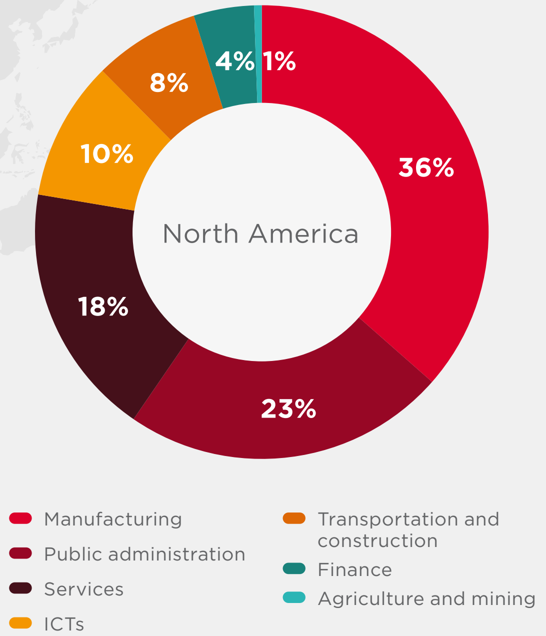
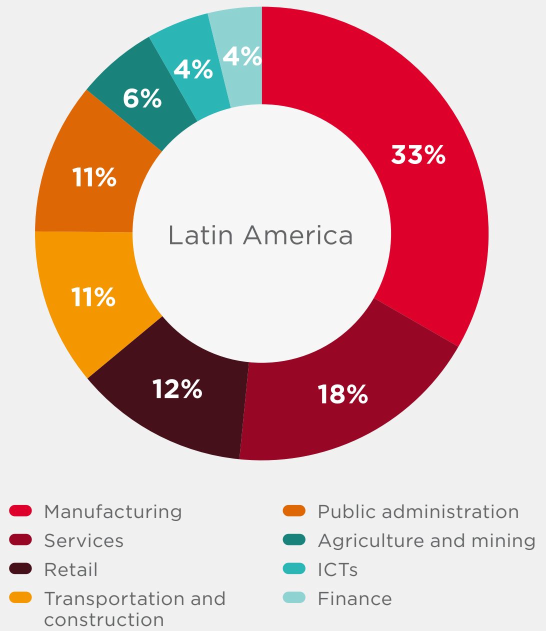


Figure 18

Latin America and the Caribbean: GDP contribution generated by low-band 5G spectrum, by sector, 2020–2030

Source: GSMA Intelligence



Asia Pacific

The Asia Pacific region is economically diverse, with advanced digital economies in East Asia and Australia and more agriculture-based economies in South Asia. The East Asia and Pacific sub-region is expected to account for most of the region's low-band 5G benefits in 2030 (led by China), but in Southeast Asia low bands will increase GDP more in relative terms. In South Asia, the impact of 5G is lower but is expected to increase from 2030, as 5G adoption grows.

Table 2: Asia Pacific: GDP contribution generated by low-band 5G, 2030

Region	$ billion	Percentage of GDP
Asia Pacific	62	0.11%
— East Asia & the Pacific	47	0.11%
— South Asia	7	0.09%
— Southeast Asia	8	0.14%

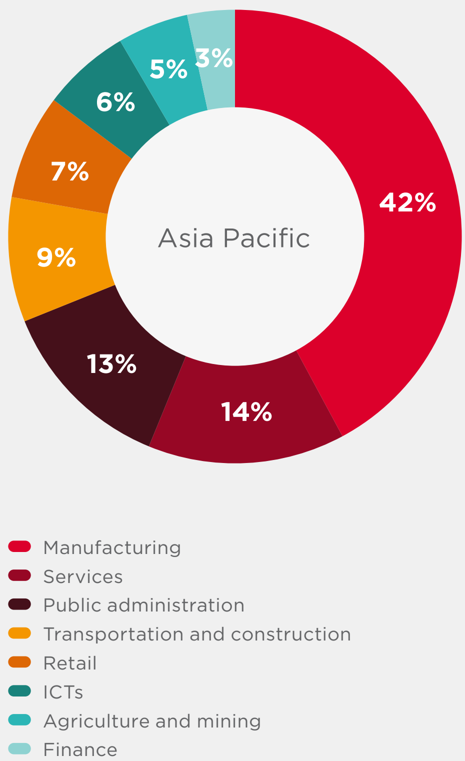
Source: GSMA Intelligence

Low-band 5G will primarily be used in the manufacturing sector, especially in China. As one of the world's leading 5G markets, China is well placed to integrate new 5G applications into high-tech manufacturing industries.

