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Perspective

Accelerating spectrum availability is crucial for Morocco to reap the benefits of 5G

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1. Executive summary

5G is expected to play a bigger role in enabling social and economic change than 3G or 4G did. This is because it supports higher data rates than its predecessors, and has a wide range of capabilities such as ultra-low latency, support for massive numbers of sensors and devices, and enhanced levels of reliability and security.

This implies that 5G networks can enable or enhance a range of use cases beyond advanced connectivity, which can benefit a variety of vertical sectors. In Morocco, 5G could contribute to the country's economic development and help the government to meet the three goals outlined in the development strategy published by government agency Agence de Développement du Digital in March 2020[1], including the digitalisation of government services combined with a broadening of internet access, the improvement of the competitiveness of the Moroccan economy, and the creation of a more inclusive digital society.

The speed at which these benefits can be achieved depends however on policymakers taking the necessary steps to facilitate the introduction of 5G and working to ensure its long-term success. We have identified four broad enablers that are relevant to the overall success of 5G.

- **Spectrum availability, neutrality and affordability.** 5G radio is designed to leverage a range of frequencies to support a variety of use cases, each with specific network requirements, such as throughput and latency. Making suitable spectrum bands available to mobile network operators (MNOs) and to others seeking to deploy 5G is essential for timely deployments of 5G networks. Providing spectrum access on a technology-neutral basis is also important. Governments and national regulatory authorities need to ensure that spectrum licensing follows best practice in terms of assignment, availability and pricing, with affordability of spectrum fees particularly relevant of the significant investments that MNOs need to make to upgrade and densify their networks while having to maintain and operate their legacy systems.

- **Licence obligations.** Governments and regulators can incorporate policy goals within the spectrum assignment process to encourage more efficient usage of spectrum, rapid network roll-out and, in many cases, to ensure that mobile connectivity is expanded in densely populated areas as well as in rural regions. The design of the spectrum award process (including the prices for licences) needs to take account of licence obligations that consider policy objectives. These obligations or restrictions take the form of spectrum caps, or guidance related to coverage, roll-out or speed.

- **A clear roadmap for 5G roll-out.** A roadmap should provide details of how 5G will be introduced to the market, the services that might be offered, the frequencies that will be available, and the timescales for any preparatory work. The roadmap should include the timescales for spectrum allocation.

- **Government policies that facilitate technology development and infrastructure deployment.** The pace of 5G development depends on the extent to which governments proactively encourage technological development and an early commercial launch of 5G services, including infrastructure build-out facilitation (for example, acquisition of new sites) and direct government funding. Beyond government policies, the adoption of 5G services in the longer term will only be achieved if industry bodies recognise the importance of 5G as a key technology for achieving national broadband targets.

Morocco has one of the most developed mobile markets in North Africa (mobile penetration was at nearly 133% of its population by 1Q 2022) but the country has yet to introduce 5G as of December 2022. ANRT published an

1 https://add.gov.ma/storage/pdf/Avril_NOG_ADD_fr_SITE_VF.pdf.

outline of its position on the timing and preparation required for 5G in 2021, planning for a study to be conducted in the next couple of years to identify the optimal conditions and modalities of operation of 5G networks in Morocco, suitable spectrum bands, obligations attached to the deployment of 5G, and technical capabilities needed to support adoption across different verticals. Specific plans for government support to facilitate infrastructure deployment have yet to be formalised.

Several countries in the Middle East and North Africa region (Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE)) and France provide a set of good practices to draw upon.

- All six countries have awarded mid-band (3.5GHz) spectrum in frequency assignments suitable for 5G radio use. Five have allocated at least 100MHz of mid-band spectrum per MNO. While there is generally more uncertainty regarding the timetable for allocating new low-band spectrum (600/700MHz), some countries (Qatar, Saudi Arabia) have recently made initial plans to release it in the future. In all countries, spectrum has been released on a technology-neutral basis.

- Some countries have imposed obligations when assigning 5G spectrum. In Qatar, the first spectrum release in 2018 required MNOs to upgrade at least 40% of their existing 4G sites to 5G, and to cover all primary roads and FIFA 2022 World Cup venues with 5G by end of 2020. In France, the obligations associated with the award of 5G spectrum required that each winning bidder must launch 5G services in at least two cities before the end of 2020. Saudi regulator CITC imposed obligations on quality of service (QoS), over the period 2020 to 2027, to encourage investment and promote efficient usage of spectrum.

- Most NRAs have published roadmaps to indicate which bands are to be made available or are being considered for 5G use, and have schemes to facilitate commercial trials. The efforts to develop national 5G roadmaps were undertaken in different periods by governments and NRAs in the countries analysed; France started to prepare its 5G strategy in 2017 and the UAE started in 2016. Oman's roadmap included a (site) roll-out plan.

- Regulatory bodies have set up national strategies and introduced policies to encourage technological development, and create suitable conditions for investment, although the emphasis on 5G and its direct benefits is rarely explicit in most markets. France has offered direct funds as part of its national strategy to accelerate the development of 5G and next-generation technologies.

We have identified several levers to be considered by policymakers to accelerate the development of 5G in Morocco (Figure 1.1).

Figure 1.1: Recommendations for policymakers in Morocco

Enabler	Comments
Spectrum	• Identify the most suitable bands for deploying 5G in Morocco as a matter of priority and plan a roadmap for spectrum assignments that will deliver enough capacity and coverage for high-quality 5G services. Policymakers should also consider the following: — Aim to assign 100MHz of contiguous mid-band (3.5GHz) spectrum to all operators in the country. This might require spectrum refarming and/or clearance, which should be carried out urgently. — Consider lower mid-band spectrum bands, such as the 1.8GHz, 2.1GHz and 2.6GHz bands that are currently assigned for previous technologies, as complementary capacity bands to 3.5GHz for supporting 5G services. Operators already have access to this spectrum and enabling operators to change the use of these bands to 5G on a technology-neutral basis could benefit coverage of 5G services. These bands are also widely supported by the vendors and manufacturers.

