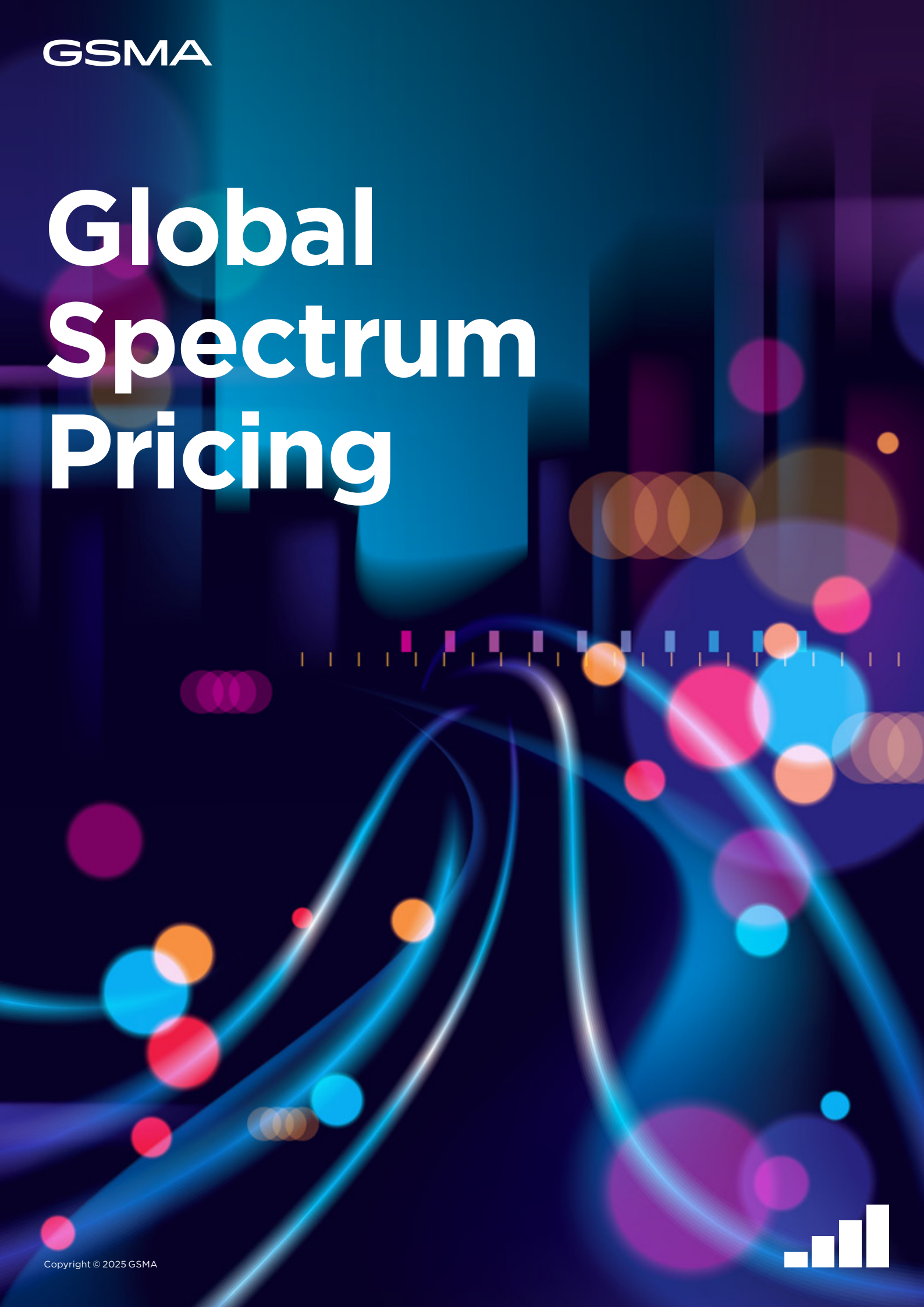
GSMA

Global Spectrum Pricing



GSMA

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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Executive summary

The cost of spectrum affects connectivity. High spectrum prices are linked to lower network coverage and lower download speeds, impacting political and social goals such as digital inclusion. Spectrum costs today are 7% of operators' revenues.

This Global Spectrum Pricing study shows trends in spectrum pricing since 2014 and their impact on consumer and enterprise connectivity.

In the last ten years:

Cost has reduced to enhance digital inclusion

Monthly bills have fallen by

38%

Cost of usage has reduced by

40%

Cost per GB has reduced by

96%

Spectrum costs have not reduced in line with pricing

Operators increased their spectrum holdings by

80%
(4G and 5G)

Revenue per MHz declined by

67%

Spectrum cost to revenue ratio increased by

63%

Higher spectrum costs mean:

- Reduction in coverage
- Lower affordability
- Lower speeds
- Lower adoption

Spectrum creates a high cost burden through:

- Excessive obligations on speed or coverage
- Artificial scarcity, including set-asides
- High reserve prices

Spectrum is indispensable to the operation of mobile networks

Building on thousands of data points, we have collated reliable spectrum cost data for more than 250 operators in almost 100 countries. The data points from licences provide information on not only current cost but also historical cost since 2014. To our knowledge, the data constitutes the most comprehensive spectrum pricing dataset assembled to date.

This allows us to form unique insights on spectrum policy trends and developments in the 4G/5G era. We examine how much additional spectrum operators have acquired in the past decade, the evolution of unit prices, and how this has influenced the total cost burden faced by operators.

By combining spectrum cost data with additional datasets on consumer outcomes, we can examine a range of hypotheses, testing how spectrum cost affects investment and deployment of networks. The results provide unique empirical insights of interest to spectrum managers and policymakers seeking to maximise the benefits of digitalisation and connectivity.

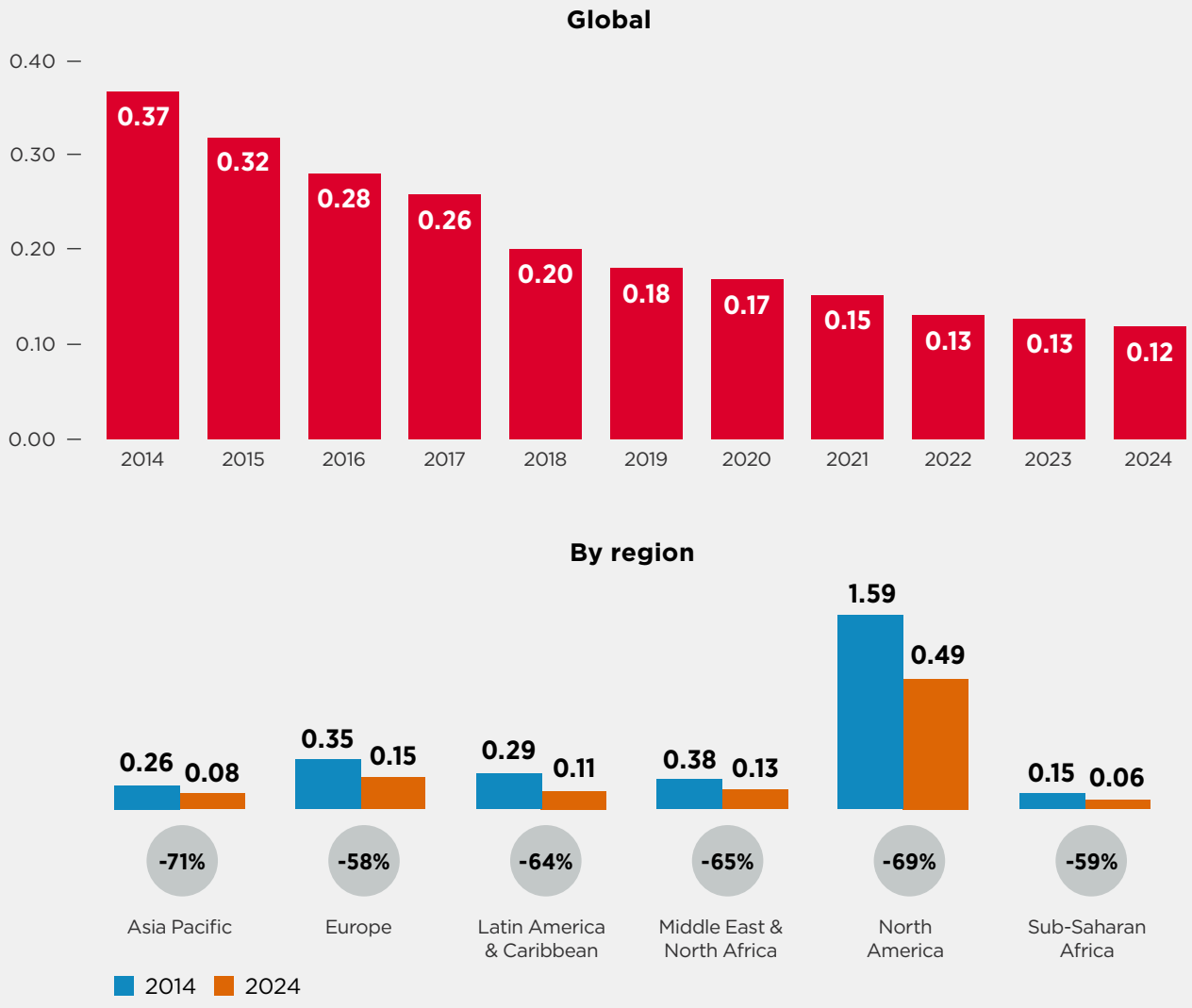
The value mobile spectrum creates for society has increased, but mobile operators capture less of it

Spectrum needs have increased over the last decade, due to rapid growth in demand for mobile data and new use cases. On average, the amount of spectrum dedicated to mobile networks has nearly doubled since 2014. Market conditions have also changed over that period. Operators have offered higher value services while prices for consumers have fallen. However, spectrum prices have not sufficiently adjusted to these changes.

In all regions, the average consumer now pays less for mobile connectivity services than a decade ago. Average revenue per GB of data also declined by 96% between 2016 and 2024. Most of the additional value brought by new generations of mobile networks has been captured by consumers or other digital ecosystem players, such as content and application providers.

The average revenue that operators generate per MHz of spectrum declined by 67% between 2014 and 2024. This reduction highlights the need to assess how spectrum prices have responded to changing market conditions.

Average monthly recurring revenue per MHz per connection ($, inflation adjusted)



Note: Data shows weighted average revenue per MHz, per connection of countries in the region where data could be collected. 2023 US dollar prices.
Source: GSMA Intelligence

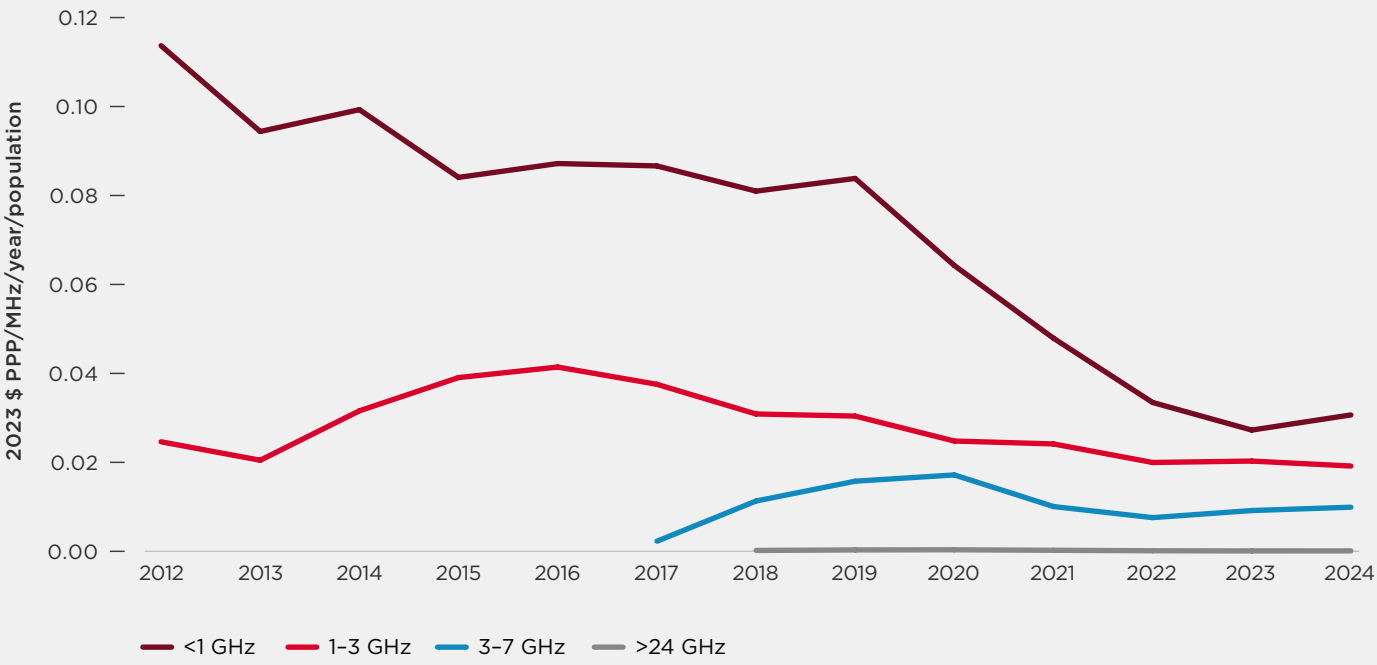
The combined cost of spectrum has increased, despite a reduction in the MHz unit price

The decline in revenue per MHz has not yet been fully reflected in spectrum prices. Spectrum pricing would normally respond to a decrease in its value in a market-driven assignment process. However, prices for spectrum licences are often influenced by non-market factors – for example, when set by regulators or when driven by artificial scarcity.

Unit prices of spectrum (per MHz and population unit) have declined in recent years. The fall has been fastest in the sub-1 GHz band, where prices declined by almost 75%. Higher frequencies saw more moderate declines. This means the values of spectrum in higher and lower bands have somewhat converged in recent years.

Declines in unit prices were not sufficient to offset the build-up in the total cost of spectrum, largely driven by acquisition of the additional spectrum needed to deliver greater mobile data traffic and the launches of 4G and 5G networks.

Global average unit spectrum prices

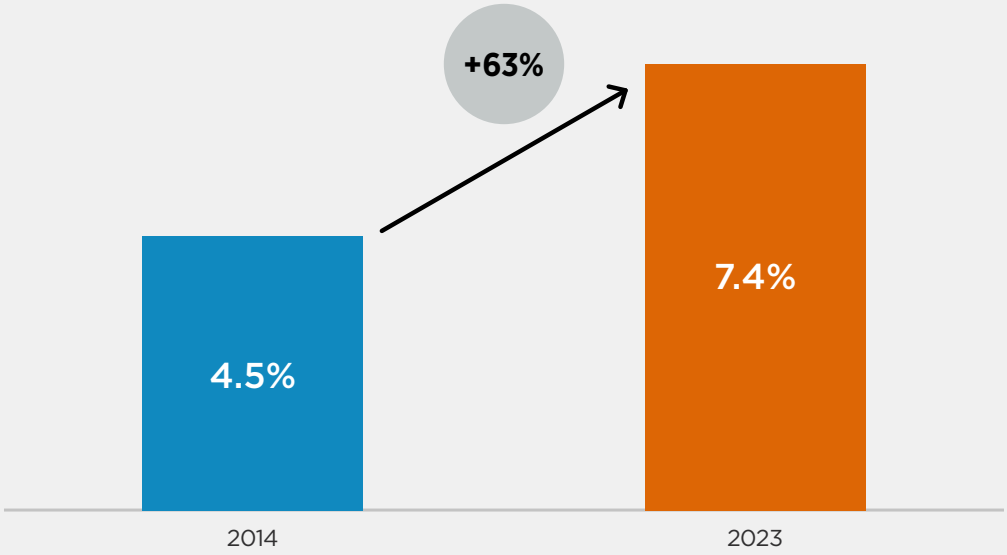


Note: Benchmark calculated as the upfront cost amortised over the duration of a licence, adjusting for the prevailing cost of capital at the time of assignment.
Source: GSMA Intelligence

Globally, ongoing spectrum cost has increased by 63%

Operators have paid $0.5 trillion in spectrum cost over the past decade. Aggregate spectrum cost has increased by 63%, reaching 7% of operator revenues in 2023. The increases in accumulated spectrum cost have varied. In some countries, such as Canada and Thailand, the ongoing cost of spectrum increased by a factor of three or more, predominantly driven by additions of new spectrum. In other countries, such as Italy and Spain, growth was somewhat moderated, as some of the expensive licences acquired in the early 2000s have expired and renewed at lower or no further cost.