The contribution of low band to the agricultural and retail sectors will be more important in South and Southeast Asia, where these sectors account for a greater proportion of economic output.

Figure 19

Asia Pacific: GDP contribution generated by low-band 5G spectrum, by sector, 2020–2030



Europe

Most European countries are expected to achieve high levels of 5G coverage and adoption by the end of this decade. Low bands will play a role in delivering this and will add around $26 billion to the regional economy in 2030, accounting for around a fifth of the global low-band 5G benefit.

Table 3: Europe: GDP contribution generated by low-band 5G, 2030

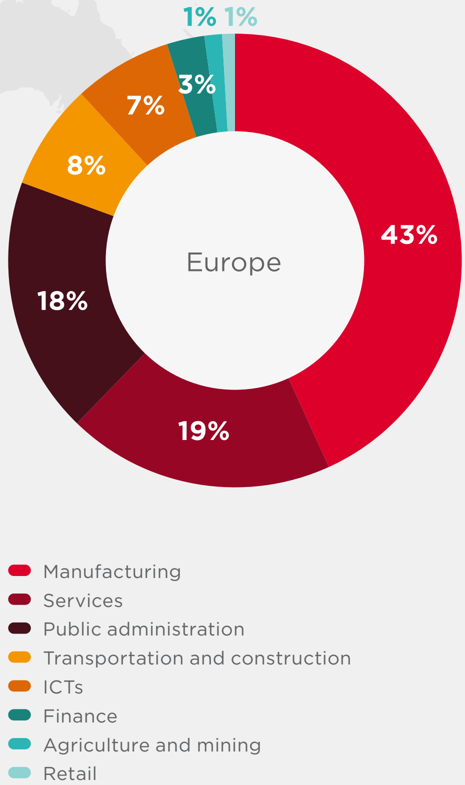
Region	$ billion	Percentage of GDP
Europe	26	0.08%

Source: GSMA Intelligence

Low-band 5G will primarily impact the manufacturing, services and public sectors. For example, applications such as smart cities and smart utility grids will contribute to the public and transport sectors, while enhanced deep-indoor coverage and network quality will further enable some of the use cases expected to benefit the manufacturing sector, including mIoT.

Figure 20

Europe: GDP contribution generated by low-band 5G spectrum, by sector, 2020–2030



Regional Commonwealth in the Field of Communications (RCC)

For countries in the RCC region, low-band 5G benefits are expected to contribute around $3 billion to GDP in 2030 – an increase of more than 0.1%.

Table 4: RCC: GDP contribution generated by low-band 5G, 2030

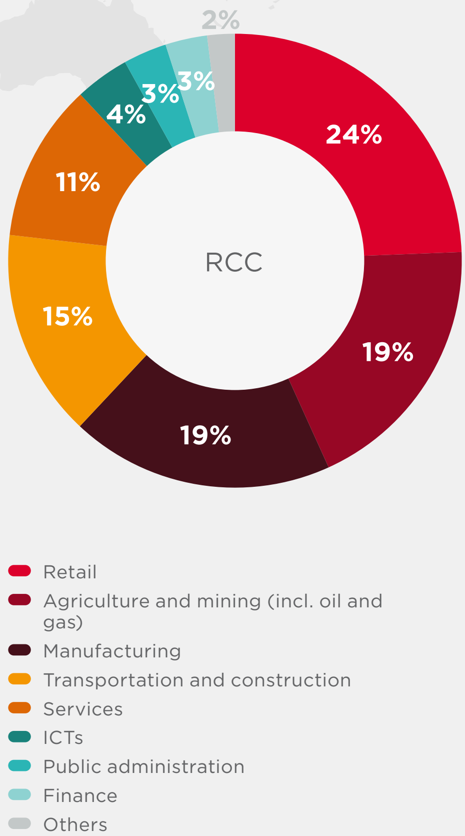
Region	$ billion	Percentage of GDP
RCC	3	0.11%

Source: GSMA Intelligence

Low-band 5G will be used by a range of sectors in the region, including retail, oil & gas, manufacturing and transport. For example, 5G applications are expected to improve the safety and productivity of oil & gas plants by increasing operational efficiency and providing timely maintenance to prevent equipment failure, with use cases such as remote device control, smart monitoring and 5G-enabled AI.