Enabler	Comments
	— Consider the 2.3GHz band as a complementary capacity band for 5G services. This band is not currently available for mobile use in Morocco, so the assignment process could potentially be concluded in a timely manner and enable operators to quickly have access to 5G-suitable spectrum. — Assign low-band spectrum. The 700MHz spectrum band has not yet been allocated in Morocco and will be ideal to support the wide coverage requirement of 5G services. — Discuss the assignment of high-band spectrum in order to complement low- and mid-band assignment with high-capacity spectrum. — Consider setting aside the upper 6GHz band (6.4–7.1GHz) for future 5G spectrum needs. Review regulatory decisions that other countries make regarding this band, and plan a consultation for future allocation.
	• Consider simplifying regulations to encourage collaboration between stakeholders to streamline decision-making processes. The allocation of temporary licences should also be considered as a lever to speed up initial launches.
	• Plan for releasing additional capacity as 5G networks expand and more capacity is needed to scale services. Discuss the allocation of additional bandwidth as a priority. — For example, the possibility of supporting new harmonised bands to help 5G services to expand over the longer term, such as the use of 6GHz band, should be taken into consideration sooner rather than later because WRC-23 and international regulatory decisions are due soon. — In many countries, such as China (including Hong Kong) and Japan, consultation and discussion on the matter are already underway.
	• Design a spectrum assignment process where spectrum fees (reserve prices, annual fees) are set at reasonable levels, to avoid negatively affecting network roll-out and quality and driving up the cost of services. • Consider the possibility of benefiting operators and accelerating 5G roll-outs by offering easier 5G spectrum payment terms.
	• Adopt a service- and technology-neutral framework and create conditions that accelerate refarming of spectrum used for 2G, 3G and 4G technology to allow a phasing in of the newer technology in line with increasing mobile broadband demand while at the same time supporting legacy users.
Licence obligations	• Encourage investments and promote more efficient usage of spectrum by imposing obligations when assigning 5G spectrum: network deployment obligations generally include requirements for minimum population or geographical coverage (or in terms of number of sites), and may also contain QoS requirements (for example, minimum end-user speed, such as in Germany or Saudi Arabia). • Monitor the deployment of 5G by MNOs to ensure that obligations are met on a timely basis.
Roadmap	• Produce a formal 5G roadmap setting out a clear vision for 5G in terms of technology development, regulatory framework and network deployment. It is crucial both for MNOs and enterprises to have access to clear information on the path towards 5G introduction, as well as action points and next steps to plan trials and commercial roll-out. 5G roadmaps also raise awareness at an international level about the country's level of development and digital ambition. • Ensure that a 5G roadmap includes a clear target for 5G adoption (for example, 5G's share of mobile connections, penetration of 5G-based FWA).
Government policies	• Take a proactive approach to 5G deployments by encouraging infrastructure developments such as small cells, as well as broader policies to streamline planning processes relating to macro sites. • Open access to public infrastructure to MNOs for 5G site construction, and ensure that any fees are charged using a cost recovery method.
	• Consider allocating public funds to accelerate research and 5G projects that are expected to stimulate demand for services and promote industry collaboration.

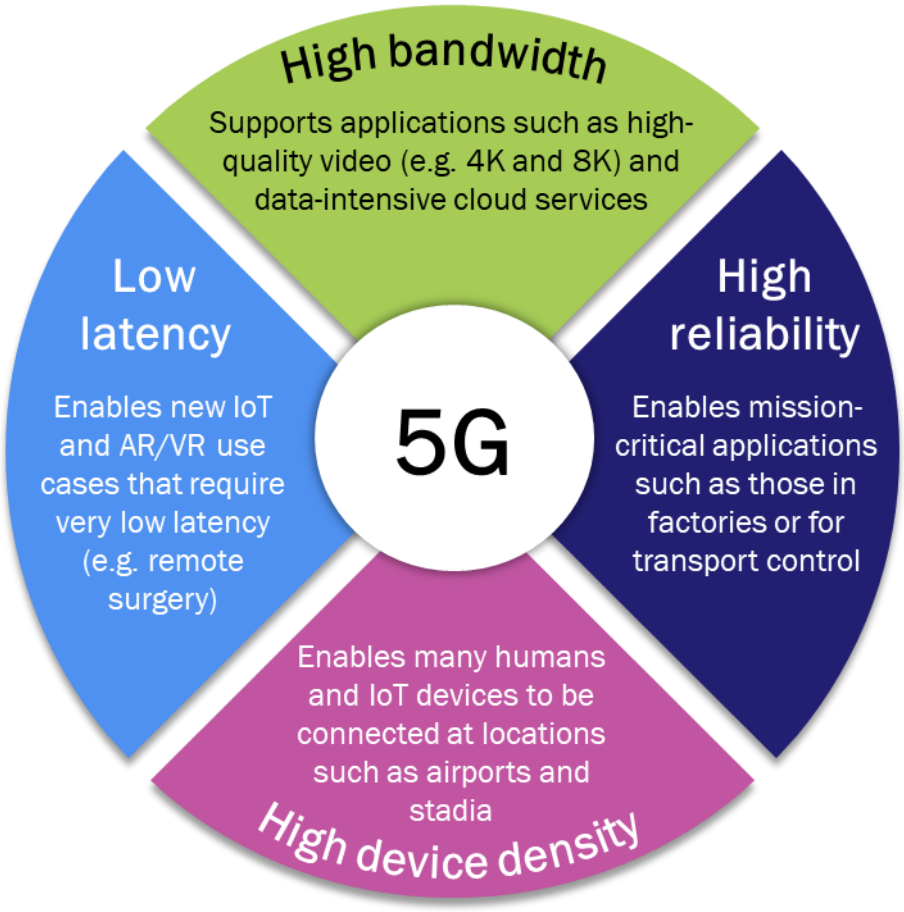
Enabler	Comments
	• Consider allocating public funds to improve coverage in areas where there is evidence that commercially led solutions are not viable (for example, in hard to reach, remote locations).

2. 5G can generate significant socioeconomic benefits in Morocco

2.1 5G brings new capabilities to mobile networks and enables new use cases

5G not only offers faster speeds than previous generations of mobile technologies, but it can also support ultra-low latency communications, offers a high degree of reliability, and can enable connectivity across a large number of sensors and devices (Figure 2.1).

Figure 2.1: Key capabilities of 5G



Source: Analysys Mason

These capabilities are expected to be further enhanced by the use of a cloud-native core. Initial 5G network deployments were based on a non-standalone (NSA) architecture, which relies on a 4G evolved packet core, but MNOs have been progressively shifting to a standalone (SA) network architecture, which is based on a full 5G

cloud-native core. The underpinning software of a 5G core is cloud-native and microservices-based, which allows greater scalability of network resources, to suit the needs of individual services and users, and enables operators to create 'slices' of the network, which can specifically support particular sectors or use cases.

These capabilities enable greater flexibility to address a variety of connectivity needs; some applications rely on high throughput, while other use cases require low-latency communications. It also has security implications because different parts of the network can be isolated from one another. A 5G SA architecture can support different access technologies beyond 5G, including legacy 4G systems and 3GPP technologies for low-power wide-area networks (for example, NB-IoT, LTE-M).

These diverse capabilities make 5G networks well-positioned to enhance or enable a wide range of applications in multiple vertical sectors (some, such as those based on augmented (AR) or virtual reality (VR), would be difficult to implement using previous mobile generations) (Figure 2.2) and drive fundamental social and economic changes.