Global spectrum cost to recurring revenue ratio (%)



Note: Calculated as an arithmetic average of countries where reliable data could be collected.
Source: GSMA Intelligence

Spectrum cost varies significantly by country. In some markets, the cost of spectrum can amount to a quarter of operator revenues (e.g. in India and Pakistan). In other countries, spectrum cost accounts for less than 2% of operator revenues (e.g. in Japan and China).

This variation points to the impact of public policy choices driving the costs faced by operators.

There are examples of countries with high and low spectrum cost regardless of the mode used to assign spectrum (auctions or administrative assignments) or charged (upfront or annual fees). Differences arise as a result of specific design aspects for auctions and administrative awards, spectrum scarcity and the objectives of the regulator, which frequently focus on revenue generation.

High spectrum cost negatively affects consumers

High spectrum cost adversely affects the viability of investments in mobile networks. Increased spectrum cost has a negative impact on consumers too.

A 10-pp higher spectrum cost to revenue ratio leads to coverage that is up to 6 pp lower. This effect is observed for both 4G and 5G coverage. There is a similar negative effect on network speeds. A 10-pp higher spectrum cost leads to a reduction in download speeds of 8%, and a reduction in upload speeds of 6%.

Making more spectrum available has positive impacts. Ten percent more spectrum results in coverage that is greater by up to 1.5 pp. The additional capacity provided by spectrum also leads to higher network speeds. Ten percent more spectrum leads to 4% greater network download speeds and 2% greater upload speeds. Latencies fall by 1% for every 10% increase in available spectrum.

These results highlight the effects of prices and availability of spectrum to be considered by spectrum managers seeking to maximise its social value. Assigning more spectrum at affordable prices increases the availability and quality of mobile services offered to consumers, which is key to closing the remaining coverage gap and reducing the technology divide between and within countries.

The impact of a 10-percentage point spectrum price increase compared to revenue

6-percentage point

Lower coverage

8%

Lower speeds

Source: GSMA Intelligence

Policy choices are driving spectrum prices

Spectrum policy decisions can have a direct effect on spectrum prices. Key policy elements that influence spectrum cost include the following:

- **Spectrum scarcity.** Operators trying to secure spectrum where little is available will have to pay more for each unit. Spectrum scarcity artificially inflates prices. We find that operators paid a 50% higher price when operating in a spectrum-constrained market, versus a market where double the amount of spectrum has been made available to operators.
- **Reserve prices.** Reserve prices are often set at a high level and no competitive bidding occurs. This was the case for 37% of examined assignments, when the final price paid by an operator during an auction was based on the reserve price, rather than competitive bidding. In these instances, reserve prices can elevate prices. High reserve prices can also lead to unsold spectrum, and in this case indirectly impose the opportunity cost of unused spectrum and artificial spectrum scarcity.
- **Obligations attached to licences.** Meeting onerous coverage and/or quality-of-service obligations can also be an important driver of high spectrum cost. Spectrum prices should be adjusted to ensure they reflect the cost to operators. Alternatively, regulators should unbundle spectrum licences from service-level obligations to ensure these are met efficiently.

Upcoming renewals provide an opportunity to rationalise pricing

Spectrum prices should adjust to changing supply and demand conditions. They should do so in line with the potential revenue opportunity or cost saving that each additional MHz can deliver. As the revenue per MHz of spectrum declines, prices should adjust accordingly. Not doing so represents a risk to efficient use and can lead to detrimental outcomes for consumers.

Between 2025 and 2030, close to 1,000 individual licences in 110 countries will expire, providing an opportunity to adjust spectrum prices to their actual market value. A rational approach to these renewals and new spectrum bands will help realise the full benefits of mobile technology.

Pricing recommendations

New spectrum

1. Regulators should not anchor administratively set prices to historical prices and outdated benchmarks.
2. Setting reserve prices at a low level allows room for price discovery and minimises the risk of unsold spectrum.
3. Making all spectrum allocated to mobile services available to operators ensures there is no artificial scarcity and supports better outcomes for consumers.
4. The cost of meeting obligations or investment commitments attached to spectrum licences should be reflected in their price.

Licence renewal

1. Fees should not be linked to historical spectrum prices, given the decrease in underlying value.
2. Renewal fees contribute to the build up of spectrum cost and can have negative impacts on consumers. A spectrum trading framework can provide the same incentives without imposing additional costs.
3. Regulators can consider renewals in exchange for investment commitments for coverage or quality of service.
4. Alternatively, administrative review can be the most cost-effective way of ensuring that spectrum remains in efficient use.

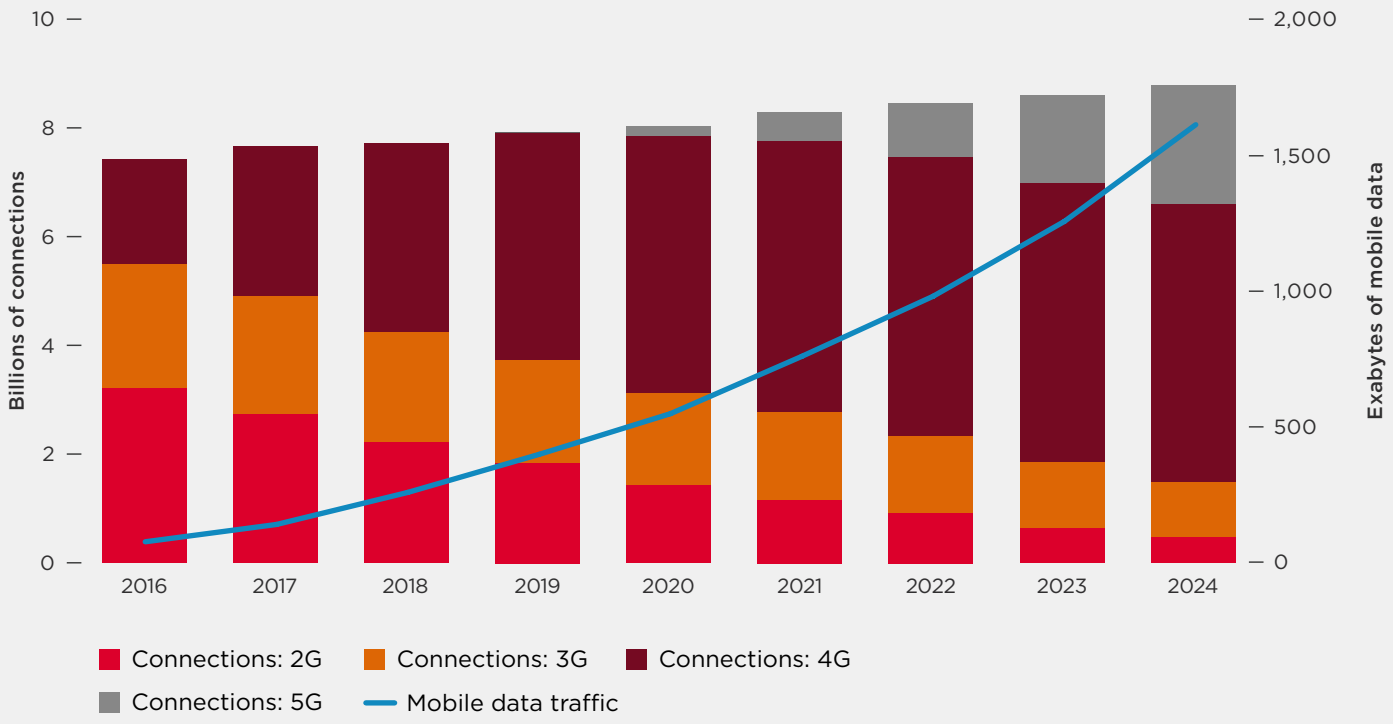
Across the world, many regulators have already identified the need for innovative approaches to deliver the required cost reductions. Recent multiband auctions using longer licence terms and a flexible approach to obligations serve as examples of a robust approach to maximising spectrum value. Cost-free renewals and renewals in exchange for investment commitments also serve as examples of alternative approaches that seek to ensure efficient spectrum use and maximise the benefits of connectivity.

1. Demand for spectrum has increased

Spectrum needs have grown with demand for mobile data

Each incremental generation of mobile has resulted in improved services. This has been achieved as a result of technological improvements and major investment in new generations of mobile networks. Fast, reliable and affordable mobile connectivity has led to the emergence of cutting-edge use cases, which has resulted in even faster growth in demand for mobile data (see Figure 1).

Figure 1
Generational changes in mobile connectivity and growth in data use

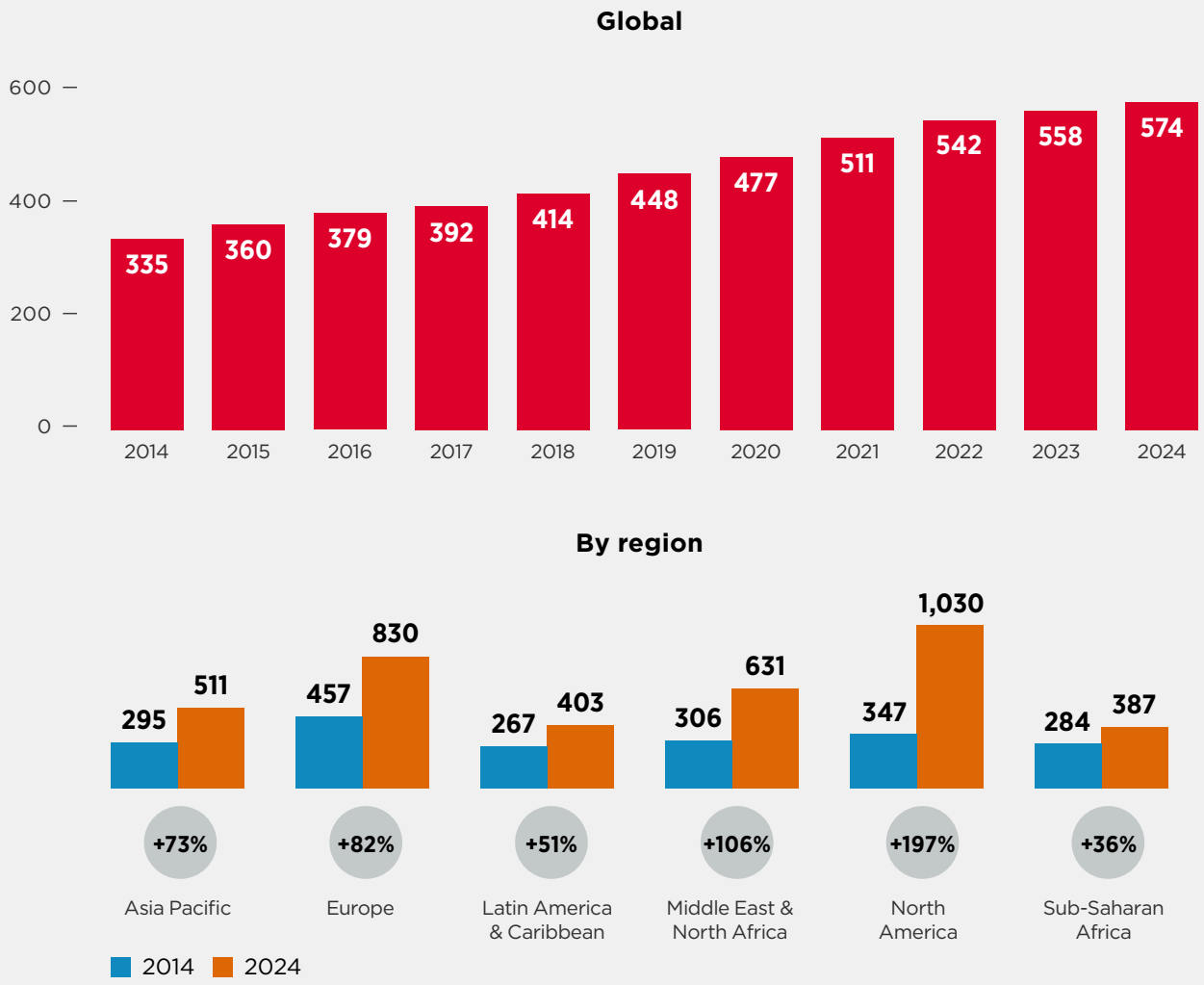


Source: GSMA Intelligence

To meet this demand, the latest generations of mobile networks use spectrum more efficiently, allowing data to be transmitted at a rate that is tens of times faster per each MHz of spectrum compared to the efficiency of early 2G networks.

However, demand for data has grown even faster than these improvements in efficiency of spectrum use. Operators have therefore needed to acquire additional spectrum to realise the full potential of 4G and 5G technologies (Figure 2).

Figure 2
Average MHz assigned to mobile operators for frequency bands below 7 GHz



Note: Average calculated as arithmetic average of countries in the region where data could be collected.
Source: GSMA Intelligence

Revenue per connection has declined

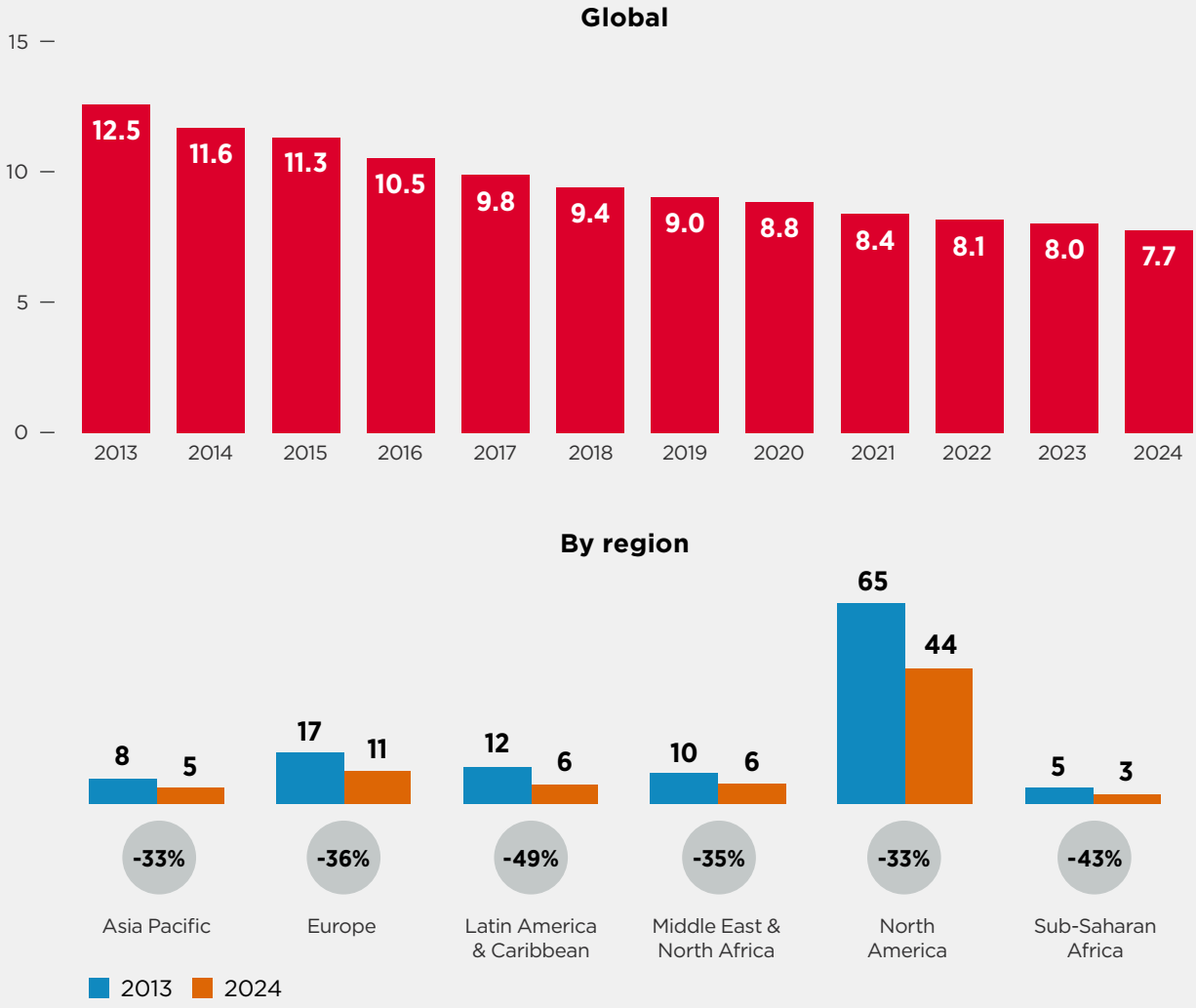
The capabilities of mobile networks have grown from basic call and text services to high-speed broadband, enabling what was once considered impossible: video calling in remote places, reliable mobile banking and more. The value of these use cases to consumers has grown well beyond what original mobile telephony offered.