Figure 21

RCC: GDP contribution generated by low-band 5G spectrum, by sector, 2020–2030



Middle East and North Africa

For countries in the Middle East and North Africa (MENA) region, low-band 5G benefits are expected to contribute around $4 billion to GDP in 2030 – an increase of 0.08%.

Table 5: MENA: GDP contribution generated by low-band 5G, 2030

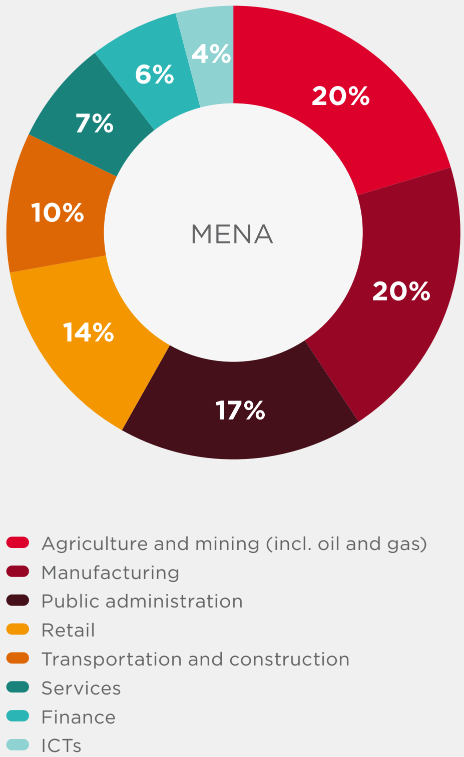
Region	$ billion	Percentage of GDP
MENA	4	0.08%

Source: GSMA Intelligence

Low-band 5G will be particularly important for the region's oil & gas sectors, as well as manufacturing, public sector and retail. Within the region, GCC countries are 5G pioneers; with high urbanisation rates, 5G is well placed to enable smart city services that help reduce pollution and traffic congestion, mitigate the consequences of climate change and manage economic resources more efficiently.

Figure 22

MENA: GDP contribution generated by low-band 5G spectrum, by sector, 2020–2030



Sub-Saharan Africa

Through early adopters in the region, low-band 5G is expected to bring benefits of almost $3 billion to the regional economy, or around 0.08% of GDP in 2030. While 5G penetration may be lower, its relative impact in 2030 will be similar to Europe and North America, paving the way for Sub-Saharan Africa to realise even greater benefits from low-band 5G going into the 2030s.

Table 6: Sub-Saharan Africa: GDP contribution generated by low-band 5G, 2030

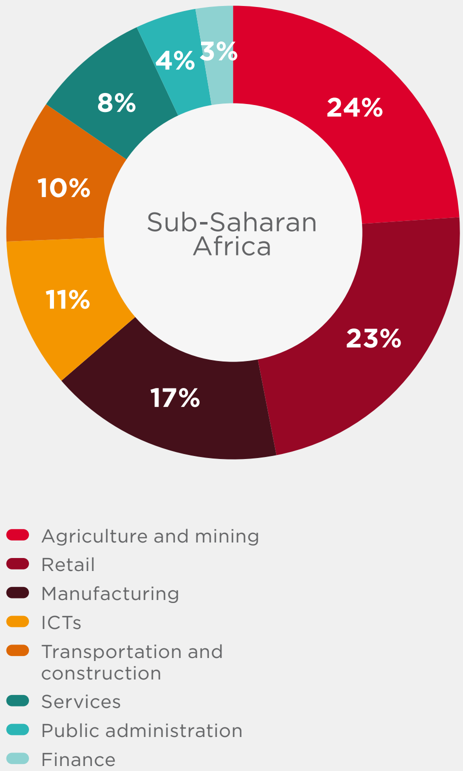
Region	$ billion	Percentage of GDP
Sub-Saharan Africa	3	0.08%

Source: GSMA Intelligence

Low-band 5G applications will mostly be used by and benefit the agricultural, mining and retail industries, reflecting the level of economic activity driven by these sectors. The wide area coverage enabled by low bands will be particularly important in driving the digital transformation of the agricultural sector, with IoT applications for smart farming and agriculture.