Figure 2.2: Examples of industrial 5G use cases with relevance to Morocco

Vertical sector	Examples of 5G use cases
Manufacturing	• Use of AR in manufacturing operations (e.g. 'digital twins') • Remote tracking and control of factory robots
Agriculture	• Precision farming • Remote control of drones for field monitoring
Public sector	• Sensor networks for sustainable living (e.g. air quality, waste management) • AR for tourism (e.g. information overlay during city tours) • Emergency communications (e.g. law enforcement, military)
Construction/ real estate	• Smart CCTV monitoring • Sensor networks for equipment predictive maintenance
Healthcare	• Teleconsultations based on VR • Remote patient diagnosis and monitoring • Use of AR/VR for surgery support or medical staff training
Education	• Enhanced remote learning enabled by fast and reliable internet access
Mining	• Remote asset and environmental monitoring • Autonomous haulage trucks and drill rigs • Real-time remote control of high-speed robots and drones
Ports	• Remote control and smart monitoring of containers • Autonomous control of cranes • Smart monitoring (e.g. using artificial intelligence for increasing work safety)

Source: Analysys Mason

2.2 5G will be crucial in supporting Morocco's national digital transformation efforts

In March 2020, Morocco's government agency for digital development, Agence de Développement du Digital (ADD), published an outline of the country's digital development strategy to 2025[2], summarised in its 'Note d'Orientations Générales pour le Développement du Digital au Maroc à horizon 2025' (General Guidelines for digital development by 2025). The strategy has three broad objectives:

2 https://add.gov.ma/storage/pdf/Avril_NOG_ADD_fr_SITE_VF.pdf

- implementing the digitalisation of government services and broadening access to internet, for all citizens and businesses to access to public services online
- making the Moroccan economy more competitive and technologically more advanced
- creating a more inclusive digital society.

5G is expected to be an important enabler of these objectives (Figure 2.3).

Figure 2.3: Potential role of 5G in achieving Morocco's digital development goals by 2025

Key goal of General Guidelines	Potential 5G relevance
Transform interactions with the public administration via the end-to-end digitalisation of priority citizen/business pathways, with the objective of improving satisfaction rate with public administration services to over 85%	• 5G can enable advanced and ubiquitous connectivity to support the development of domestic information and communications technology (ICT) industry and stimulate the use of new technologies (e.g. cloud). • This will be crucial in enabling a more accessible form of public services, such as the digitalisation of administrative services, and hyperconnected public services. For enterprises, it provides a more efficient set of interactions with the state, encouraging further investment. • Improved network resilience and customer experience will lead to higher consumer spending in Morocco.
Establish Morocco as a flagship digital and technological hub in Africa, with the objective of ranking third in the continent and among the top 40 countries in the United Nations Online Service Index ranking[3]	• 5G underpins and enables new technologies (e.g. IoT, cloud computing, cognitive computing) through high-capacity networks, and enables smarter businesses and new digitalised services. • Access to 5G networks facilitates the creation of start-ups centred on new use cases as well as the creation of digital hubs and ecosystems. This will be essential for the region's economic development and the consolidation of the role of Morocco as a connectivity hub. • There is significant potential for further economic growth in Morocco due to its geographical position and the large investments expected in submarine cables in areas that have yet to experience the growth in internet usage observed in other parts of the world. Investment in new submarine cables leads to an increase in the supply of international bandwidth that, together with the increased availability and penetration of 5G advanced connectivity, can have a positive impact on the economy and make Morocco a digital hub at a global scale. • Improving its score on the United Nations' Online Services Index (Morocco currently in 113th position out of 193 countries included in the 2022 Online Services Index) requires Morocco to improve the scope and quality of online services, including government approaches, open government data, multi-channel service delivery, mobile services, usage take-up and digital divides, as well as innovative partnerships through the use of ICT. 5G can transform how digital services are offered and consumed and will be a key element in raising Morocco's ranking in the survey. • Advanced mobile connectivity stimulates wider foreign direct investment that benefits local wholesalers, service providers and the region's overall business sector.
Reduce the digital divide, train 50 000 young employable talents and develop specific initiatives in industry sectors such as education, healthcare, agriculture and handicraft	• Network infrastructure investments include job creation, which can either be direct (e.g. jobs in the telecoms sector) or indirect (e.g. jobs associated with improving broadband connectivity across the broader economy, particularly in service industries such as IT, education and manufacturing).

3 https://publicadministration.un.org/egovkb/en-us/Data/Compare-Countries

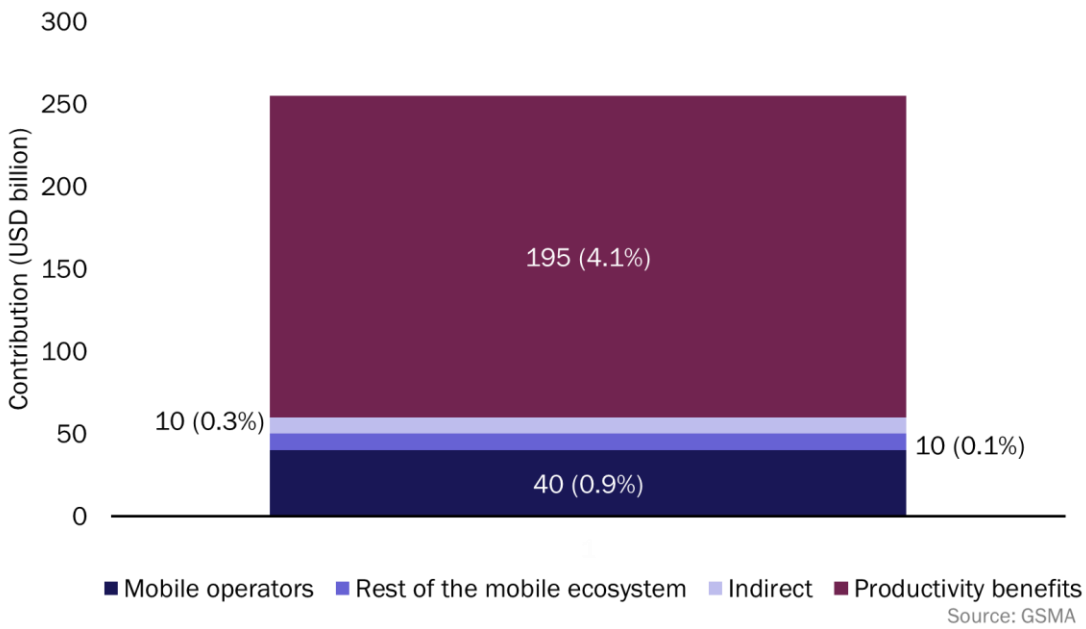
Key goal of General Guidelines	Potential 5G relevance
	• 5G also contributes to closing the digital divide by enabling remote services, such as telehealth and remote education, which require faster and more reliable internet connections than are currently widely available.