Most additional value brought by the latest generations has been captured by consumers and other digital ecosystem players, such as content and application providers. Over the past decade, operators in most regions have seen declines in average revenue per connection (Figure 3). This can be attributed to factors such as:

- mobile service becoming a mature market, with high levels of competition driving down prices
- mobile reaching the lower end of the consumer market and providing services to lower-income consumers
- regulatory restrictions and price caps in some countries.

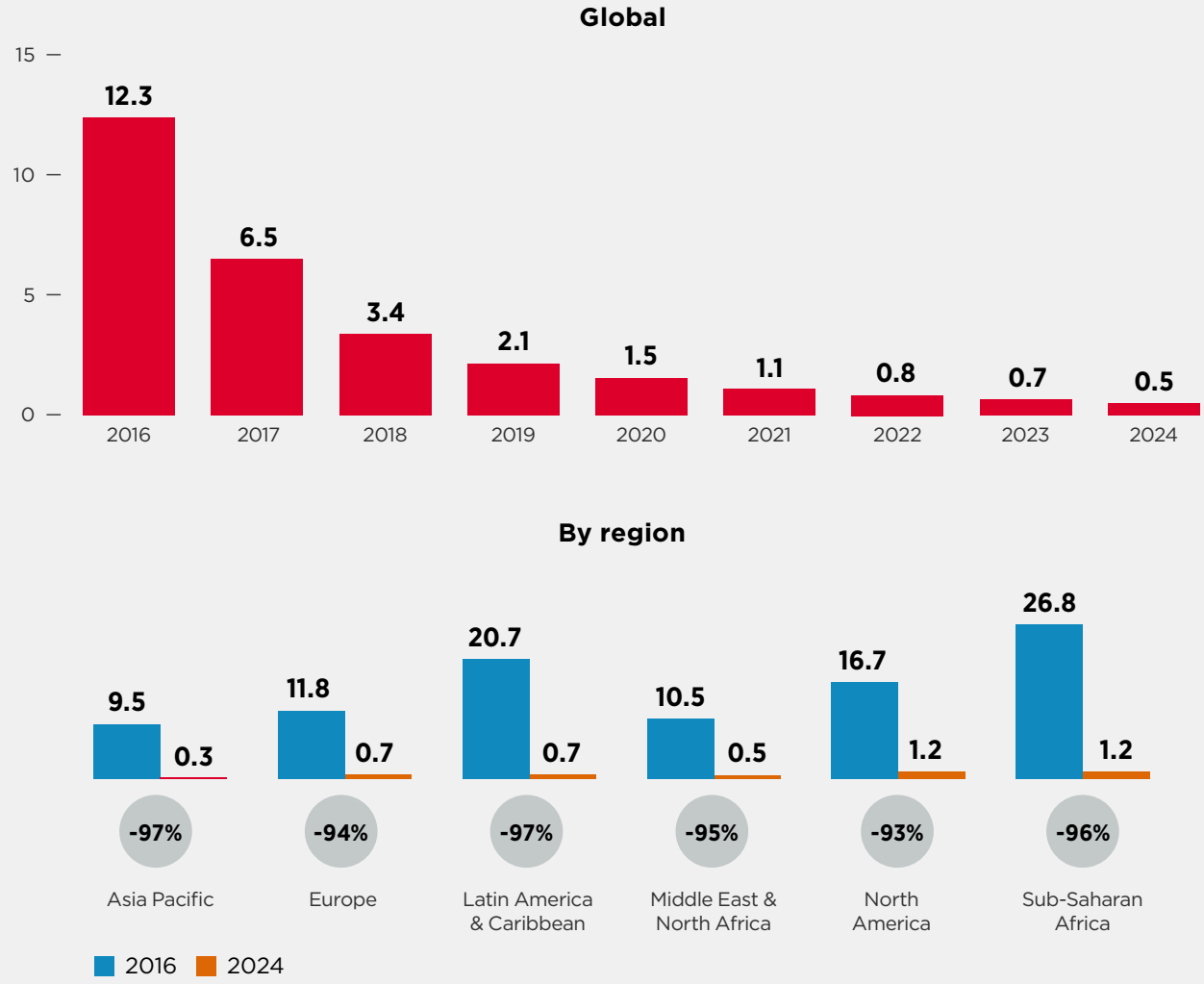
Examining average revenue per GB of mobile data leads to similar conclusions (Figure 4). Thanks to investment in technological progress, operators have been able to offer consumers more mobile data for less. Between 2016 and 2024, average revenue per GB of data declined by 96%.

Figure 3
Average recurring revenue per connection ($, inflation adjusted)



Note: Average shown as a weighted average of countries in the region. 2023 US dollar prices.
Source: GSMA Intelligence

Figure 4
Average revenue per GB of data ($, inflation-adjusted)



Note: Weighted average of countries in the region where data is available. 2023 US dollar prices.
Source: GSMA Intelligence

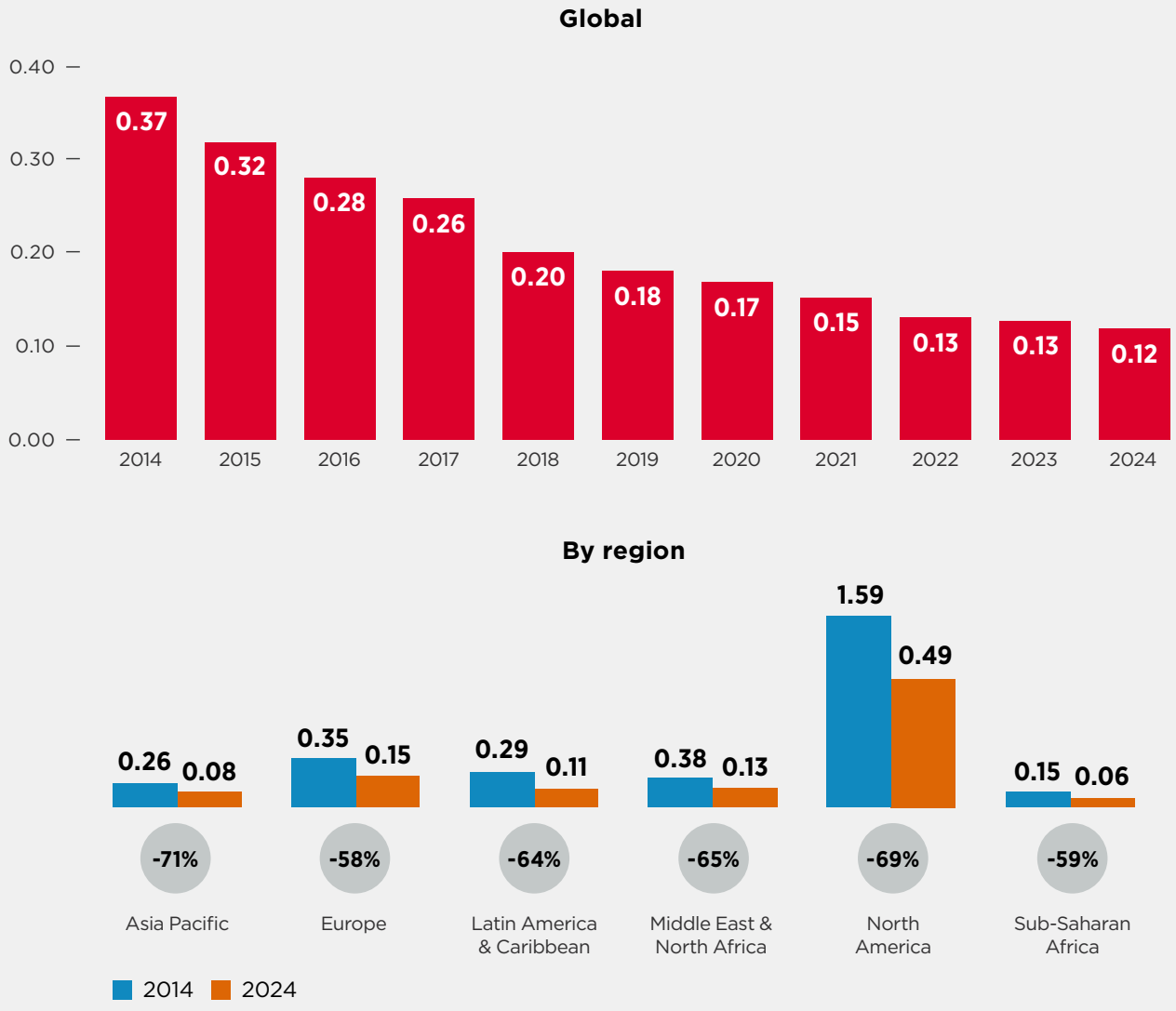
Revenue per MHz has declined

The declining trend in revenue per subscriber and the growth in spectrum held by operators have meant operator revenue per MHz has declined. This trend is evident across all regions (Figure 5). In other words, an average consumer pays less for mobile services than a decade ago. At the same time, to support the throughput generated by an average user, operators require more spectrum than a decade ago.

This has two implications:

- The value of each unit of spectrum to operators has declined in recent years, in proportion to the change in market revenue that each MHz can support.
- Prices for spectrum licences should have responded by falling. However, prices paid by operators for spectrum licences are often driven by non-market factors, so this may not have fully materialised.

Figure 5
Average monthly recurring revenue per MHz per connection ($, inflation adjusted)



Note: Data shows weighted average revenue per MHz per connection of countries in the region where data could be collected. 2023 US dollar prices. Based on spectrum below 7 GHz.

Source: GSMA Intelligence

2. Spectrum unit prices have declined

Spectrum prices should have reflected the changing reality of declining revenues that each MHz can generate for operators.

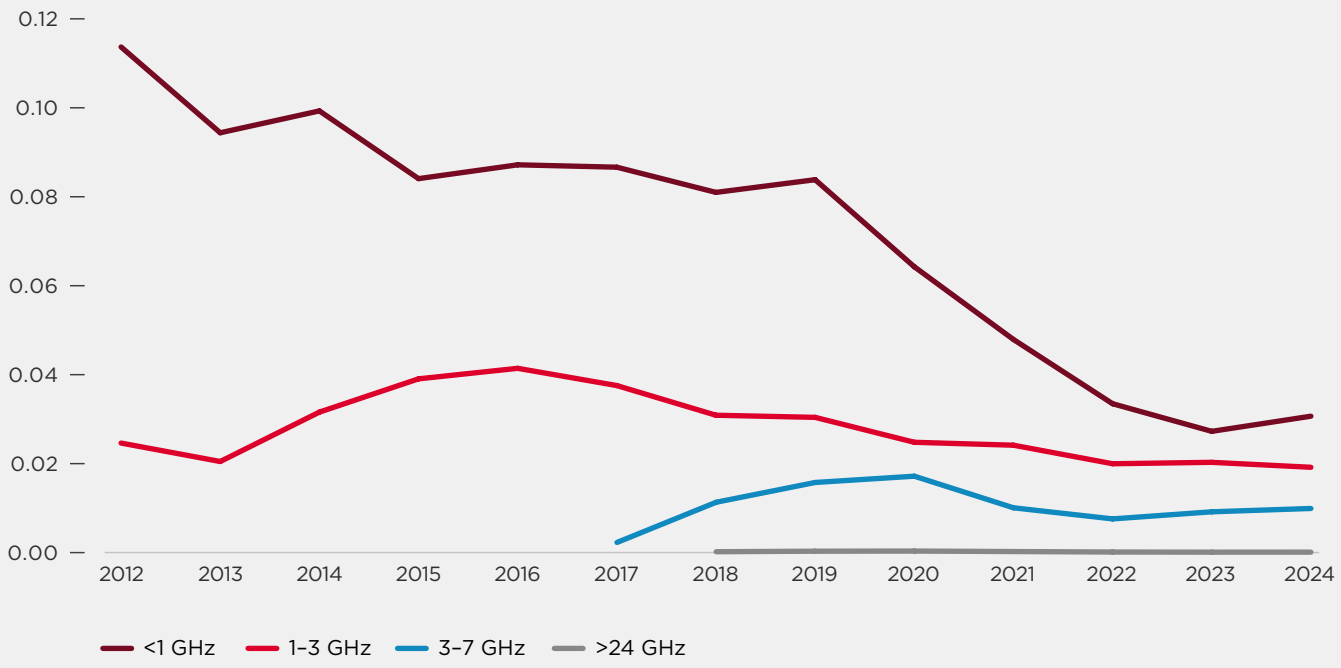
Prices per MHz per unit of population have declined in recent years. However, the declines were not sufficient to offset the build-up in spectrum cost burden over the years due to the acquisition of the additional spectrum necessary to bring 4G and 5G networks to consumers.

2.1 Unit spectrum prices worldwide

Examining average global prices (Figure 6), low-band spectrum prices have declined the most, with the average cost per MHz in 2023 being 75% less than in 2012. These bands are more valuable due to their scarcity in terms of bandwidth and their superior propagation properties compared to higher bands. However, relative prices between <1 GHz, 1–3 GHz and 3–7 GHz bands have been converging, likely due to network densification and the increased importance of adding capacity in new technologies to meet growing demand for data.

Regardless, large differences in prices remain between bands. Spectrum in the sub-1 GHz band is the most expensive, with prices gradually declining for mid- and higher frequency bands. Each MHz of spectrum in the mmWave range (>24 GHz) is priced at less than 1% of the average price of spectrum in low bands.

Figure 6
Global unit spectrum price trend: three-year moving average (2023 $ PPP, MHz/year/population)

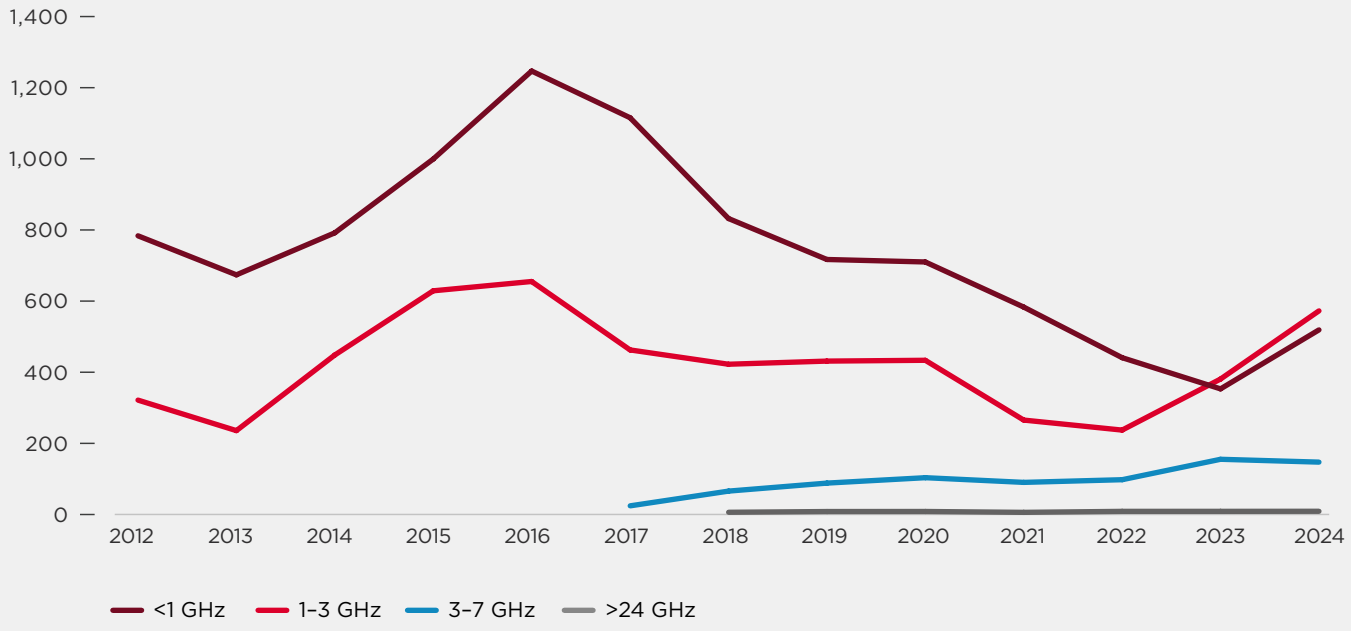


Note: Benchmark calculated as the upfront cost amortised over the duration of a licence adjusting for the prevailing cost of capital at the time of assignment.
Source: GSMA Intelligence

In Figure 7, unit prices are expressed per MHz, per year and per million of combined recurring (subscription) revenue of all operators in the country. This metric considers the revenue stream of a market that the licence gives access to, adjusting simultaneously for factors such as population size, penetration rate and average revenue per subscriber.