Figure 23

Sub-Saharan Africa: GDP contribution generated by low-band 5G spectrum, 2020–2030, by sector



04 Cost-benefit analysis guidelines for assessing sub-1 GHz options

Applying a cost-benefit analysis framework to five specific settings

Regulatory impact assessments help to determine the spectrum use that delivers the greatest socio-economic benefits. This section provides a cost-benefit analysis (CBA) of sub-1 GHz frequency band options, presenting the results of five scenarios for allocating parts of the 470–694 MHz band for mobile use in ITU Region 1, through a framework that can be applied in any country. It builds on previous CBAs applied to sub-1 GHz bands.[27] Further details of the model are provided in the Appendix.

While regulators should consider the costs and benefits for the mobile and broadcasting sectors in their own markets, we consider five country 'settings' based on specific assumptions typical of countries in Europe, the Middle East and Africa.

In every setting, the benefits of assigning additional UHF spectrum for mobile significantly exceed the potential costs for the broadcasting sector.

Table 7: CBA modelling assumptions

Demographic characteristics	Broadcast characteristics	Mobile characteristics
— Total population — Urban and rural population distribution — Number of households	— Number of national multiplexes and programmes — Number of broadcast transmitter sites — DTT transmission technology	— Expected 5G penetration (urban and rural) — Spectrum available

Source: GSMA Intelligence

In Settings 1, 3 and 5, we assess the impact of allocating 80 MHz of UHF spectrum to mobile within the 600 MHz band (614–694 MHz), while assuming continued DTT deployment in the 470–614 MHz band. In Settings 2 and 4, we assume DTT is discontinued and the whole of the 470–694 MHz band is made available for mobile. An alternative option could be to allocate more than 80 MHz of UHF spectrum but not the entire DTT band, allowing enough spectrum to maintain the most popular and widely viewed DTT channels while assigning additional spectrum for IMT. Although we do not model this in the study, the same framework could be applied by national authorities.

27 See, for example, the 700 MHz cost-benefit analyses carried out by Ofcom in the UK and ComReg in Ireland.

Table 8: Assumptions for the CBA

	Setting 1	Setting 2	Setting 3	Setting 4	Setting 5
UHF spectrum scenario	Allocate 80 MHz to mobile (614–694 MHz)	Allocate 224 MHz to mobile (470–694 MHz)	Allocate 80 MHz to mobile (614–694 MHz)	Allocate 224 MHz to mobile (470–694 MHz)	Allocate 80 MHz to mobile (614–694 MHz)
Total population (2022)	8.75 million		12 million		18.6 million
Rural population % (2022)	26%		15%		54%
Forecast 5G penetration in 2030	111%		100%		11%
Number of DTT programmes	51		11		48
Number of national broadcasting multiplexes	5		4		4

Source: GSMA Intelligence

CBA results

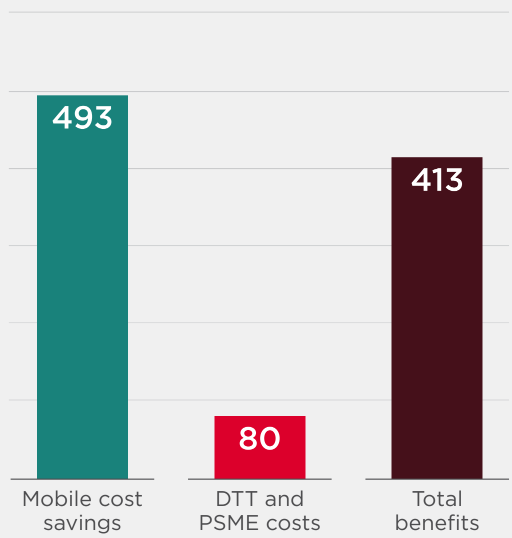
Setting 1: Modelled on a typical country in Europe assigning the 600 MHz band

Under this setting, the benefits from assigning 80 MHz of UHF spectrum to mobile would be 6× greater than the costs incurred by the broadcasting sector to upgrade all multiplexes to DVB-T2, which would offer the same number of programmes as the baseline (or status quo).