Source: Agence de Développement du Digital, Analysys Mason

2.3 The economic impact of 5G in the Middle East and North Africa is expected to be significant

In 2021, the Global GSM Association (GSMA)[4] estimated that mobile technologies and services generated USD255 billion of economic value in the Middle East and North Africa (MENA), and accounted for 5.4% of the aggregated GDP of countries in the region. A total of USD50 billion was contributed by the mobile ecosystem directly, most of that by MNOs[5], and USD195 billion from productivity benefits enabled by cellular networks (Figure 2.4).

Figure 2.4: Contribution of the mobile industry to GDP (in value and percentage of GDP), Middle East and North Africa, 2021



The adoption of 5G across a range of industry sectors is expected to have further economic benefits. In a study published in February 2022[6], the GSMA estimated that 5G mid-band spectrum could drive an increase of USD16.0 billion in GDP in MENA in 2030 (0.35% of overall regional GDP in 2030). A report published in

4 https://www.gsma.com/mobileeconomy/wp-content/uploads/2022/05/GSMA_MENA_ME2022_R_WebSingles.pdf.

5 The rest of mobile ecosystem includes infrastructure providers, device manufacturers, distributors, retailers, content, apps and service providers.

6 https://www.gsma.com/spectrum/wp-content/uploads/2022/02/mid-band-5G-spectrum-benefits.pdf.

October 2019[7] estimated that 5G services leveraging millimetre-wave (mmWave) spectrum would contribute USD3.9 billion in additional GDP in the region in 2030.

7 https://www.gsma.com/spectrum/wp-content/uploads/2019/10/mmWave-5G-benefits.pdf.

3. The long-term success of 5G depends on several key enablers

5G has the potential to positively affect society and the economy, in Morocco and the broader MENA region (see previous section of this report). However, these benefits will be achieved only if policymakers take steps to facilitate the introduction of 5G and work to ensure its long-term success. We have identified four broad enablers that are relevant to the overall success of 5G, including:

- spectrum availability, neutrality and affordability
- licence obligations
- clear roadmap for 5G rollout
- favourable government policies for 5G technology development and infrastructure deployment.

The definition and importance of each factor are described in the following sub-sections.

3.1 Spectrum availability, neutrality and affordability

Spectrum availability

5G can support a variety of use cases that can have a positive impact on industry. Each use case has specific network requirements, such as throughput, device density, availability, latency and mobility (Figure 3.1).

Figure 3.1: Network requirements for selected use cases[8]

Vertical sector	Use case	Throughput	Density	Availability	Latency	Mobility
Manufacturing	Remote control of industrial machinery	●●●●●	●●●●○	●●●●●	●●○○○	●●○○○
Agriculture	Long-range remote control of drones for inspection	●●●●○	●○○○○	●●●●●	●○○○○	●●●○○
Public sector	Smart CCTV	●●●●○	●●●●○	●●●●●	●●○○○	●●○○○
Healthcare	Remote surgery	●●●●●	●●●○○	●●●●●	●○○○○	●○○○○
Transportation	In-vehicle infotainment	●●●●○	●●●●○	●●●○○	●●●○○	●●●●○

Source: Analysys Mason

To address those requirements, 5G is designed to leverage a range of frequencies, each with specific and complementary characteristics. These frequency ranges can be categorised into three groups: low band (sub-1GHz), mid band (1–7GHz) and high band (above 24GHz).

8 Throughput: ●○○○○: ≤1Mbit/s, ●●○○○: 2–50Mbit/s, ●●●○○: 51–100Mbit/s, ●●●●○: 101–1000Mbit/s, ●●●●●: ≥1001Mbit/s. Density: ●○○○○: <10 per km², ●●○○○: 11–1000 per km², ●●●○○: 1001–10 000 per km², ●●●●○: 10 001–1 million per km², ●●●●●: ≥1 million per km². Availability: ●○○○○: N/A, ●●○○○: N/A, ●●●○○: 95–99%, ●●●●○: 99.1–99.9%, ●●●●●: 99.901–99.999%. Latency: ●○○○○: ≤1ms, ●●○○○: 2–10ms, ●●●○○: 11–50ms, ●●●●○: 51–1000ms, ●●●●●: ≥1001ms. Mobility: ●○○○○: 0km/h, ●●○○○: 1–10km/h, ●●●○○: 11–100km/h, ●●●●○: 101–350km/h, ●●●●●: ≥350km/h.

► *Low band (sub-1GHz)*

Low-band spectrum typically includes frequencies in the 600MHz, 700MHz, 800MHz and 850/900MHz ranges, which are essential for cost-effectively providing 5G coverage in rural areas and deep indoor environments (especially relevant for massive IoT and ultra-reliable communications). Limited spectrum is available however, which reduces capacity and throughput. Low-frequency bands may be combined with mid-band spectrum using carrier aggregation, to achieve a cost-optimal balance of capacity and coverage.

Core bands that have been made available by NRAs to MNOs for 5G services include 600MHz (for example, USA) and 700MHz (for example, Austria, Germany, Netherlands, the UK and other European countries). Where applicable, existing mobile spectrum in the 800MHz band is expected to be retained for 4G services in the long term, while 900MHz spectrum used by 2G, 3G or 4G services may be refarmed by MNOs to 5G in due course or used via dynamic spectrum sharing (subject to the technology-neutrality of the spectrum – see below for more details).

► *Mid band (1–7GHz)*

Mid-band spectrum can be split into two categories: upper mid bands (for example, 3.3–4.2GHz, 4.5–5.0GHz, 6.4–7.1GHz), and lower mid bands (for example, 1.5GHz, 1.8GHz, 1.9GHz, 2.1GHz, 2.3GHz, 2.6GHz).

- **Upper mid band (3–7GHz)**

Upper mid-band spectrum is widely considered as the primary frequency range for 5G, providing higher capacity than low-band frequencies, while offering wider coverage and stronger propagation than high band. It has been the main driver of 5G commercial launches so far and is expected to help to realise the largest proportion of 5G's socioeconomic benefits in the next decade (72% by 2030 in the MENA region). The 3.3–3.8GHz range (C-band) is the most commonly used band for 5G so far. A minimum of 100MHz of contiguous spectrum per MNO has been recommended by the mobile industry as being needed to deploy 5G with massive MIMO, which improves overall network throughput, while maximising spectral efficiency.