Although the general trend of declining prices per unit of revenue is clear, in particular for sub-1 GHz spectrum, the declines were not as marked when prices are expressed in terms of population. This is because revenue per subscriber has declined in the most recent years, leading to a smaller market size despite some growth in population. For the same reasons and an additional effect of network densification, prices of spectrum relative to operator revenues have increased in the 1–3 and 3–7 GHz bands, leading to convergence in unit prices between the high and low bands.

Figure 7
Global unit spectrum price trend: three-year moving average ($/MHz/year/$ million of market revenues)



Note: Benchmark calculated as the upfront cost amortised over the duration of a licence adjusting for the prevailing cost of capital at the time of assignment.
Source: GSMA Intelligence

How trends in unit prices are examined

To allow for comparisons across countries and over time, we standardised prices by appropriate market size proxies, such as population and market revenues. In addition, when expressing prices in terms of per unit of population, we adjusted prices for inflation and differences in purchasing power parity between countries.

2.2 Spectrum prices across regions

Unit prices of spectrum vary within each region and over time (Figure 8). This can be explained by the particular conditions of each market at the time of assignment, and the approach to pricing taken by the regulator. Hence, we frequently observe significant differences in unit prices of licences acquired in the same year and in the same region.

While there is significant variation in prices between individual assignments, these generally balance out and over time lead to similar average price levels across all regions. This is after adjusting for differences in purchasing power parity and inflation, to ensure monetary values are comparable.

The declining trend in prices per unit of population is reasonably clear across all regions when measured in terms of per unit of population. In terms of per million $ of operator revenues (Figure 9), the trends are mixed. Unit prices of spectrum below 3 GHz have declined slightly, while prices of higher bands have slightly increased relative to operator revenues.

Some high-level differences between regions include the following:

- Prices in Asia Pacific and MENA tended to be somewhat higher than in other regions. This is evident across low and mid-bands.
- Prices in Europe, Latin America & the Caribbean and North America are generally closely aligned and sit close to the global mean.
- Prices in Sub-Saharan Africa were typically lower than in other regions when measured in terms of per unit of population. However, when measured in terms of per unit of revenue, they were generally aligned with other regions.

Figure 8
Spectrum prices by region and band (2023 $ PPP/MHz/year/population)

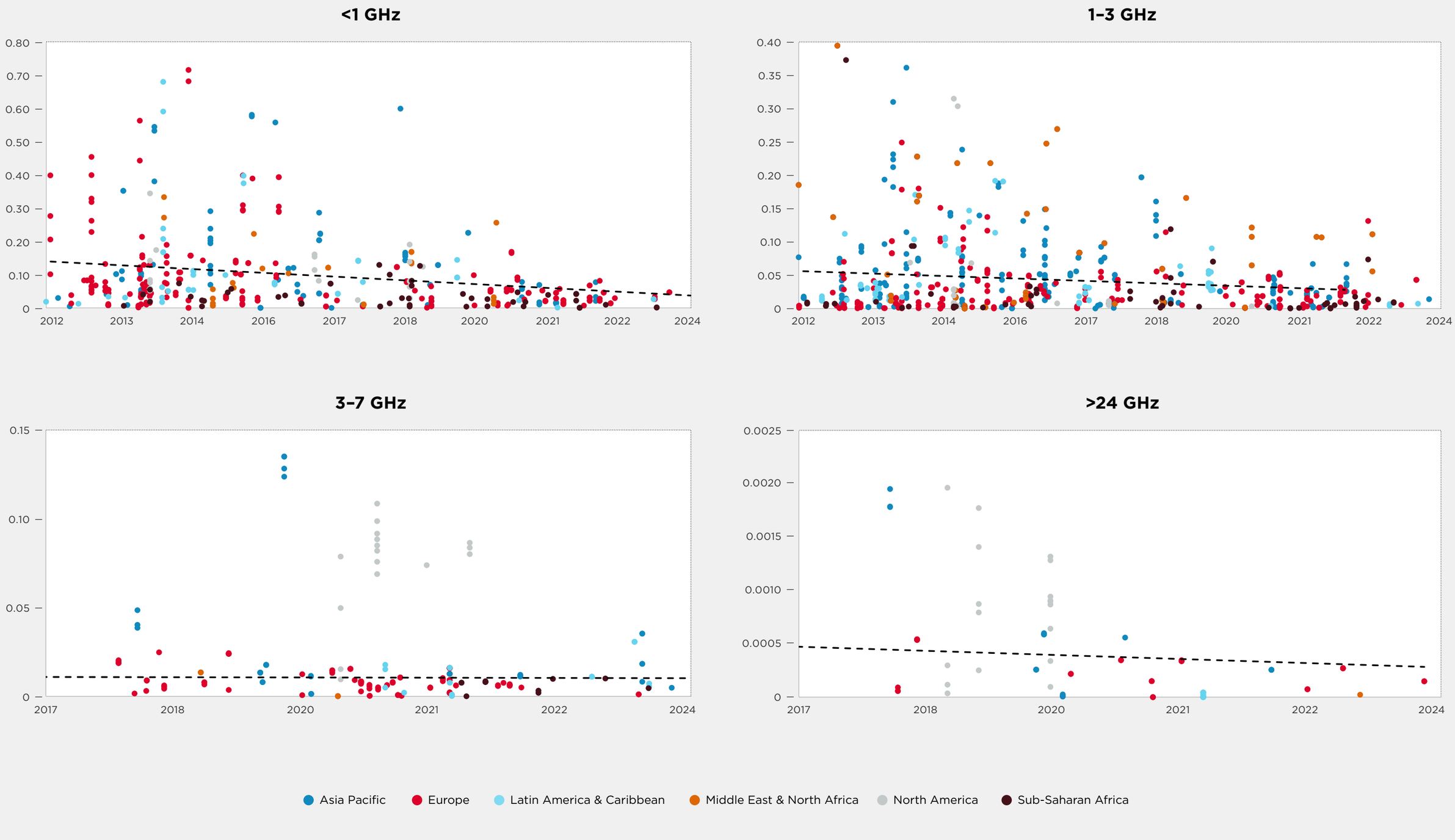
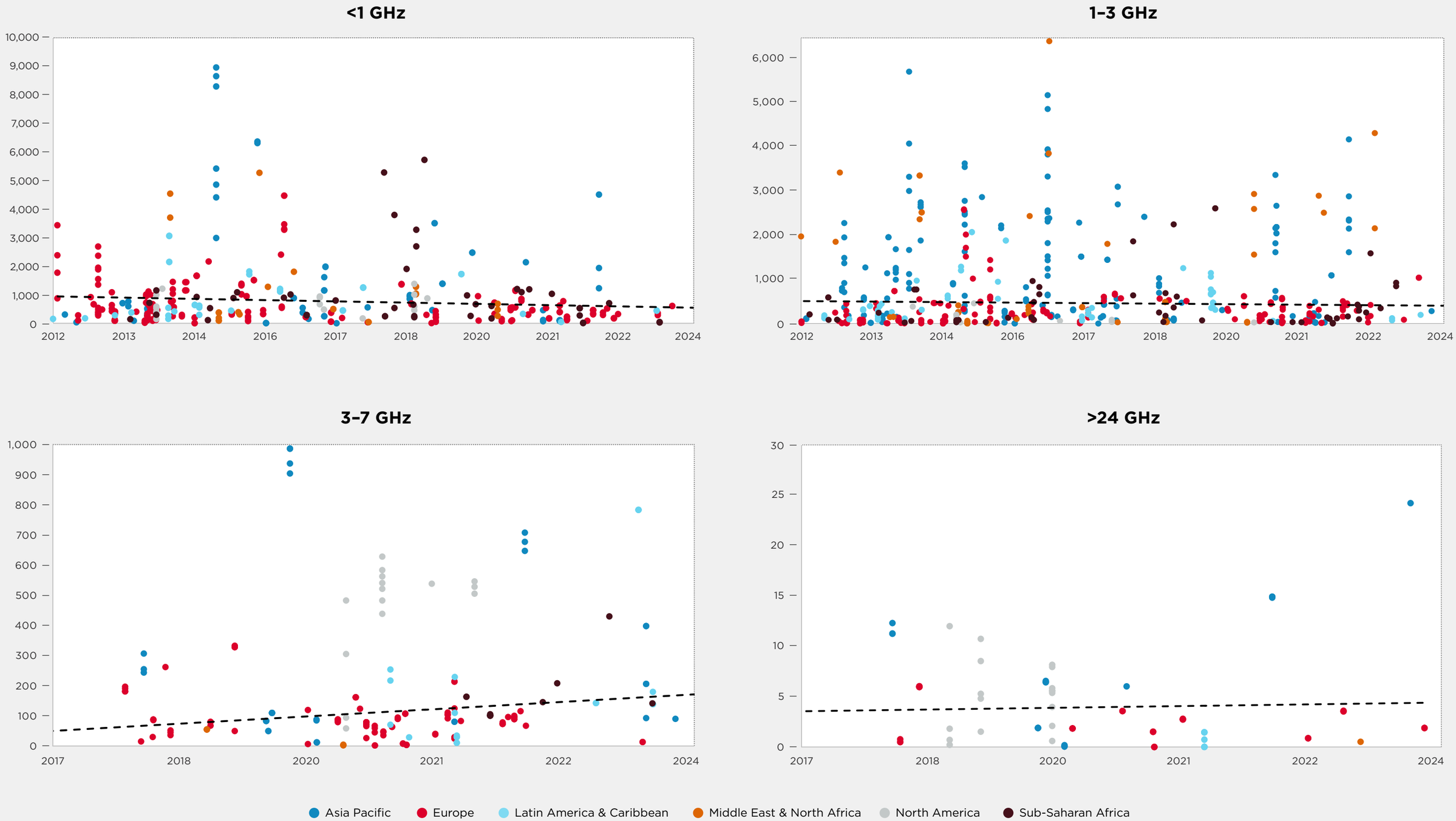


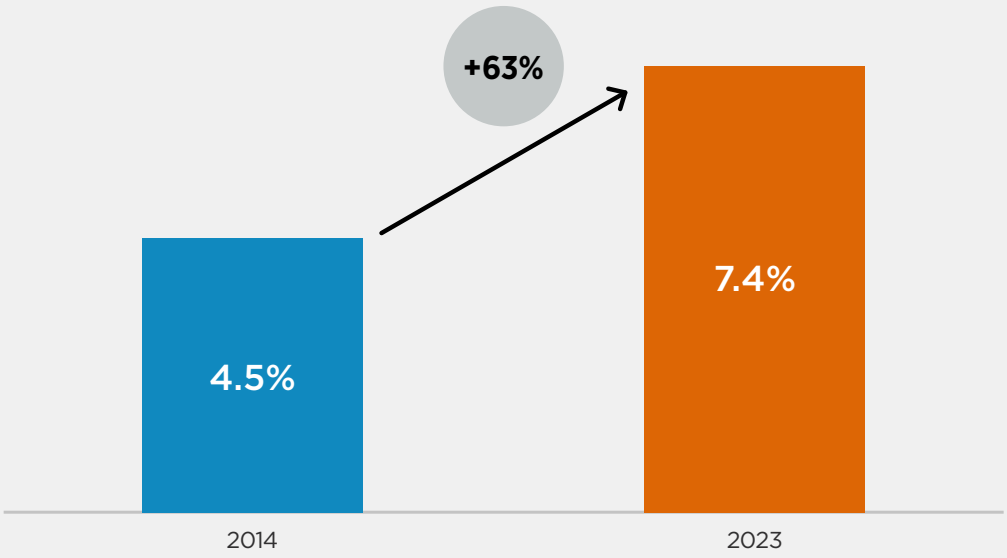
Figure 9
Spectrum prices by region and band ($/MHz/year/$ million of revenues)



3. Spectrum cost burden has grown over the past decade

The increase in spectrum holdings and decline in revenues per connection have reduced operators' ability to pay for additional spectrum and renewals. Reductions in unit spectrum prices to date have not been sufficient to offset this, leading to the increased cost burden of spectrum (Figure 10). The overall increase in the long-term spectrum cost burden can pose a risk to further investment and future consumer outcomes.

Figure 10
Spectrum cost to recurring revenue ratio (%, global average)



Note: Calculated as an arithmetic average of countries in the region where reliable data could be collected.

Between 2014 and 2023, the spectrum cost burden increased by 63%. This has been driven by spectrum acquisitions to bring 4G and 5G to consumers. The increasing trend was seen across all regions, with some seeing a tripling of the accumulated spectrum cost. Based on data available, the total cumulative cost of spectrum to operators globally between 2014 and 2023 reached $0.5 trillion.

How to measure spectrum cost accumulation

The spectrum cost burden is measured through the spectrum cost to recurring revenue ratio (cost-to-revenue ratio or CRR). This provides an aggregate estimate of accumulated spectrum cost based on all active licences, taking into account upfront fees (amortised over the licence duration) and any annual fees, where applicable. It does not consider any other fees, such as operating licences or the cost of meeting obligations attached to licences.

Post 2020, there are signs of the spectrum cost burden stabilising in some areas. In certain countries in Europe and MENA, the expiry of expensive licences acquired in the 2000s and renewal at a lower or no additional cost have helped ease the increase in the spectrum cost burden. However, this has not been sufficient to offset the overall growth in spectrum cost relative to revenues observed since 2014.

Cross-country comparisons show a significant degree of variation in spectrum cost (Figure 11 presents selected examples). In some countries, the burden of spectrum cost reaches up to a quarter of operator revenues (e.g. India, Pakistan and Egypt). Meanwhile, in a number of countries, operators can pay as little as 1% of their recurring revenues (e.g. China, Japan and South Africa).

These differences arise as a result of diverse approaches to assigning and charging for spectrum.

Some countries, such as China and Japan, primarily rely on annual fees set at a level deemed sufficient to ensure spectrum is put to best use and that the regulatory cost is recovered.

Other countries rely on auctions for initial assignments, frequently combined with additional annual fees. However, assignment method or choice between upfront and annual fees is not a driver of spectrum cost as such. We observe examples of countries with high and low spectrum cost regardless of the mode used to assign spectrum. Rather, differences arise as a result of specific design aspects for auctions and administrative awards, spectrum scarcity and the objectives of the regulator, which can often focus on revenue generation.

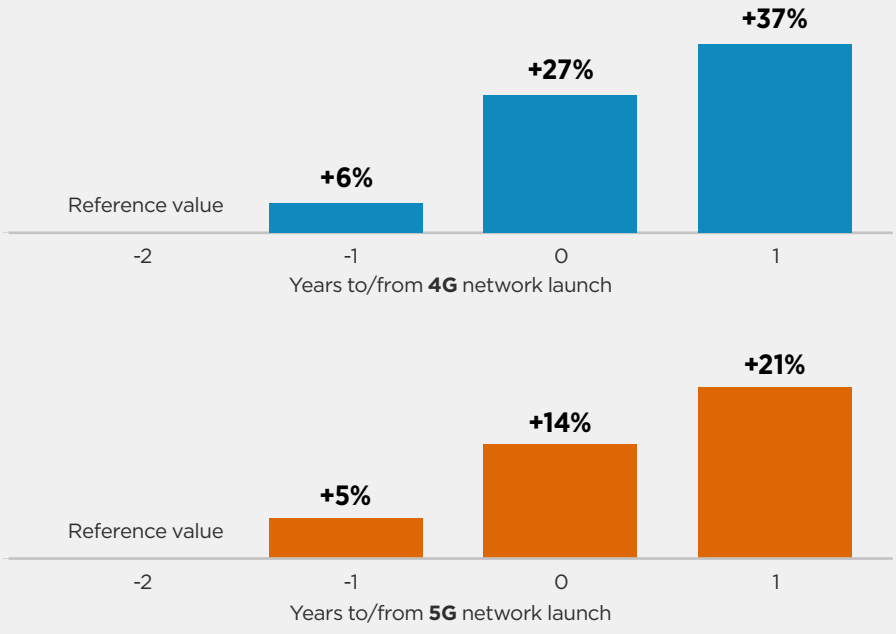
Further differences arise because of different approaches to spectrum licence renewal, from re-auctioning of licences towards their expiry date (Thailand) to presumption of renewal (US).