Figure 24

CBA results for Setting 1

$ million



Source: GSMA Intelligence

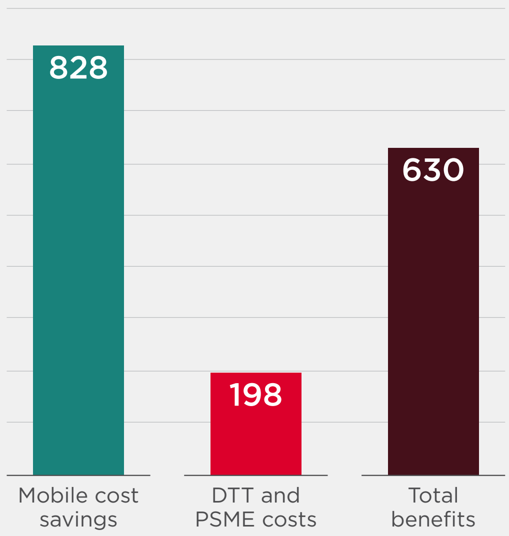
Setting 2:
Modelled on a typical country in Europe assigning the 470–694 MHz band

The results for this setting show that the benefits in the mobile sector would be 4× greater than the costs associated with migrating DTT programmes to another platform.[28] In practice, if DTT viewership continues to decline and broadcasters begin to move the majority of their programming to other platforms, whether IPTV, satellite or cable, then some of the costs associated with this option could be over-stated as there would be fewer programmes to migrate. However, given the potential social impact that closing the DTT platform could have, there may be other mitigation costs necessary to follow through with this option.

Figure 25

CBA results for Setting 2

$ million



Source: GSMA Intelligence

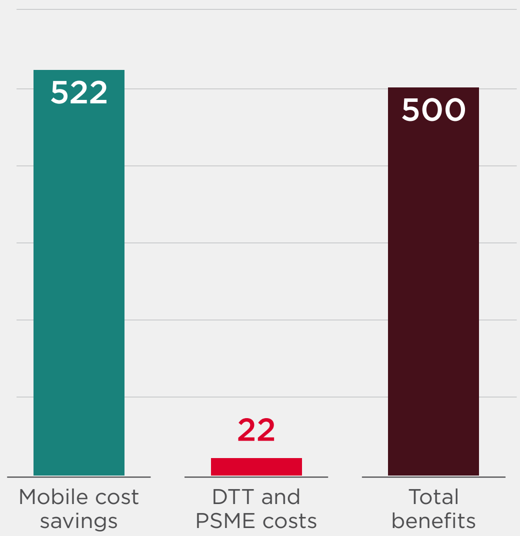
Setting 3:
Modelled on a typical country in the Middle East assigning the 600 MHz band

The benefits from assigning 80 MHz of UHF spectrum to mobile under this setting would be almost 24× greater than the costs incurred by the broadcasting sector from moving channels in the 614–694 MHz frequencies to a lower band. This is driven by the strong expected growth in 5G demand in the region and the fact that there are far fewer DTT programmes to manage compared to countries in Europe and Africa, meaning the mitigation costs of repurposing the spectrum are significantly lower.