Discussions on future use of the 6GHz band (5.9–7.1GHz) spectrum are ongoing in Europe, the Middle East and Africa. The band could supplement licensed mid-band spectrum for 5G services and offer the necessary bandwidth to reach the 2000MHz target. To date, the lower band (5.9–6.4GHz) has been made available on an unlicensed basis in Europe, but future use of the upper band (6.4–7.1GHz) is under discussion. The use of the upper 6GHz band (6.4–7.1GHz) is to be considered at ITU World Radiocommunication Conference 2023 (WRC-23) for mobile/IMT in ITU Region 1, which includes Morocco. In the meantime, progress has been made for standardising and accelerating the production of 6GHz 5G equipment and devices; the technical specifications of 5G new radio (NR) band 104 were completed as part of 3GPP Release 17 for the upper part of the 6GHz band for licensed 5G services in June 2022.

- **Lower mid band (1–3GHz)**

Lower mid-band spectrum is already used for 2G, 3G and 4G services in many countries. Bands in the 1.8GHz, 2.1GHz and 2.6GHz ranges have been typically used by MNOs as a capacity layer for 4G traffic, primarily in paired/FDD mode. These bands may be exploited and used for 5G networks, allowing operators to benefit from faster and cost-efficient deployment, thus delivering enhanced capacity when combined with upper mid-band spectrum. The importance of making some of the lower mid-band spectrum ready for use by 5G services was recently recognised by the European Commission, which published, in February 2022, a decision to make 1.8GHz spectrum suitable for 5G services.

Other bands in the lower mid-band spectrum range, such as the 2.3GHz band (up to 100MHz) and 2.6GHz (190MHz) are becoming more and more popular as primary 5G bands, especially in countries where limited C-band spectrum is available (for example, due to legacy issues that delay the clearance of the C-band). Both bands have good propagation characteristics, provide good capacity and are widely supported by device manufacturers and the overall supply ecosystem due to their existing use for 4G services in many countries. By updating the regulatory conditions on use or technology, the 2.3GHz and 2.6GHz bands could become complementary spectrum bands for 5G deployments. Examples of countries that have awarded unpaired/TDD spectrum in the 2.3/2.6GHz band include Brazil, Saudi Arabia and Tanzania (2.3GHz) and Egypt, India, South Africa and Tanzania (2.6GHz).

As demand for 5G services grows over the next few years, it is expected that each network will need over 2000MHz of mid-band spectrum by 2030.

- *High band (above 24GHz)*

High-band spectrum includes frequencies in the millimetre-wave bands (for example, 26GHz, 28GHz, 40GHz, 50GHz, 60GHz), and is expected to play an important role for 5G because these bands can support applications with ultra-high speed and very low latency requirements (for example, augmented and virtual reality, fixed-wireless access).

Millimetre-wave frequencies have, so far, not been widely used in commercial deployments, but the 24.25–27.5GHz (26GHz) is one of the bands identified in Europe for 5G deployment and hence licensing of this band is expected to accelerate. The 37–43.5GHz band was identified as a global IMT allocation at the ITU's World Radio Conference in 2019 (WRC-19) and has also received 3GPP support as a 5G band. Some countries are consulting on 5G licensing in this band, carrying out studies and issuing trial licences (for example, Sweden, UK). Other countries have announced plans to begin investigations into the band (for example, Germany, Spain), while others are monitoring future trends and demand (for example, France, Saudi Arabia). The mobile industry has recommended that at least 800MHz of contiguous millimetre-wave spectrum per MNO is necessary for early deployments of 5G.

Spectrum neutrality

As outlined previously, a mixture of bands is required to realise the full potential of 5G. Some frequencies are new additions to mobile technology specifications (for example, 3.5GHz, millimetre-wave), other bands have been, or are being, used by previous generations of mobile services (for example, 900MHz, 1.8GHz, 2.1GHz, 2.6GHz). Spectrum neutrality can help MNOs to re-use existing spectrum holdings (refarming) to accelerate technological upgrades to 5G and promote efficient spectrum usage: newer technologies such as 4G/5G have higher spectral efficiency compared to legacy 2G/3G, delivering higher throughput and improved spectrum usage, and generating benefits for consumers as a result (for example, lower retail prices, enhanced customer experience).

Spectrum neutrality also allows MNOs to react to market demand and decide how best to address user needs by using spectrum bands for different technologies and services based on their business goals. Imposing restrictions on the use of bands licensed for 2G and 3G may force MNOs to serve a shrinking number of customers using those legacy technologies. MNOs need to be able to carefully manage the transition to new technologies and to flexibly use spectrum bands in a technology-neutral fashion. This stimulates competition between MNOs and ultimately drives investment in new technologies.

Spectrum affordability

Beyond making suitable spectrum available in the right amount, governments and NRAs also need to ensure that spectrum is priced appropriately, in particular in the light of the significant investments that MNOs need to sustain to upgrade and densify their networks while having to maintain and operate their legacy systems. Prohibitive spectrum fees can undermine the pace at which MNOs can deploy 5G networks, which would impact the speed at which the potential economic benefits of 5G can be achieved. This is a key issue for policymakers, which are looking to maximise the socioeconomic impact of 5G in their countries.

Policymakers can consider several measures to improve affordability and facilitate spectrum access.

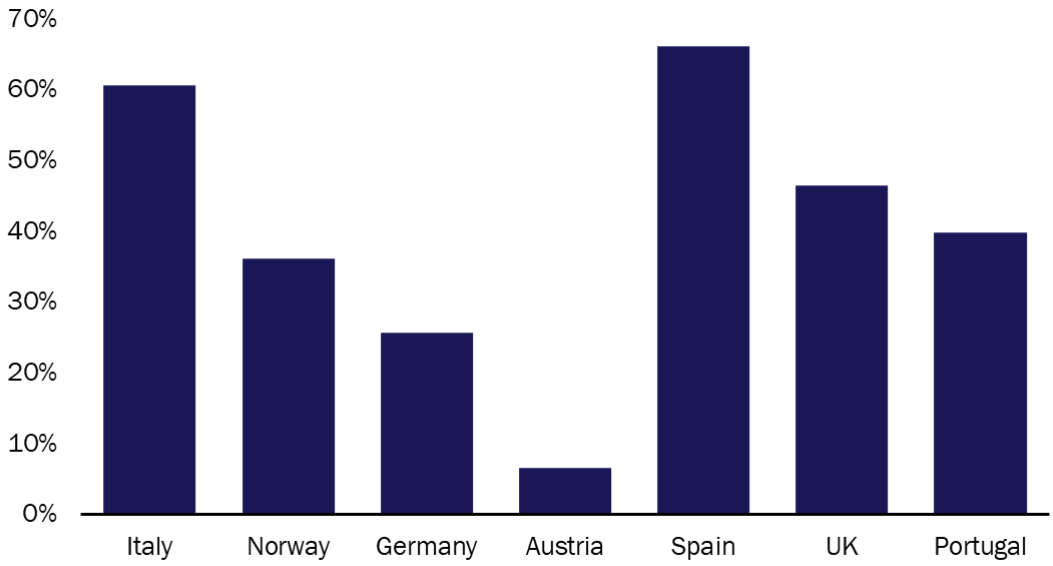
- **Discounts in spectrum fees in return for coverage commitments.** In Austria, where the award of the spectrum in the 700MHz band was linked to coverage obligations (winning bidders should cover over 900 out of 2100 local communities identified as lacking adequate broadband access), bidders could receive a discount on spectrum fees if they committed to cover more communities. Similarly, in Norway, three mobile operators accepted the regulator's offer to obtain spectrum at a discounted price in return for a commitment to offer broadband services with download capacity of at least 100Mbit/s in rural areas.