Some countries offer spectrum at discounted or no fee, in exchange for commitments to service quality or other regulatory obligations or investment commitments (see case study on France's New Deal).

The remaining differences in the burden of spectrum cost can be explained by different strategies taken by operators and local conditions such as geography or market competitiveness. For example, some operators may choose to acquire less spectrum, potentially offering lower network quality, and instead focus on customer-service quality.

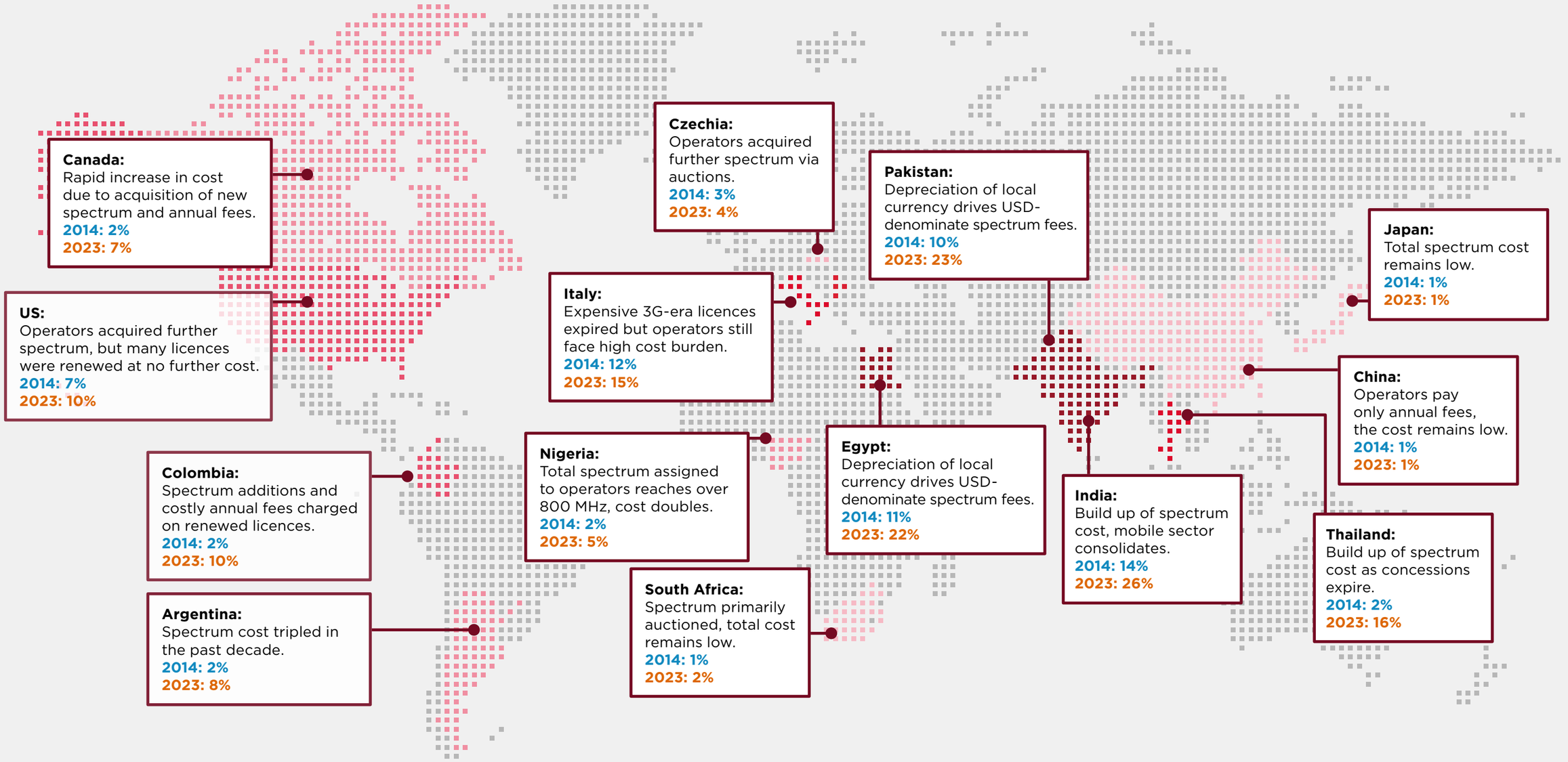
Part of the accumulation of cost coincides with acquisition of additional spectrum ahead of the launch of a new technology (Figure 11). On average, the spectrum cost-to-revenue ratio increased by 37% during the launch of 4G networks by operators. This accumulation was somewhat lower ahead of 5G launch. On average, operators' spectrum cost burden increased by 21% during the period of 5G network launches.

Figure 11
Growth in spectrum cost to recurring revenue ratio before network launch



Note: Based on selected operators where data was available.
Source: GSMA Intelligence

Figure 12
Cost to recurring revenue ratio by country

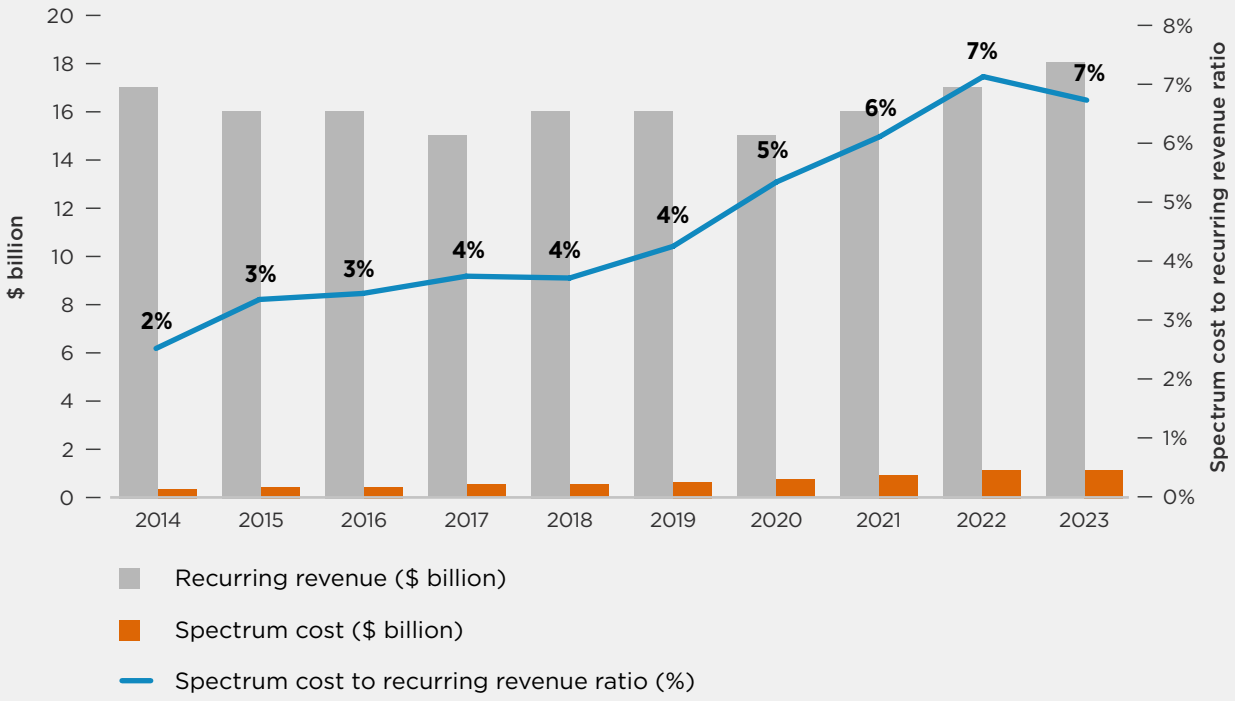


Source: GSMA Intelligence

Country focus: Canada

Since 2013, the burden of spectrum cost in Canada has increased by more than 300%. This was primarily driven by the acquisition of additional spectrum, with major additions in 2014 (700 MHz band), 2019 (600 MHz) and 2021 (3.5 GHz).

Growth in spectrum cost burden in Canada



Policy has contributed to the build-up of spectrum cost. For example, the first assignment of the 3.5 GHz band took place in 2021, later than in most of Canada's peers. Only 150 MHz was made available to three major operators, with 50 MHz set aside for other users. This has led to artificial spectrum scarcity and higher prices paid by operators, which in per-capita terms were more than 10× greater than in some comparator countries.[1]

Canada has relied on setting aside spectrum for regional operators on several occasions. As well as their impact on spectrum cost, set asides can be detrimental to the efficiency of allocation of spectrum to its best use. According to estimates, setting aside 44% of available spectrum during the 2008 auction led to inefficiency and underutilisation of spectrum. As a result, consumer prices of mobile services were estimated to be higher by up to 4%.[2]

Canada's example illustrates the importance of the indirect impact of scarcity on spectrum prices, leading to gradual build-up of cost. According to operators' reports, recent costs due to acquisition of spectrum were higher than spending on network physical infrastructure, a potential sign of crowding out of further investments into networks.

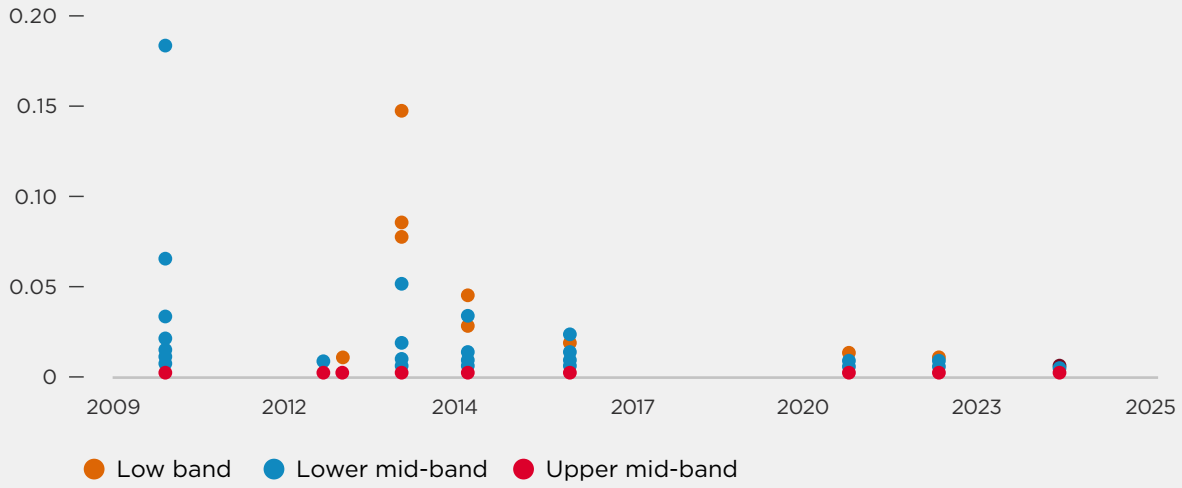
1. Falling Behind: Comparing 5G spectrum policies in Canada and OECD countries, Analysys Mason, 2021
2. Efficient Policy to Promote the Interests of Wireless Consumers: Lessons from Misallocating Spectrum to Promote Competition in Canada, Fellows and Church, 2023

Country focus: India

India has traditionally relied on spectrum auctions, but these have frequently been hindered by excessive reserve prices, leading to unsold spectrum and contributing to spectrum scarcity. In other instances, high reserve prices contributed to higher final prices paid by operators.

In recent years, the approach has been revised, and reserve prices have been reduced to avoid further failures.[3] Simultaneously, already accumulated spectrum cost meant operators were able to pay much less per unit of additional spectrum.

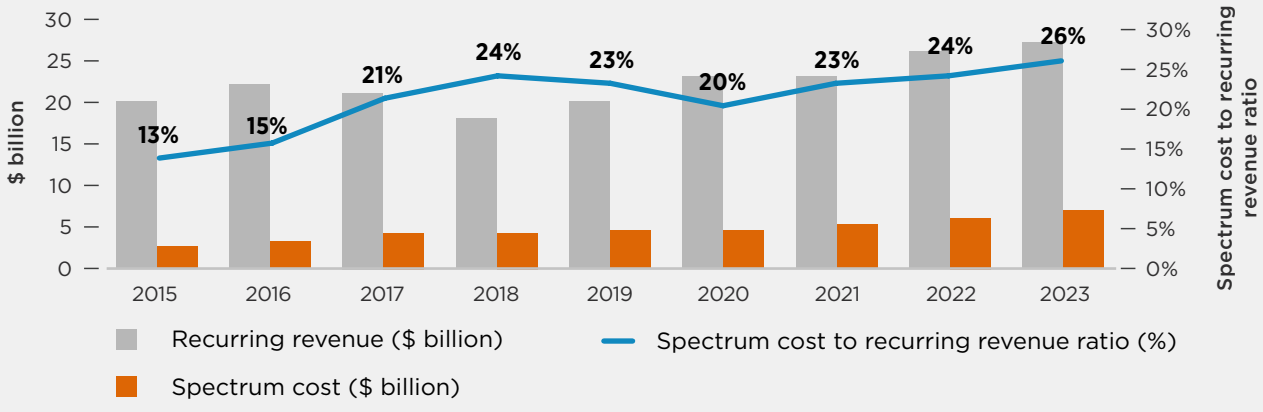
Average unit price in India's auctions ($/MHz/year/population, inflation-adjusted)



Source: GSMA Intelligence

However, lower unit prices in recent assignments were not sufficient to reverse the trend in spectrum cost build-up. The acquisition of new bands to support 5G and improved 4G networks has meant that the spectrum cost burden gradually increased between 2015 and 2023. This currently stands at 26% of operator recurring revenues and is among the highest in the world. Rationalised spectrum pricing can be seen as a catalyst for recent accelerated 5G rollout and improved network quality in India. However, the burden of spectrum cost will continue to influence India's progress towards its digital goals for years to come.

Growth in spectrum cost burden in India



Source: GSMA Intelligence

3. Spectrum Licensing Best Practice: India, GSMA, 2023

4. The rising cost of spectrum negatively affects consumers

4.1 How does the build-up of spectrum cost negatively affect consumers?

When spectrum cost does not reflect its underlying value, it leads to distorted investment incentives for operators, resulting in potential underdevelopment of networks. A previous study conducted by GSMA Intelligence found that, in the era of 3G and 4G, high spectrum prices negatively affected consumer outcomes such as speeds and coverage.[4]

In the 5G era, the aggregate cost burden of spectrum has increased further, as much more spectrum has been required for 5G. Examining the impact of spectrum cost on consumer outcomes in the 4G/5G era shows that:

- a 10-pp higher spectrum cost to revenue ratio leads to coverage that is lower by about 4 pp
- a 10-pp higher spectrum cost means a reduction of download speeds by 6%, and a reduction in upload speeds by 4%.

Statistical analysis also confirms the vital role of making sufficient spectrum available to enable network rollout:

- 10% more spectrum leads to 1-pp greater coverage based on 4G networks, and 2-pp greater coverage based on 5G networks
- 10% more spectrum leads to 4% higher network download speeds and 2% higher upload speeds. Latencies decline by 1% for every 10% increase in spectrum.