Figure 26

CBA results for Setting 3

$ million



Source: GSMA Intelligence

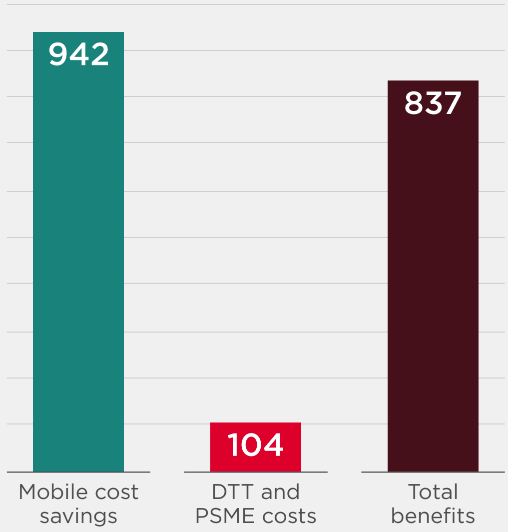
28 For the purposes of this CBA, we quantify the cost of migrating DTT channels to satellite due to the availability of data (see Appendix). However, alternative migration options are available (particularly IPTV) and could be assessed by national regulators.

Setting 4:
Modelled on a typical country in the Middle East assigning the 470–694 MHz band

The results for this setting show that the benefits in the mobile sector would be 9× greater than the cost associated with migrating DTT programmes to another platform. This is again driven by expected 5G demand and the more limited number of DTT programmes to migrate.

Figure 27
CBA results for Setting 4

$ million



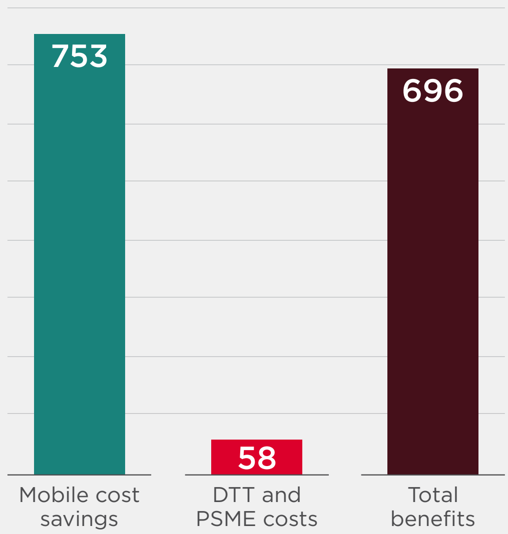
Source: GSMA Intelligence

Setting 5:
Modelled on a typical country in Africa assigning the 600 MHz band

The benefits from assigning 80 MHz of UHF spectrum to mobile would be 13× greater than the costs incurred by the broadcasting sector from adding a single frequency network (SFN) multiplex, which would offer the same number of programmes as the baseline. The benefits from assigning 80 MHz of additional sub-1 GHz spectrum for mobile are even greater than in the settings based on other regions due to the large proportion of the African population that lives in rural areas, which are best covered using low-band spectrum.

Figure 28
CBA results for Setting 5

$ million



Source: GSMA Intelligence

Using UHF spectrum for mobile will provide greater value to society than maintaining it for broadcasting

Given the transformative impact that 5G technology can have on the global economy, it is critical that sufficient amounts of sub-1 GHz spectrum are available in order to ensure that rural populations are not left behind and to address deep indoor urban demand. Existing 5G deployments show that countries using the 600 and 700 MHz bands are able to offer consumers 5G services that are more widely available and of better quality than those only using mid-band and mmWave bands.

In many countries, to realise the full socio-economic benefits of 5G, additional spectrum is required in frequencies below the 700 MHz band. Having access to greater sub-1 GHz spectrum will allow mobile operators to dedicate further capacity to 5G at both existing and new sites. Where there is existing coverage, operators may be unable to provide the capacity upgrades needed to meet 5G performance requirements without additional low-band spectrum. In rural areas, adding base stations to increase capacity is often not affordable, while in urban areas operators may have reached the technical limits of densification. The only way to increase capacity and offer the speeds needed is to utilise additional low-band spectrum at existing base stations.

The results of the CBA in this study highlight the size of the cost savings from assigning additional UHF spectrum to operators for a typical country in Europe, the Middle East and in Africa when deploying 5G networks. Without this spectrum, operators would incur higher costs, which would have implications for the affordability of 5G and reduce adoption and therefore the wider socio-economic benefits. Alternatively, they may decide not to incur the additional costs, particularly if the deployments are technically or financially unsustainable; in this case, consumers will not get the quality of service they need to fully benefit from 5G (i.e. slower speeds, higher latencies and less availability).