- **Temporary reduction or waiving of upfront fees or annual spectrum fees.** Relevant examples include Qatar, where no upfront and annual spectrum fees were demanded for the 3.5GHz bands, and India, where the regulator removed upfront payment for winning bidders and allowed operators to pay in equal annual instalments over 20 years in order to ease cash flow requirements.

- **Setting modest reserve prices and carefully choosing the size of spectrum lots assigned.** A poorly designed spectrum assignment process, due to an artificial scarcity of spectrum (that is what happened in the 5G auction in Italy) or high reserve prices risk inflating spectrum prices, distorting the market and ultimately disrupting the development of new mobile technologies.

Policymakers can use these tools to improve spectrum access, but other factors, such as the number of bidders participating in a spectrum auction as well as the technical and commercial value that each MNO attributes to spectrum when entering bidding processes, also affect the outcome of the assignment process. The varying degree of importance of these factors has led to a wide variation of spectrum prices (in USD per MHz per pop) across countries but it is worth noting that, in selected European markets, the average price paid for low-band 700MMHz spectrum (typically used as a coverage layer for 5G services) by MNOs in recent auctions has been in general lower than the average price paid for low-band 800MHz spectrum (typically used as a coverage layer for 4G services) (Figure 3.2).

Figure 3.2: Prices for 700MHz spectrum as a proportion of prices for 800MHz spectrum, normalised for a 20-year licence duration, ITU Region 1



Source: Analysys Mason

3.2 Licence obligations

Governments and regulators can incorporate policy goals within the spectrum assignment process to foster more-efficient usage of spectrum, a rapid network roll-out and, in many cases, to ensure an expansion of mobile connectivity in densely populated areas as well as in rural regions. Licence obligations need to take into account policy objectives and can take the form of spectrum caps, or guidance related to coverage, roll-out or speed.

Examples of countries where 5G spectrum has been awarded with obligations are as follows.

- In the Netherlands, 5G licence holders must achieve 98% geographical coverage across all municipalities nationwide within 2 years of the start of the licence. MNOs should provide coverage with a minimum speed of 8Mbit/s, which should be available with a 90% certainty level. Minimum speeds should be 10Mbit/s 6 years after the licences are issued.

- In Denmark, MNOs that were awarded 3.5GHz spectrum in June 2021 are expected to reach a population coverage of 60% by 31 December 2023 at the latest, and a population coverage of 75% by 31 December 2025.

- In Germany, licence obligations for mobile operators that were awarded 5G spectrum in the 2019 auction included an obligation to cover 98% of households and all major transport infrastructure (such as major roads, rail- and waterways) with speeds of at least 100Mbit/s by the end of 2022, and an obligation to deploy and operate at least 1000 new 5G base stations by the end of 2022.

3.3 Roadmap for 5G roll-out

Developing a national implementation roadmap can help to accelerate 5G roll-out. The roadmap should detail how 5G will be introduced to the market, the services that might be offered (for example, enhanced mobile broadband, fixed-wireless access, services for enterprises), the frequencies to be made available for 5G, and the

timescales for any preparatory work needed (for example, plans for equipment testing, schemes to facilitate early commercial trials, update to or withdrawal of legacy licences, detailed schedule for spectrum release). A national roadmap can provide MNOs with increased visibility on the likely timescale for spectrum allocation, helping them to plan activities such as trials and network roll-out leading to commercial launch. Examples of countries that have developed 5G roadmaps include the following.

- In South Korea, the government launched in May 2013 a 5G forum to kick-start formal discussions on the national 5G strategy. Since then, the government has expanded its support for 5G and announced various initiatives (for example, 4th Industrial Revolution, I-Korea 4.0 Plan and HyperConnected Intelligent Network Deployment Strategy in 2017; 5G+ Strategy and Manufacturing Renaissance Strategy in 2019; Korean New Deal in 2020).

- The European Union announced a 5G Action Plan in September 2016, with the goal of launching 5G services in all Member States by the end of 2020 at the latest, followed by a rapid build-out to ensure uninterrupted 5G coverage in urban areas and along main transport paths by 2025.

- In the UK, the government published a national strategy in March 2017 ('Next Generation Mobile Technologies: A 5G Strategy for the UK'[9]), providing an overview of the UK government's ambition for 5G and including the steps to be taken by the government to help to build the case for investment in 5G, create a suitable regulatory framework, make sites available for infrastructure development, improve mobile coverage and ensure a secure deployment of 5G. It also outlines spectrum-related issues

3.4 Government policies for 5G technology development and infrastructure deployment

Beyond spectrum availability, the speed at which 5G can be deployed depends on the extent to which governments and industry bodies proactively take steps to facilitate and accelerate the process, and set out policies to encourage technological development and an early commercial launch of services, such as:

- **Policies and funding aimed at encouraging new infrastructure developments**. In 2017, the German government launched a programme to invest EUR100 billion in 5G and fibre networks by 2025. In the European Union, the European Investment Bank (EIB) has provided EUR2.5 billion for nine 5G projects in five Member States, as of August 2021. In early 2021, the European Union (EU) set up its Recovery and Resilience Facility (RRF) initiative in the form of a EUR673 billion fund, to help EU member states to mitigate the impact of the COVID-19 pandemic. At least 20% of RRF spending must focus on digital transformation, of which 5G is a key enabler; Italy, for example, allocated EUR2 billion of RRF funds to telecoms operators in April 2022 for the roll-out of 5G networks. Countries such as United Kingdom have explicitly included wireless technologies in the scope of national broadband technology and financial subsidies.

- **National-level guidelines to facilitate the acquisition of new sites** such as lamp posts, traffic signals and public transportation infrastructure can help to accelerate small-cell deployments and streamline planning processes to avoid lengthy deployment delays.