4. The impact of spectrum prices on consumers, GSMA, 2019

Figure 13
The Impact of spectrum pricing on consumer outcomes

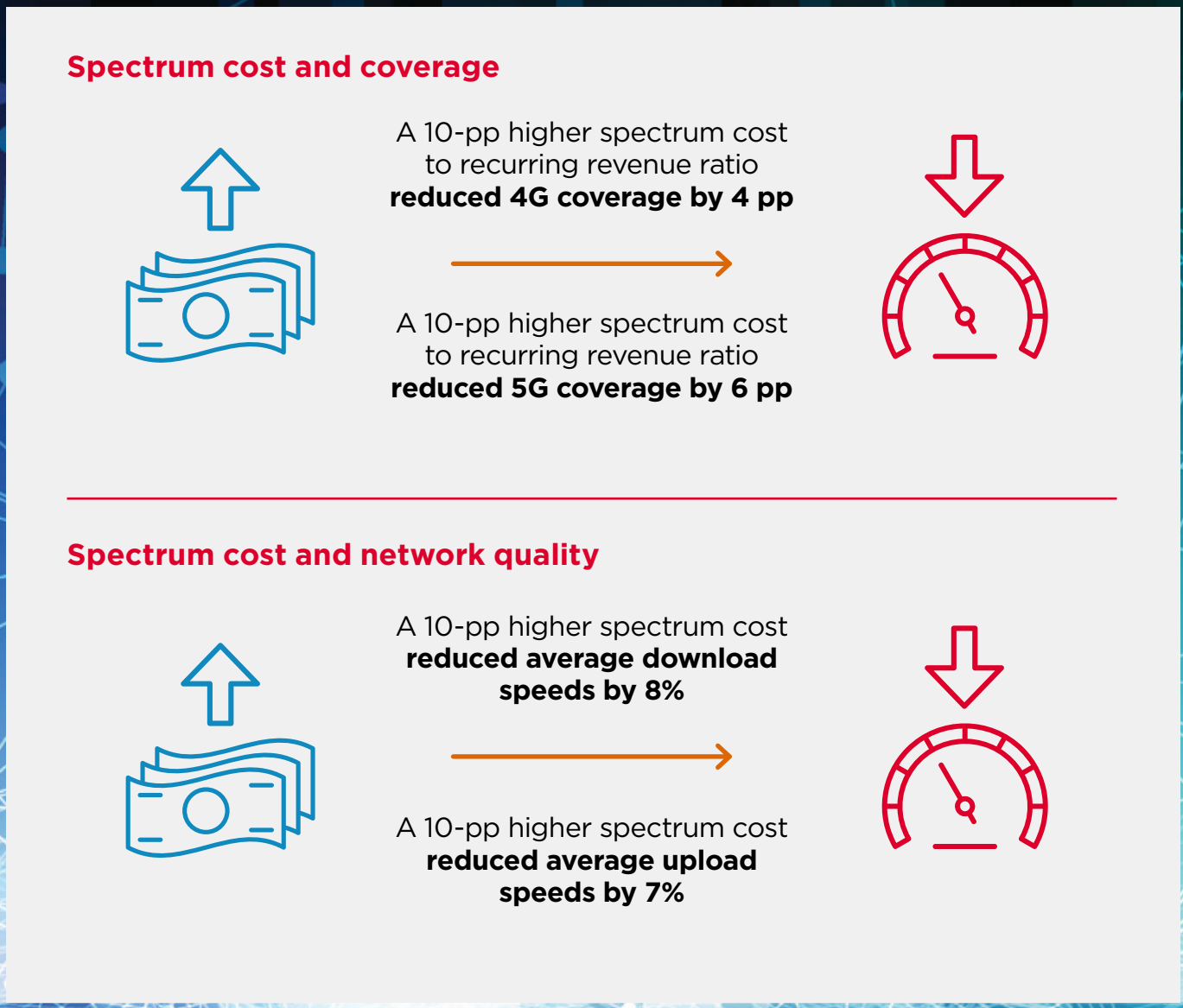
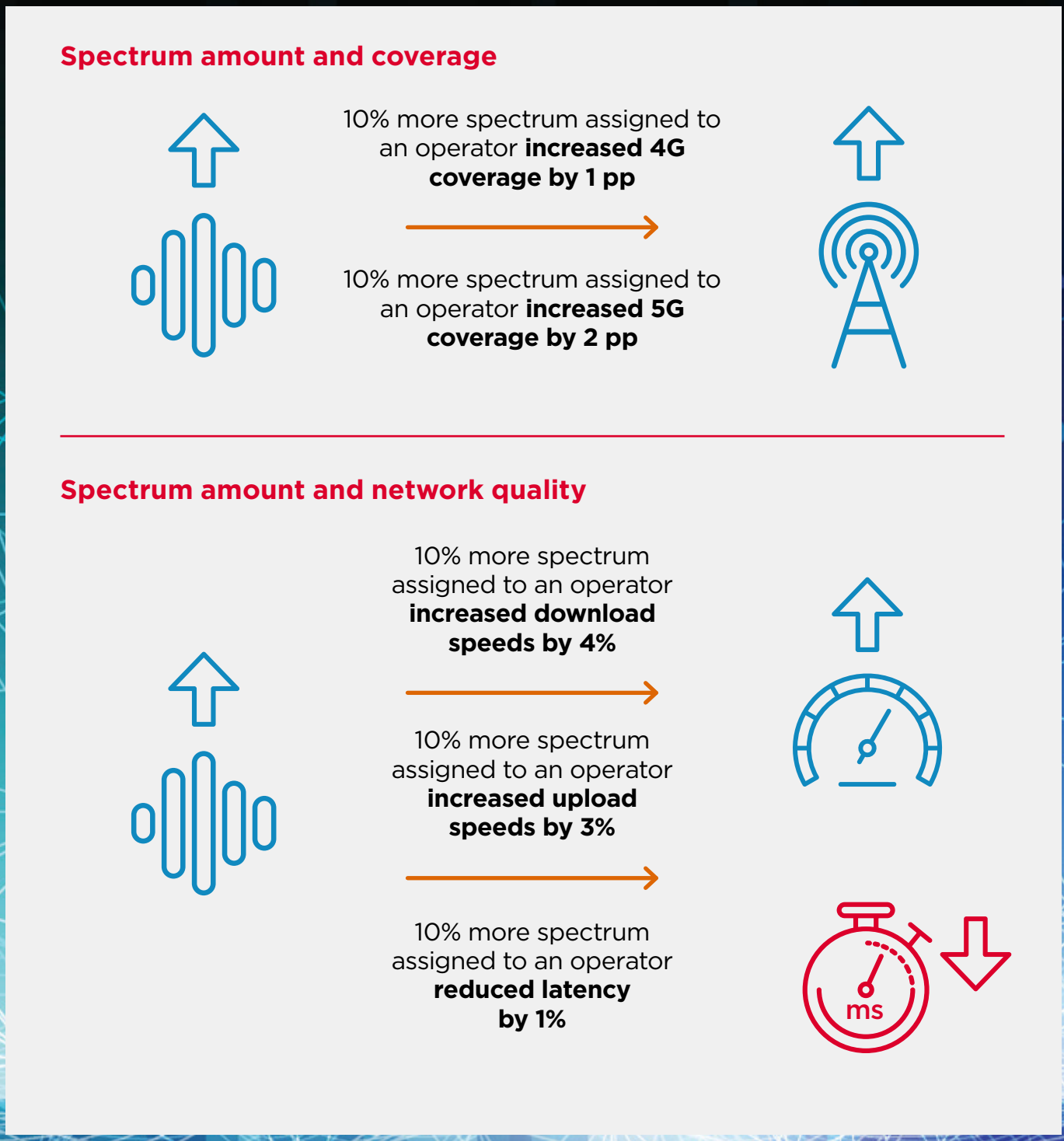


Figure 14
The impact of spectrum availability on consumer outcomes



These findings demonstrate the importance of taking the right approach to spectrum pricing. Policy is a major determinant of the prices operators pay for spectrum. Regulators seeking to maximise the social value of spectrum should therefore ensure their approach to pricing does not result in undue negative effects.

How the statistical analysis was conducted

To provide robust evidence, we empirically measure the relationship between spectrum cost, spectrum amount and various consumer outcomes. The methods are discussed in detail in the Appendix to this report. In brief, they consider:

- independent growth trends in the acquisition of spectrum, its cost and the simultaneous trends in adoption of the new mobile generations and observable confounders, adjusting for factors such as:
  - GDP per capita
  - market concentration index, as a proxy for competitiveness
  - rural population share, as an influential driver of network cost
- unobservable confounders (we eliminated the effect of these by estimating the effect on the basis of comparisons between operators in the same country and across time)
- potential compounding effects as accumulated spectrum cost reaches a certain threshold.

The dataset used covers more than 230 operators in 97 countries between 2014 and 2023. The examined variables and data sources are summarised in Table 1.

Table 1
Datasets used to estimate the impact of spectrum cost on consumer outcomes

Outcome variables	Spectrum cost variables	Control variables
4G and 5G coverage *(GSMA Intelligence, 2024)*	Spectrum cost to revenue ratio *(GSMA Intelligence data collection, 2023)*	Amount of spectrum assigned to an operator *(GSMA Intelligence data collection, 2024)*
Experienced mobile network download and upload speeds, latencies *(Ookla, 2024)*	Average spectrum cost per MHz per connection *(GSMA Intelligence collection, 2023)*	Logarithm of GDP per capita in US dollar constant prices *(IMF WEO projections, 2024)*
		Market concentration index *(GSMA Intelligence, 2024)*
		Rural population share *(World Bank, 2024)*

To ensure robustness, we limit the sample of analysis to operators where data is most reliable. We rely on transparent inclusion criteria based on measures of data completeness.

The allocation or classification of general regulatory costs as spectrum cost is sometimes open to different interpretations. For example, in some countries, spectrum is awarded as part of a general operating licence awarded to an operator. Conversely, some annual and incidental costs may not be fully reflected in our estimates – for example, those linked to conversion to use by different technology or administrative costs. By consistently treating and classifying these across the dataset, we ensure robust analysis of the effects.

5. How public policies influence spectrum cost

5.1. Which key factors determine spectrum cost?

Spectrum licence prices can, in part, be explained by the basic determinants of the value of spectrum to operators. Operators value licences based on the amount of bandwidth, their duration and the market size that spectrum licence covers.

In line with these expectations, our examination of data on more than 1,000 individual licences shows the following:

- Licence prices increase almost directly proportionally to their bandwidth, duration and population covered.
- However, when it comes to revenues and spectrum prices, the relationship is not directly proportional, as prices decline by only about 30% when revenue per connection halves. This finding is consistent with trends presented in Chapters 2 and 3, which show that while ARPU levels reduced over time, spectrum unit prices reduced significantly less. This is likely caused by various policy factors that artificially prevented spectrum prices from adjusting to lower revenues.

Figure 15
Basic drivers of spectrum prices

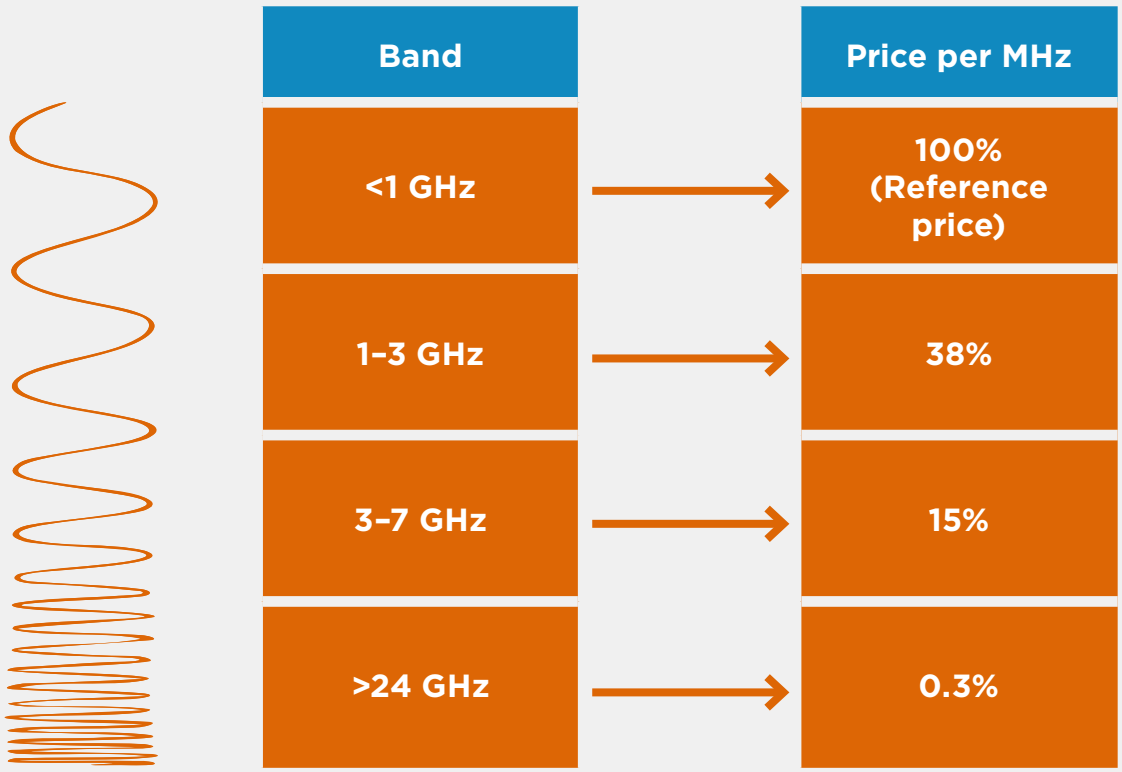
Bandwidth (MHz):	Licence price increases **proportionally** to MHz of bandwidth
Duration (years):	Adjusted for the cost of capital, licence price increases **proportionally** to its duration
Population (country):	Licence price increases **proportionally** to population covered
Average revenue per connection:	When revenues per connection halve, spectrum prices decline by **only** 30%

Note: Relationships between licence and market conditions and licence prices estimated hedonically using licence-level dataset.
Source: GSMA Intelligence analysis

The relative prices of different bands vary given the differences in characteristics and how they can be used to enhance the coverage or throughput of networks, and their scarcity.

In line with these factors, on average, 1–3 GHz band spectrum was priced per MHz at less than a half of the value of low-band spectrum. Similarly, 3–7 GHz spectrum (predominantly in the 3.4–4.2 GHz range) was priced at about half the value of 1–3 GHz spectrum. Given the specificities of its use constrained to high-density areas, mmWave spectrum (>24 GHz) was typically priced much lower. However, the relative prices of all bands have converged in recent years.

Figure 16
Difference in unit prices of spectrum per band



Note: Relationships between licence and market conditions and licence prices estimated hedonically using licence-level data on assignments awarded between 2012 and 2024.
Source: GSMA Intelligence analysis

5.2. Policy choices drive spectrum prices

Spectrum policy affects prices. Its effect can be direct when regulators set prices and annual fees via administrative process. In other instances, the effect of policy can be indirect and linked to a broader set of spectrum policy issues, such as scarcity of spectrum or assignment method. These issues have had a material impact on the prices paid by operators and could be contributing to the burden of spectrum cost and consumer outcomes.

Key findings include the following:

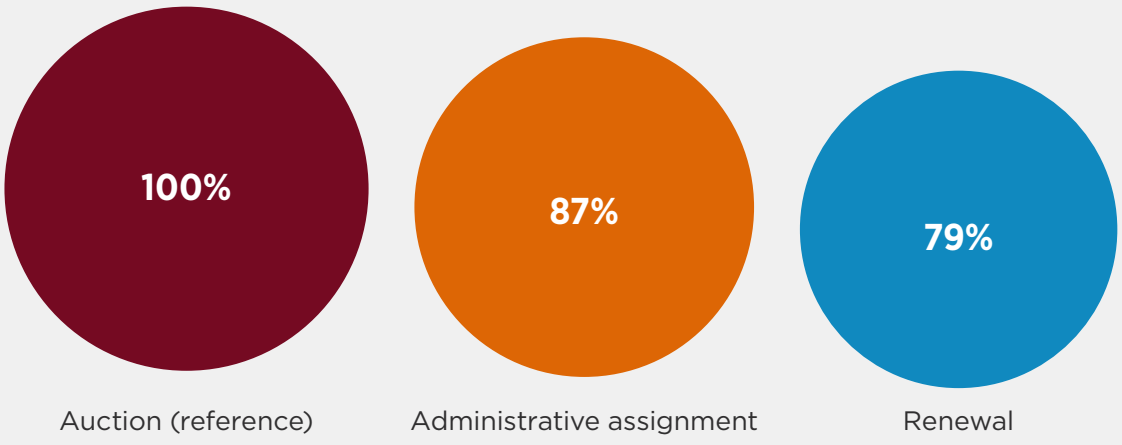
- There is no material difference in the average prices of similar assignments with respect to the use of auctions or administrative assignments. This shows that it is not the assignment method as such that contributes to the cost of spectrum; rather, it is the specific design aspects, regulators' objectives and underlying conditions.
- In markets where spectrum is scarce, operators pay more for each unit. Hence, artificial scarcity can drive up spectrum cost.
- In 37% of examined auctions where reserve price data was available, no competitive bidding occurred. This contributed to higher prices paid by operators. Reserve prices are frequently set at a level that introduces an extremely high risk of spectrum remaining unsold, with an associated significant cost of unused spectrum.
- Obligations attached to spectrum licences impose additional cost on operators. Prices should reflect this additional cost and be appropriately adjusted.