The results of a CBA will be specific to the circumstances of each market, depending on the level of expected 5G adoption, the population level and distribution, and the expected reliance on DTT for TV viewership. It is therefore clear from this study that a uniform approach to UHF spectrum use across all countries needs to be avoided. Governments should pursue the spectrum policies that generate the most economic and social value for their populations.

In each of the settings considered in the CBA in this report, the cost savings generated from assigning additional UHF spectrum to mobile significantly exceed the costs that would be incurred to ensure consumers are able to continue accessing the broadcasting services they demand. This reflects the growing demand for 5G bandwidth and the general decline in DTT, driven in significant part by the rise of IPTV and on-demand viewing. The results therefore show that the utilisation of more UHF spectrum for mobile use will provide greater value to society than maintaining it for broadcasting.

Trends in DTT and mobile usage

The results of the CBA are partly driven by the longer term trends in DTT and mobile usage. In most countries in Europe and the Middle East, DTT networks were launched in the 2000s or early 2010s to replace analogue broadcast networks as part of the digital switchover (DSO) process. In Sub-Saharan Africa, some countries have completed DSO, but many have found the analogue switch-off process more challenging and are still completing their migrations.[29]

DTT has played an important role in delivering both public and commercial broadcasting services, but its use is far from universal. It is not the primary TV platform in most European countries, and in half of the region it is the primary TV platform in fewer than 20% of households.[30] Looking at changes over time, there has been a reduction in the proportion of households that primarily rely on DTT (see Figure 29). Over the same period, there has been a significant increase in the share of IPTV. Going forward, the EC expects this to continue. IPTV households will increase from around 45 million to more than 60 million by 2030. Meanwhile, other platforms are expected to decline, especially DTT.[31] There has also been significant growth in the number of households subscribing to video on-demand (e.g. Netflix, Amazon Prime Video, Apple TV+ and Disney+), with the number of SVOD households in the EU increasing from 39 million in 2017 to 133 million in 2021 (or from around 20% household penetration to approximately 65%).[32]

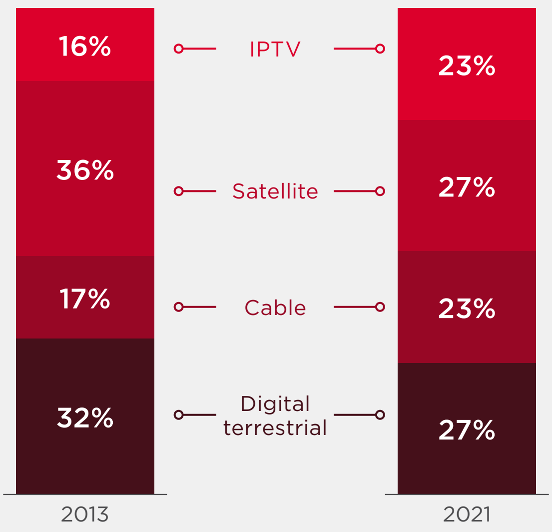
Similar trends for DTT have been observed in the Arab states, where it accounts for less than 20% of primary TVs.[33] In Africa, the trends in terrestrial TV are not the same as in Europe or the Middle East, but fewer channels are typically used, so less spectrum is required.[34]

In some countries, the DTT platform has either been shut down already (e.g. in Switzerland) or there are plans scale it down, especially where there are a limited number of channels and multiplexes. As a result, many broadcasters are focusing fewer resources on linear TV channels and more on IPTV and on-demand content.[35]

By contrast, demand for mobile data and services continues to increase. The number of 5G connections in Europe, the Middle East and Africa is forecast to grow from 100 million in 2022 to 1.3 billion in 2030, a 13× increase. Ericsson's mobile data traffic forecasts suggest that, in the same regions, monthly mobile data traffic will increase from 20 EB per month to more than 72 EB per month in 2028, driven by continued internet and video demand, as well as new use cases such as augmented and extended reality applications.[36] The growth in mobile demand is therefore in contrast to the declining trend in DTT viewership.