- **Funding for testing and developing 5G technology**. In the UK, a dedicated 5G unit, set up in the UK Department for Media, Culture and Sport (DCMS), has been tasked with managing the allocation of government funds for 5G testbeds and trials. In Japan, the Ministry of Communications' 2016 5G roadmap committed to a package of 'comprehensive promotion strategies for 5G', including conducting 5G trials and

[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/597421/07.03.17_5G_strategy_-_for_publication.pdf.

promoting 5G research and development (through ‘Industry-Academic-Government Cooperation’ and the 5G Mobile Forum).

Beyond government policies, the adoption of 5G services in the longer term will only be achieved if industry bodies recognise the importance of 5G as a key technology for achieving national broadband targets.

- In October 2020, the Body of European Regulators for Electronic Communications (BEREC) issued a set of Guidelines on very high-capacity networks (VHCNs), providing guidance to telecoms regulators on the criteria that fixed or mobile networks must fulfil if they are to be considered to be VHCNs, and highlighting 5G as a key technology for VHCNs.

- In October 2022, the ITU drafted an updated framework for its strategic plan for 2024–2027, with specific references to 4G/5G and FWA as key technologies to achieve ‘inclusive and secure telecoms infrastructure and services’, one of the key priorities of the updated plan. The proportion of broadband connections by technology (including 5G) is expected to be used by ITU as a key indicator to track progress towards this priority.

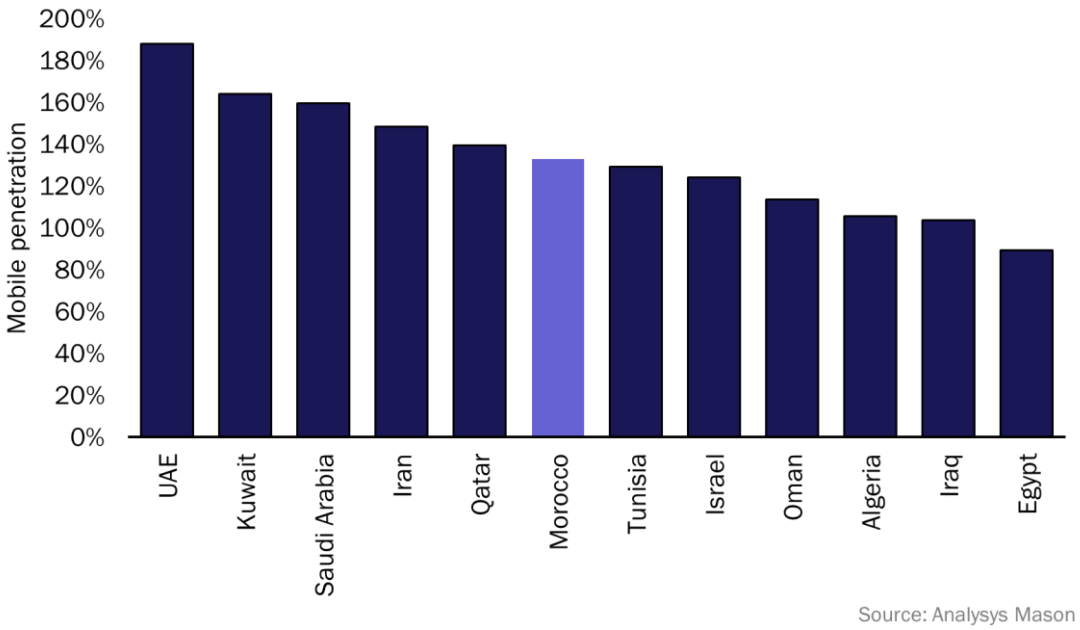
- In October 2022, the National Broadcasting and Telecommunications Commission (NBTC) of Thailand released an outline of a broadband infrastructure development plan (‘Giga Thailand Infrastructure’), which aims to increase broadband penetration over the next few years in Thailand through the deployment of high-speed broadband technologies, including 5G and FTTx.

4. Morocco is at an early stage of introducing 5G

4.1 MNOs have been trialling 5G in preparation for launch

Morocco is one of the most developed mobile markets in North Africa, with mobile penetration at nearly 133% of its population by 1Q 2022, in line with comparable countries in the region (Figure 4.1). The rapid adoption of 4G services, a healthy level of competition between MNOs and the relatively limited availability of fixed broadband services, have been key contributing factors to increasing mobile adoption in Morocco.

Figure 4.1: Mobile penetration in countries in the Middle East and North Africa, 1Q 2022



MNOs launched 4G services between June and July 2015, a few months after ANRT allocated licences in the 800MHz, 1.8GHz and 2.6GHz bands to all three MNOs in March 2015.

4.2 Progress to achieve 5G readiness has been slow

It is our understanding that ANRT is in the process of preparing to achieve 5G readiness, but limited information is available in the public domain.

Plans for new spectrum allocation have yet to be publicly disclosed

ANRT has made few details available about spectrum bands to be allocated for 5G services.

Spectrum in the 700MHz band could be suitable for low-band 5G services in Morocco. Spectrum in the 700MHz band was assigned to mobile services as a result of the adoption of the new national frequency plan in December 2017[10] and appears to be free of any existing MNO allocation.

Upper mid-band spectrum is available in the C-band in the 3.3–3.4GHz, 3.6–3.8GHz and 3.8–4.2GHz ranges. Using the 3.4–3.6GHz band in addition would add more contiguous blocks, but it will need to be freed up first because Orange uses it to offer fixed-wireless access and BLR services, and inwi uses it to offer BLR services.

As in other countries, lower mid-band spectrum in the 1.8GHz, 2.1GHz and 2.6GHz bands have been licensed for previous generations of mobile technologies. Because technology-specific spectrum licences are in place in Morocco, the use of dynamic spectrum sharing is *de facto* impossible, preventing MNOs from leveraging their existing spectrum holdings to introduce 5G services (via dynamic spectrum sharing for example). The 2.3GHz band is unused in Morocco and could be used as a substitute for, and/or complement to, the C-band.

A provisional 5G roadmap outline has been published

ANRT outlined an initial position on the timing and preparation required for 5G in a note published in 2021 defining the objectives and goals for the development of the telecoms sector between 2020–2023. It emphasised the technical and economic challenges of successfully launching 5G in Morocco, with launch timing being particularly important to strike the optimal balance between rolling out 5G early enough such that Morocco can retain a leading place in the Middle East and North Africa in terms of digital technology progress, but not so early that the launch suffers from the limited maturity of the technology, or risks undermining the development of the fixed market. The government expected 5G services to be commercially available in Morocco from 2023 onwards (at the earliest).