Assignment type

We found that administrative assignments do not result in prices different from those when spectrum is auctioned. On average, administrative assignments were sold at about a 13% lower price – though this difference was not statistically significant. This suggests the key driver of final prices is not the choice of assignment method as such, but rather the design aspects, market factors and others.

Renewed spectrum was about 20% less expensive than similar spectrum that was auctioned. However, part of this difference may arise as a result of some confounding factors linked to timing, or missing data on renewals in some countries.

Figure 17
Spectrum price by assignment method relative to auctions



Source: GSMA Intelligence

Spectrum scarcity

Spectrum scarcity can also contribute to higher spectrum prices. Operators trying to secure spectrum when there is little of it will have to pay more for each unit. This is because each incremental unit of spectrum could provide large relief on capacity-constrained networks and still prove to be more cost-effective than alternative ways of increasing capacity (densification).

We find that operators in spectrum-constrained markets paid 50% higher prices per additional unit of spectrum, compared to operators in markets where twice as much spectrum had been made available. Conversely, operators that already own more spectrum tend to pay less for each additional unit they acquire.

Making sufficient spectrum available is therefore an essential part of rational spectrum policy that maximises its benefits to society.

In addition to spectrum scarcity driving up prices, scarcity has other negative effects. As our earlier empirical analysis shows, less spectrum available to operators results in worse network quality, as measured by coverage, speeds and latency.

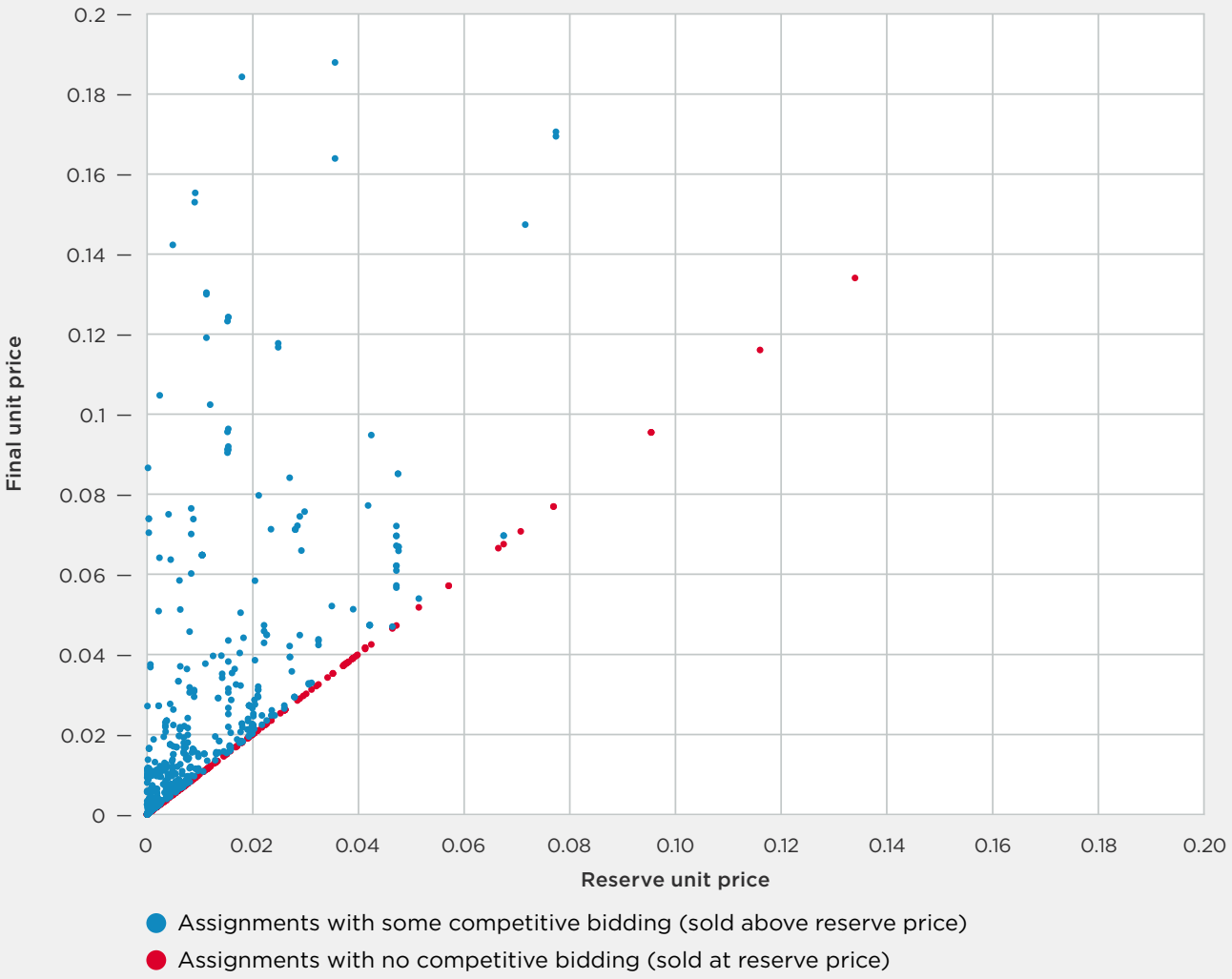
Reserve prices

Regulators rely on reserve (starting) prices in auction design to limit frivolous bidding and reduce the potential incentive for strategic bidding. However, reserve prices are also frequently seen as a mechanism to increase revenues from the auction and become a potential factor driving spectrum prices. In many other cases, reserve prices are set based on historical prices of spectrum, which can be an invalid reference for its current value to operators, considering the overarching trend of declining value.

As shown in Figure 18, reserve prices often become final prices as no competitive bidding occurs. In these instances, reserve prices do not allow for price discovery and can increase the prices paid by operators. The winning operator pays the price set by the reserve price level, not the price set by another bidder's valuation in second-price auction designs.

The effect of reserve prices elevating the cost can be detrimental because operators face uncertainty about the true value of spectrum from a commercial perspective. When reserve prices become final prices, they can amplify the effect of the winner's curse: a situation in which the operator overvalues spectrum and becomes the sole bidder acquiring spectrum at a high reserve price, rather than the lower price offered by other bidders.

Figure 18
Reserve unit prices and final unit prices



Note: Unit price expressed in $ 2023/MHz/year/population. Based on data for auctions where reserve prices were set and final prices are available.
Source: GSMA Intelligence

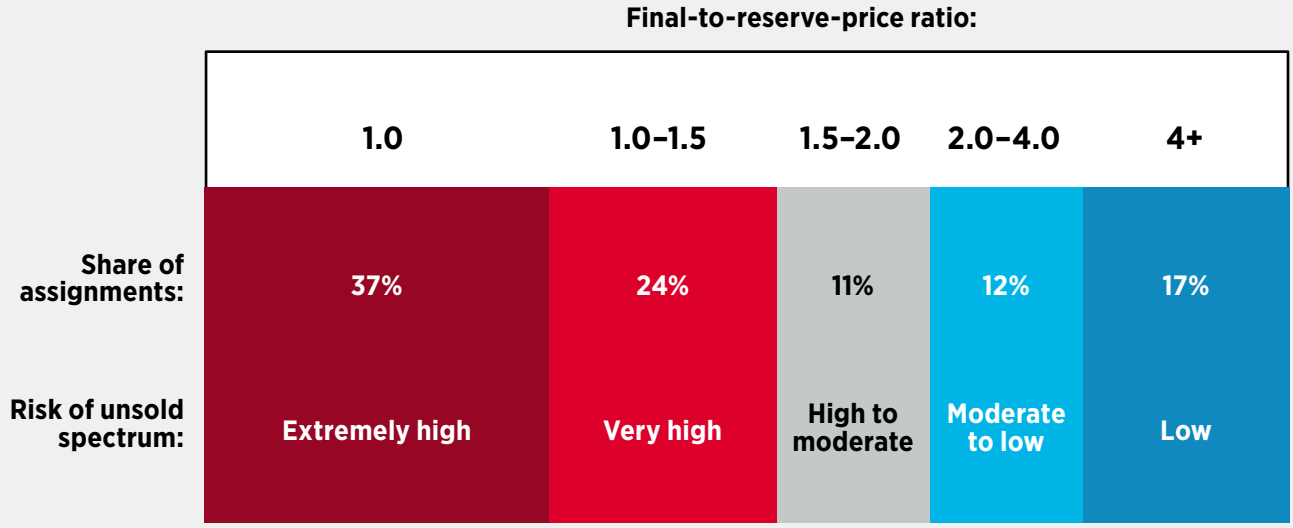
Reserve prices became final prices for 37% of assignments (Figure 19). This is indicative of an extremely high risk of unsold spectrum, as the reserve price was only lower than one bidder's valuation. In these cases, reserve prices likely influenced the prices paid by the winners. The final-to-reserve-price ratio of 1 to 1.5 was observed for 24% of auctions, indicating a very high risk of finding no buyer. This is because there is a large degree of uncertainty about the value of spectrum and, even if some bidding occurred, the risk remained high because reserve prices did not leave sufficient margin for error, creating a near-miss situation. As a practical example of this uncertainty, in India regulators have relied on different approaches to valuing spectrum which resulted in estimates differing five or more times in magnitude.[5] Setting reserve prices in reference to estimated value of spectrum means that this uncertainty is translated into risk of unsold spectrum.

In 11% of cases, the final price was not more than twice the reserve price. Only for 29% of assignments was the risk moderate to low or low.

This illustrates the scale of risk of unsold or returned spectrum introduced by the approach to reserve prices taken by regulators in most cases, with 62% of all assignments showing an extremely high or high risk of unsold spectrum.

5. Recommendations on Auction of Spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz, 3400-3600 MHz Bands, TRAI, 2018

Figure 19
Share of assignments by final-to-reserve-price ratio



Note: Based on data for auctions where reserve prices were set and final prices are available.
Source: GSMA Intelligence

Obligations

Obligations can mandate a higher level of service to what commercial considerations would incentivise an operator to deploy – for example, mandating coverage in rural areas where it would not have otherwise been financially viable to do so. Meeting obligations is costly to operators as the investment and operating costs outweigh the potential revenue gain. Because of this, obligations affect licence value to operators.

It is therefore important that regulators reflect these costs when pricing spectrum. Spectrum prices should be adjusted to ensure they reflect the cost to operators. Unbundling spectrum licences from service-level obligations can lead to improved efficiency. For example, market mechanisms can be used so that operators can commit to service quality in exchange for bidding credits or reduced fees.

In some instances, regulators have entered into consultations with operators to understand how the service quality targets can be extended efficiently, as in the case of the UK, where the regulator decided to forgo the plans to attach obligations to spectrum licences in favour of a joint commitment by operators to build a shared rural network.[6] In other countries, such as France, consultations with operators led the regulator to renew licences at no additional cost, in exchange for a commitment to expand networks to underserved areas.

6. Shared Rural Network Coverage Obligations, Ofcom, 2024

6. Spectrum prices need to reflect changing market conditions

Operators require more spectrum, but each MHz supports less revenue than a decade ago

Technological advancements and investments in mobile networks have led to improved services and increased demand for mobile data, requiring more spectrum. However, revenues have remained relatively unchanged. Despite the expansion of mobile network capabilities, average revenue per subscriber has declined due to market maturity, competition and regulatory constraints. This suggests a lower value of spectrum to operators. However, we find spectrum prices do not always reflect this due to other influencing factors.

Importantly, the decline in the value of spectrum from the operator perspective does not mean the value it creates to society as a whole has decreased. Due to high levels of competition and the lower prices of ever-improving mobile services, an increasing proportion of the value created by mobile spectrum is now being captured by consumers and other digital economy players.

Prices paid for spectrum by operators have not yet fully adjusted to reflect its changing value, leading to growth in the burden of spectrum cost

Over the past decade, spectrum prices per MHz and per unit of population have generally fallen. However, the falls were not sufficient to reflect the declining value of spectrum from an operator perspective and the declining revenue that each MHz can support. Price setting by regulators, restricted supply and assignment design did not allow prices to fully adjust. This contributed to growth in the spectrum cost burden in most countries.

Along with policy decisions that can drive up spectrum prices, this has weakened operators' ability to continue investing, which translates to lower investment and poorer consumer outcomes.

Rising spectrum cost negatively affects consumers

High spectrum cost can constrain operators, leading to reduced or delayed investments, which result in scaled down network deployment. Our analysis confirms that high spectrum cost leads to poorer consumer outcomes, particularly coverage and network quality.

Separately from the impact of cost, we find that more spectrum assigned to operators improves the same consumer outcomes, underscoring the importance of making sufficient spectrum available in a timely manner.

Policy can relieve the spectrum cost burden and contribute to better networks and consumer outcomes

Spectrum prices are influenced by policy choices, either directly when set by regulators, or indirectly when influenced by factors such as assignment method, spectrum scarcity and existing cost burden.

Regulators can therefore play a role in the rationalisation of spectrum cost. Below discusses areas and examples of policy tools that can alleviate cost build-up.

6.1. Policy actions

High spectrum prices that fail to adjust to market realities lead to negative outcomes for consumers. This section explores the main options available to policymakers to adjust spectrum cost so that they better reflect prevailing market conditions.

New spectrum

Regardless of the method used to assign new spectrum, prices need to reflect the reality of declining value that operators can generate from each unit of spectrum.

Pricing should therefore be allowed to follow the fundamental drivers of its value, such as the potential profit or revenue opportunity that each MHz can support. Adjusting prices to reflect these will ensure spectrum becomes available for its most efficient use but will not unduly increase the cost burden, which could lead to detrimental outcomes to consumers.

Spectrum managers can examine various assignment aspects to ensure efficient use. Regardless of the approach, the following principles should be followed:

- **Regulators should not anchor administratively set prices to historical prices** – either those observed in other markets, or the market in question. Given the falling price of spectrum over the past decade, they are unlikely to reflect the current reality of the domestic market. Similar caution should be taken in setting reserve prices for auctions based on historical benchmarks.
- **In the case of auctions, setting reserve prices at a low level** allows room for price discovery and minimises the risk of unsold spectrum.
- **The cost of meeting obligations or investment commitments attached to spectrum licences should be reflected in their price.** Alternatively, obligations can be unbundled from spectrum licences, which can result in improved efficiency of allocation of both, as an operator that can generate the most value from spectrum may be different from an operator that can most efficiently meet service quality obligations.
- **Prices of higher frequencies should reflect their lower unit value.** Operators increasingly rely on higher frequencies that can provide the required bandwidth. Unit prices of these frequencies should reflect the relatively lower revenue-generating potential of each MHz of the frequencies. This will ensure efficiency of allocation but not burden the user with cost that can negatively impact deployment of the newest technologies, such as 5G Standalone and 5G-Advanced.

Brazil's multiband auction

The multiband auction in Brazil in 2021 was designed to address demand for mid-band 5G spectrum. Spectrum availability was achieved through long-term planning of the relocation of legacy satellite services. Thanks to this, Brazil was able to offer 400 MHz in the 3.5 GHz band and pave the way for future use of 3.8–4.2 GHz.

The process of laying the policy foundations for the auction started much earlier. In 2019, Brazil updated its telecoms regulations, which set out:

- a longer licence term of 20 years (previously 15 years)
- a secondary spectrum market to allow the trading and leasing of licences
- unlimited renewal terms based on a presumption-of-renewal approach.

These conditions allowed for maximisation of the value of spectrum from the perspective of future users. Taken together, these actions built an attractive proposition to operators, which could maximise the value of spectrum and pick from the menu of options that serve the market best.

Long-term planning and timely relocation of legacy services to make sufficient spectrum available for mobile.

Restructuring licence terms to maximise incentives for long-term investment: longer licence terms, allowing for trading and leasing.

Automatic renewal permitted subject to fulfilling coverage and service obligations.

Given the size of potential market niches, regional licensing allowed for interest from national and regional operators. No set-aside spectrum.

Flexible payment terms provide options to operators and can aid investment in network rollout.

Bids over the reserve price could be converted into investment obligations. Cost of meeting licence obligations deducted to promote investment in rural areas.