Figure 29

Primary TV platform share in the EU, 2013–2021



Source: GSMA Intelligence

29 Digital Switchover in Sub-Saharan Africa: Bringing Low-Band Connectivity Within Reach, GSMA, 2022
30 European Audiovisual Observatory
31 Study on the use of the sub-700 MHz band (470-694 MHz), European Commission, 2022
32 European Audiovisual Observatory. Further trends in TV viewership can be found in Study on the use of the sub-700 MHz band (470-694 MHz), European Commission, 2022
33 Terrestrial broadcasting and spectrum use in the Arab states, Plum Consulting, 2015
34 Digital Switchover in Sub-Saharan Africa: Bringing Low-Band Connectivity Within Reach, GSMA, 2022
35 For further details, see The future use of UHF spectrum in ITU Region 1, Plum Consulting, 2021
36 Ericsson Mobility Report, November 2022

Approach to the CBA

The CBA in this section considers whether to use spectrum in the UHF frequency range for broadcasting services or mobile technology in ITU Region 1. When carrying out a CBA, national regulators can consider the following economic effects:[37]

— **Direct effects** that impact stakeholders directly:
  - Consumer surplus – the difference between the price consumers pay and the price they are *willing* to pay for a product or service
  - Producer surplus – the amount producers benefit from by selling at a market price higher than the minimum price they would be *willing* to sell for

— **Indirect effects**, which can be generalised as spill-over effects that generate value for the wider economy (i.e. GDP benefits) and society.

Mobile technology is a general-purpose technology that enables economic growth via improvements in productivity and efficiency, and gives social value to consumers. Broadcasting, and DTT in particular, provides consumers with free and universal access to TV and generates social and economic value.

Both mobile and broadcasting therefore drive significant consumer surplus, due to the number of consumers willing to pay much more than they do for entertainment, leisure, information and other services.[38] However, for the purposes of this CBA, we focus on producer surplus – specifically, the costs that would be saved from using UHF spectrum for either mobile or broadcasting. This is because consistent and comparable data on producer costs is more readily available than data on consumer willingness to pay, which can vary significantly based on the type of consumer. Furthermore, there is limited recent evidence that allows the indirect economic and social benefits to be considered in a comparable manner between mobile and broadcasting.

The costs and benefits of each spectrum policy scenario are estimated using net present value (NPV) between 2021 and 2040:

— **Benefits** are based on mobile network capex and opex savings delivered by greater low-band spectrum access in both urban and rural areas.

— **Costs** are based on repurposing DTT and PMSE services which currently operate in the 470–694 MHz UHF band. They are estimated based on a requirement for DTT providers to maintain the same level of broadcast output in terms of national, regional and local TV programmes.[39] There are a number of ways to achieve this but, for the purposes of this study, we consider four options: move to a reduced band; upgrade to DVB-T2;[40] upgrade to SFN[41] and DVB-T2; or migrate DTT channels to another platform. Further details on each are provided in Appendix.

37 For further details, see Maximising the socio-economic value of spectrum: A best practice guide for the cost-benefit analysis of 5G spectrum assignments, GSMA, 2022
38 See, for example, Economic impact of the use of radio spectrum in the UK, Europe Economics, 2006; Valuing the use of spectrum in the EU, Plum Consulting, 2013; and Impact of radio spectrum on the UK economy and factors influencing future spectrum demand, Analysys Mason, 2012
39 This is potentially a conservative assumption, as the number of programmes on DTT may decline given the downward trend in viewership and the fact that the majority of audience market share is accounted for by a small number of channels. In the EU, on average 72% of daily audience market share was driven by the four leading channels (Source: European Audiovisual Observatory)
40 DVB-T2 refers to the latest broadcasting transmission standard. The previous standard is DVB-T, which carries less capacity per multiplex. Further details on the assumptions are provided in Appendix.
41 Most broadcasting networks in Region 1 are multi-frequency networks (MFNs), where neighbouring transmitter sites broadcast on different frequencies to avoid interference at the receiver. This means that not all available frequencies are used at each tower. In SFNs, the same content is broadcast in the same frequencies in neighbouring cells, enabling greater spectral efficiency.

An appendix containing all details of the modelling used in this report can be found at: **www.gsma.com/spectrum**

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