The auction attracted 15 entities, with competitive bidding leading to nearly all the frequencies being awarded, the exception being elements of the mmWave band. In a year since the award of spectrum, operators requested permission to deploy 1,400 antennas – three times the number required by licence conditions. As of the end of 2024, almost 38,000 5G base stations had been deployed, reaching nearly 95% population coverage.[7]

The approach to ensuring the success of the auction was a big step forward for Brazil. It emphasised cooperation among regulators, operators, vendors, broadcasters, academia and other stakeholders.

7. Estações do SMP, Anatel

Austria's multiband auction in 2020

In 2020, the Austrian regulator (RTR) held an auction for the 700, 1500 and 2100 MHz bands. It combined multiple approaches to ensure widespread coverage in the country.[8]

Austria's multiband award relied on various approaches to setting coverage obligations

Bundled with spectrum lots	**Band-specific deployment obligations:** The winning bidders in certain bands were required to deploy the spectrum on a specified number of base stations by a certain date. For example, winners of spectrum in the 700 MHz band had to deploy at least 500 base stations by the end of 2022 and 1,500 base stations by the end of 2023.
	Band-specific coverage obligations: The winning bidders in certain bands were required to achieve pre-defined levels of coverage. For example, winners of spectrum in the 2100 MHz band had to use the spectrum to cover 75% of the population by the end of 2023 with a 5G service that provided 30 Mbps download and 3 Mbps upload speeds. The obligation increased to 80% by the end of 2025. Obligations were also set for coverage in large cities, and on roads, motorways and railways.
Reverse auction	**Extended coverage of communities:** The two levels of obligations described above were bundled with spectrum lots. In addition, RTR identified 2,100 communities underserved with existing mobile networks. Each lot in the 700 MHz band was associated with a list of 350 municipalities, and the winner of each lot was required to select 150 from the list (900 in total). Separate lists were maintained to avoid deployment duplication. The areas not selected in this stage were then offered in a reverse auction in return for a discount on spectrum fees. The bidders nominated municipalities and the price discount, and communities were assigned to maximise the number served. After the auction, bidders could trade obligations during a two-month period.

The final result of the auction was the award of all available spectrum for around €200 million, and coverage was procured for 1,702 of the underserved communities (81% of the 2,100 defined). Almost half of these (802) were assigned in the reverse auction.[9]

A key lesson from the auction was recognition that coverage obligations for the most difficult-to-reach areas represent a significant additional cost associated with acquiring the spectrum licence. If obligations are bundled with a spectrum award but are too onerous, the spectrum award may fail, meaning spectrum is not put to efficient use and the obligations are not met. This can be the result of trying to apply a tool for one specific objective (auctioning spectrum to the most efficient users in a given country or geographic area) to address a separate problem (market failure in specific locations where the high costs of deployment and limited revenue mean certain populations are underserved).

The Austrian auction addressed this by using a market mechanism (reverse auction) to decouple spectrum awards from specific coverage obligations in high-cost communities. The importance of this is demonstrated by the fact that one operator (Telekom Austria) did not acquire any 700 MHz spectrum but acquired obligations to cover 349 communities in the reverse auction stage. This reflects the possibility that one operator can put a band to optimal use across a country, while another is better placed to deploy in hard-to-reach areas at lower cost.

8. Band specific coverage obligations, Austrian Regulatory Authority for Broadcasting and Telecommunications, 2020
9. Auction results, Austrian Regulatory Authority for Broadcasting and Telecommunications, n.d.

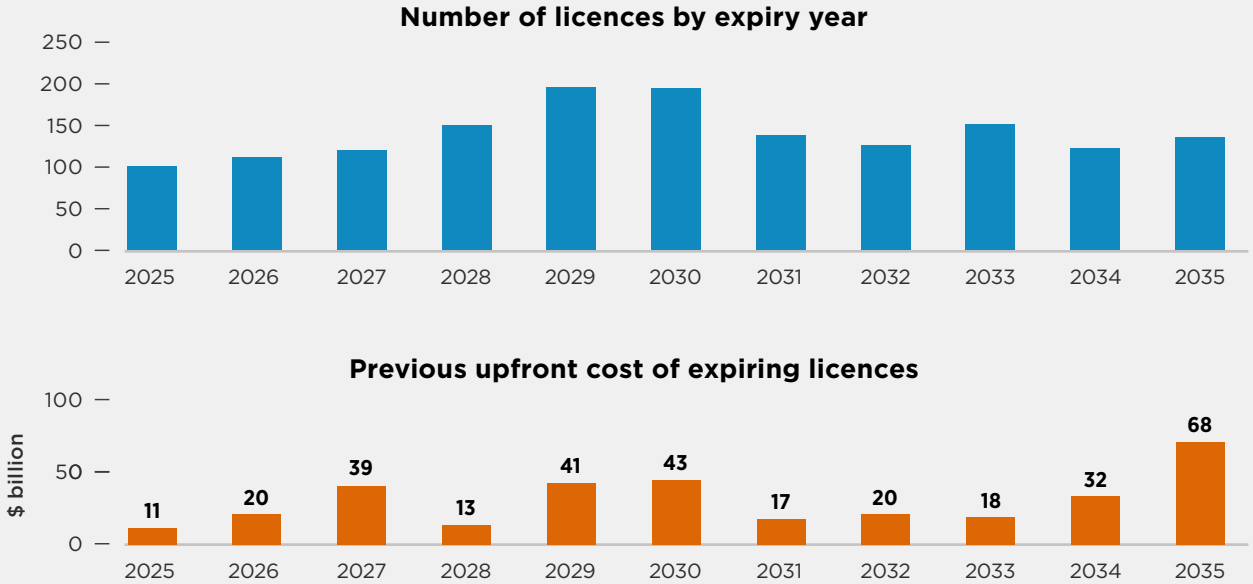
Spectrum licence renewals

Regulators often rely on fees as an incentive for the incumbent user to relinquish spectrum if not using it. Typically, this incentive takes the form of administratively set annual fees. However, in some instances, regulators have also re-auctioned spectrum. There is a risk that such an approach drives spectrum total costs higher, with negative impacts for consumers. Some regulators are therefore exploring alternative approaches to licence renewals:

- Administrative review compares the benefits of current use with other contending uses. Where it is determined that existing users remain the most efficient users of spectrum, free-of-charge extension of licences and commitment to continued service may prove a cost-effective approach to licence renewal.
- Free-of-charge renewals, in exchange for commitment to quality of service, are also sometimes considered. This approach is motivated by the societal benefits of improved connectivity as a result of meeting the obligation. At the same time, the obligation cannot be too costly to meet for operators, risking return of spectrum. Achieving the right balance requires quantification of potential social benefits and costs of meeting the obligations, making the approach advisable only when these can be sufficiently and reliably measured (see case study on France).
- A spectrum trading framework, between operators and other third parties, may mean that renewal fees are not needed to ensure efficient use of spectrum.
- As spectrum is falling in value, administratively set renewal prices or auction reserve prices should not be linked to historical spectrum prices. The fundamental determinants of the value of spectrum have changed, such as the revenue it can generate per MHz of bandwidth. Regulators should therefore take a cautious approach that minimises the risk of returned spectrum during renewals, as this can lead to a significant opportunity cost of unused spectrum.

The expected schedule of renewals (Figure 20) shows that the number of licences expiring each year will increase from about 100 in 2025 to nearly 200 licences in 2030. This increased level of renewal activity offers an opportunity for regulators to rationalise spectrum prices during renewal.

Figure 20
Expiring spectrum licences



Note: Licence number aggregates regional licences to a single, national-level licence.
Source: GSMA Intelligence

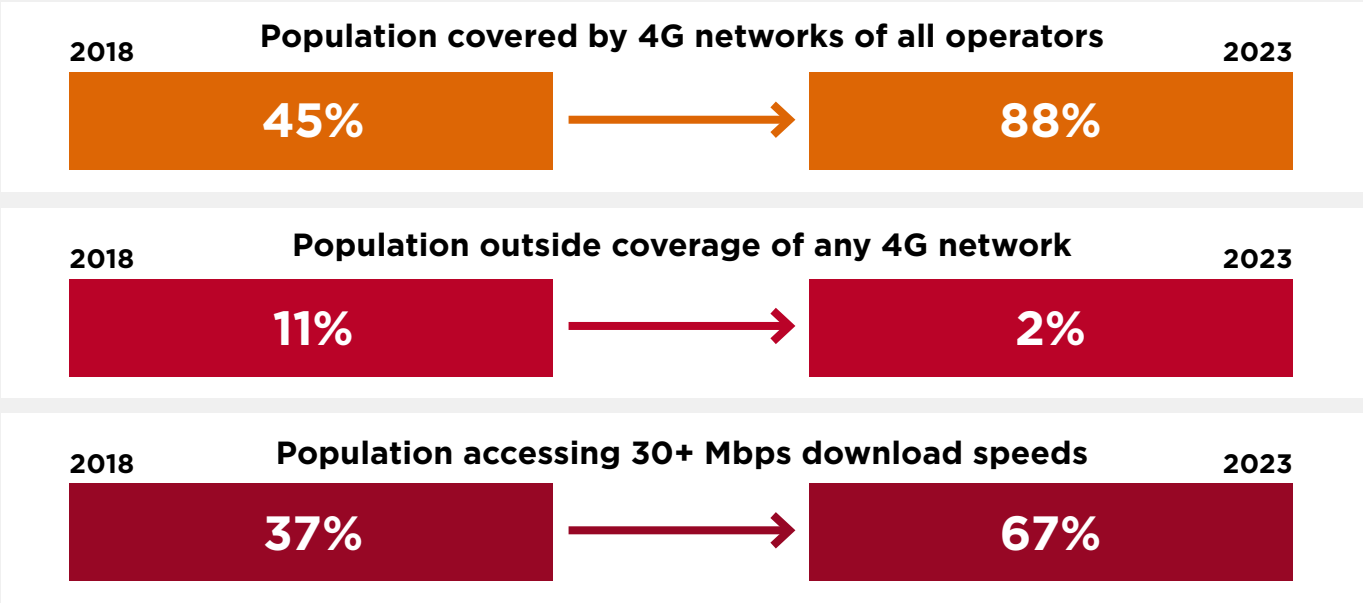
France's New Deal for Mobile

In 2018, the regulator Arcep renewed licences for 900, 1800 and 2100 MHz, due to expire between 2021 and 2024. Given the regulator's concerns over low availability of 4G in rural areas, Arcep agreed with operators to trade the licence renewal fee for the acceleration of 4G rollout and provide "nationwide, high-quality mobile coverage for everyone in France".

Government and local authorities identified areas that need to bolster regional development through improved coverage. The commitments included the following:

- Provide mobile coverage in selected 'white zones' (areas without mobile network access) identified by local authorities and the government.
- Achieve ubiquitous 4G coverage in 10,000 municipalities, by upgrading all cell sites to 4G.
- Accelerate the pace of 4G rollout by deploying 5,000 new 4G sites in underserved municipalities across the country (including shared sites), including 1,000 new sites for fixed wireless access using 4G.
- Accelerate the pace of transport corridor coverage, so that all roads and railway lines have 4G coverage.
- Achieve ubiquitous indoor coverage, notably by offering voice-over-Wi-Fi solutions for customers with compatible devices.
- Improve reception quality nationwide, and particularly in rural areas. The new standard applied to operators' obligations is that of "good coverage".

Arcep regularly tracks operator progress on the New Deal targets.[10] To date, a number of achievements have been made:[11]



The impact of the New Deal in France demonstrates the trade-off highlighted in Chapter 3, which shows that high spectrum cost results in lower coverage and network quality. By placing more value on the long-term social and economic benefits that are driven by increased coverage and network quality than the short-term revenue gains for the government, French consumers and businesses have benefited from significantly improved 4G and 5G services.

10. Suivi du New Deal Mobile, Arcep, 2024
11. Mobile Coverage, Arcep, 2024

Spain's cost- and obligation-free licence renewal

The Spanish government, seeking to align domestic regulation with the European Electronic Communications Code (EECC), commissioned a review of the approach to renewal of spectrum licences acquired by mobile operators. Based on the findings, all existing licences were extended by 10 years, up to a maximum of 40 years since the date of the first award. No additional costs, obligations or charges were involved, beyond the continued payment of existing annual fees.

Timeline of spectrum policy developments in Spain

2018

Introduction of the European Electronic Communications Code

— Mandates regulatory predictability for a minimum of 20 years

— Mandates regulators to evaluate the options for spectrum renewals

2022

Spanish Telecom Law

— Transposes EECC

— Establishes minimum of 20-year licences, with semi-automatic extension for 20 more years (40 years in total)

2023

700 MHz and 26 GHz licences are awarded for 40 years (20 + 20)

The review found no alternative spectrum uses that could deliver greater or similar socioeconomic benefits. Extension ensured the most efficient use of spectrum while minimising administrative costs. The government expected that cost-free renewal will mean "savings of hundreds of millions of euros for operators, which can be invested directly in deployment and innovation".[12]

Besides cost saving, extension provides certainty of access, allowing long-term planning to carry out new investments involving spectrum bands on expiring licences. This was especially important for bands expiring in the short to medium term (before 2030). Many of these bands are expected to be refarmed for use by 5G networks, with coverage reaching 91% of Spain's population in 2024.

Foundations

Making sure that a sufficient amount of spectrum is made available can alleviate artificial scarcity and keep the growth in spectrum cost to more sustainable levels.

As the value of spectrum is related to its quantity, providing a roadmap can aid operator planning, so they can take into account future releases, value spectrum accurately and deploy networks in accordance with optimal strategies.

12. Suivi du New Deal Mobile, Arcep, 2024

Making spectrum available takes priority in Saudi Arabia

The example of Saudi Arabia highlights the importance of assigning to operators all spectrum allocated to use by mobile networks, leading to sustainable prices and long-term investment incentives.

Saudi Arabia has assigned 1,400 MHz of spectrum to mobile networks (excluding mmWave bands) – the highest amount worldwide. The country had already assigned spectrum in almost all mid-bands, with early awards in 2019 in the 2.3, 2.6 and 3.5 GHz bands enabling all three operators to launch 5G, allowing Saudi Arabia to become one of the first countries to deploy 5G. In December 2024, Saudi Arabia became the first country in EMEA to assign spectrum in the 600 MHz band. The latter was in addition to assignments in the 3.8–4.0 GHz band, meaning Saudi Arabia has assigned more spectrum in the 3.5 GHz range than almost every other country (except Japan).[13]

This reflects the regulator's priority of making spectrum available for mobile operators. Despite the greatest amount made available, the operators' spectrum cost as a proportion of revenue, at around 7%, is close to the global median. When factoring in the amount of spectrum assigned, the unit cost as a proportion of revenue per MHz is less than 50% of the global median. However, the 2024 auction included coverage and quality-of-service obligations that will increase the effective licence cost to operators.[14]

Saudi Arabia has provided clarity and predictability with forward-looking spectrum roadmaps; operators can plan their investments accordingly. With the launch of its National Transformation Plan 2020, the regulator confirmed its move away from administrative assignments for spectrum awards and set out its plans to conduct five auctions, all of which have now been completed.

In preparation for the auctions, the regulator was proactive in releasing spectrum from legacy users (including TV and radio in the 600 MHz band and radio altimeters in the 3.8–4.0 GHz band). The spectrum is also allocated on a technology-neutral basis, allowing legacy 2G and 3G bands to be refarmed for 4G and 5G. Saudi Arabia was also the first in the world to hold an auction for non-terrestrial network (NTN) spectrum in the 2.1 GHz band, recognising the potential of satellite mobile communications, high-altitude and low-altitude platform stations and hybrid 5G connectivity to enhance broadband connectivity in remote areas, including uninhabited locations.[15]

The impact of Saudi Arabia's proactive and enabling spectrum policy on consumers and businesses is reflected in the country being among the leading tier-1 markets in the GSMA Intelligence 5G Connectivity Index.[16] Saudi operators provide some of the fastest download speeds globally, and consumers used almost 45 GB of data per month in 2024 – more than any other country except Finland and Bahrain.[17, 18]

13. "CST Announces the Winners of the Spectrum Auction in the Frequency Bands (600, 700, 3800) MHz for Mobile Telecommunication", CST, 2024
14. "Saudi Arabia Leads the Way", GSMA, 2024
15. "CST Announces that STC has won both channels in the Spectrum Auction for NTN the 2100 MHz band", CST, 2022
16. GSMA Intelligence 5G Index, 2024
17. Ookla Speedtest Global Index, Ookla, n.d.
18. GSMA Intelligence, 2024

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