The note suggested, in addition, that the government would identify the optimal conditions and modalities of operation of 5G networks in Morocco and spectrum bands, while also defining the obligations attached to the deployment of 5G (for example, coverage, national roaming), identifying the technical capabilities needed to support adoption across different verticals, and establishing frequencies that can be granted to commercial companies for industrial purposes.

The note also highlighted that the government would aim to support the development of a strong industry ecosystem to enable the growth of key vertical sectors in the country.

The government estimated that implementing these guidelines would help to generate telecoms revenue of ~MAD35 billion (USD3.2 billion) by 2023, based on an internet subscriber base of 33 million, a broadband subscriber base (including both ADSL and fibre-to-the-home) of 24 million and a national coverage of the entire population with a minimum speed of 2Mbit/s. No specific link was made to 5G economic benefits, however.

Government support to facilitate infrastructure deployment is being considered

The note on the development of the telecoms sector by 2023 suggested that the Moroccan government would favour infrastructure-sharing models, with the use of passive site sharing and national roaming being encouraged during the first few years of 5G operation.

10 https://www.anrt.ma/sites/default/files/document/rapport_annuel_2017_vf.pdf.

5. Countries that are making good progress with 5G are addressing most of the four key enablers

Morocco is one of the countries in MENA that has not launched 5G to date and is therefore lagging behind in the race to achieve the socioeconomic benefits that 5G could generate.

The following sub-sections explore how NRAs and governments in six countries – France, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates (UAE) – have addressed some the key enablers of long-term 5G success described in the previous section. All six countries have launched 5G services. Some of the good practices identified in these countries can provide useful lessons for Morocco.

5.1 All countries have allocated mid-band spectrum

All six countries have awarded mid-band (3.5GHz) spectrum for 5G use. Five have allocated at least 100MHz of mid-band spectrum per MNO. While there some more uncertainty regarding the timetable for allocating new low-band spectrum (600/700MHz), some countries (Qatar, Saudi Arabia) have recently made initial plans to release additional low-band spectrum in the future. In all countries, spectrum has been released on a technology-neutral basis.

Figure 5.1: Availability of 5G spectrum by country[11]

Country	Low band	Mid band[12]
Kuwait	• None disclosed	• 100MHz (unpaired) in the 3.5GHz band was assigned to all three MNOs (Zain, Ooredoo, STC) in May 2019.
Oman	• 20MHz of paired spectrum in the 700MHz band, and 19.8MHz of paired spectrum in the 900MHz band were allocated to Oman Future Telecommunications (Vodafone Oman) in 2021.	• 100MHz (unpaired) in the 3.5GHz band allocated to Ooredoo and Omantel in December 2018. Spectrum fees were waived for 12 months.
Qatar	• Release of spectrum in 700MHz planned for 2023	• 100MHz (unpaired) in the 3.5GHz band was assigned to Ooredoo and Vodafone in December 2018. • Additional spectrum in the 3.5GHz band will be released in 2023.
Saudi Arabia	• 30MHz of paired spectrum in the 700MHz band was assigned to STC in 2017. • 40MHz of paired spectrum in the 800MHz band was assigned to Mobily and Zain in 2018. • Spectrum in 600MHz and 700MHz bands was planned to be released in mid-2022, although this has yet to happen as of January 2023	• 290MHz (unpaired) in the 2.3GHz and 2.6GHz bands were allocated to all three MNOs In January 2019. • 100MHz (unpaired) in the 3.5GHz band was allocated to all three MNOs (STC, Mobily, Zain) in mid-2019.

11 For readability, this table focuses on spectrum that been allocated to MNOs, and is either currently used by MNOs to provide 5G services, or is currently un-used by MNOs (but is technology neutral, and therefore could be used for 5G in the future). Frequency bands that are currently used by MNOs to provide existing 2G/3G/4G services are excluded from the table.

12 In this table, mid-band spectrum refers to 2.3GHz unpaired, 2.6GHz unpaired or 3.5GHz spectrum.

Country	Low band	Mid band[12]
		• The regulator plans to make other bands available between 2021 and 2023, including 1.5GHz, 2.1GHz and 26GHz.
UAE	• Plans to allocate (technology neutral) spectrum in the 700MHz band to MNOs were announced in 2013, but a schedule has yet to be published as of January 2023. • Spectrum in the 900MHz band has been used by MNOs to offer 2G services, but 2G networks are expected to be shut down by the end of 2023, which could allow spectrum to be repurposed to support 5G networks in the future.	• 100MHz (unpaired) in the 3.5GHz band was assigned to Etisalat and du in 2018.
France	• 60MHz of paired spectrum in the 700MHz band was assigned to Bouygues Telecom, Iliad, Orange and SFR in 2015.	• 310MHz (unpaired) in the 3.4GHz–3.8GHz range was assigned to Bouygues Telecom, Iliad, Orange and SFR in October 2020.

Source: Analysys Mason

5.2 Some countries have imposed specific licence obligations

A few countries have imposed obligations when assigning 5G spectrum.

- In Qatar, the first spectrum release in 2018 required MNOs to upgrade at least 40% of their existing 4G sites to 5G, and to cover all primary roads and FIFA 2022 World Cup venues with 5G by end of 2020. For the second spectrum release, MNOs were required to cover 98% of the landmass and provide a minimum speed of 100Mbit/s to all users of 5G services by the end of 2024. In December 2021, the government published updated conditions on network roll-out and coverage obligations in relation to existing spectrum licences and additional (optional) assignments, including indoor coverage (e.g. stadiums, hotels, shopping malls, airport), provision of fixed access connectivity, support of different technical capabilities for varied use cases across different verticals, such as manufacturing, health, automotive and media.

- In France, the obligations associated with the award of 5G spectrum required that each winning bidder must launch 5G services in at least two cities before the end of 2020. Optional commitments were also announced as part of the bidding process, which will enable operators that intend to satisfy them to obtain additional spectrum.

- Saudi regulator CITC imposed obligations on quality of service (QoS), over the period 2020 to 2027, to encourage investment and promote efficient usage of spectrum. It also designed less competitive auctions to moderate prices as a function of the corresponding obligations.

5.3 Most countries have developed and published a 5G roadmap strategy

Most NRAs have published 5G roadmaps, providing a detailed schedule to help MNOs to plan the steps required to launch 5G commercially.

Figure 5.2: 5G roadmap developments by country

Country	5G roadmap released	Detail
Kuwait	No	• Not applicable
Oman	Yes	• Published in October 2019, outlining site roll-out strategy, key investments and co-operation activities between government and private sectors to accelerate 5G adoption.
Qatar		• Preliminary frequency bands plan for 5G[13] published in February 2018, defining blocks in the 700MHz band to be used to accommodate future demand from MNOs, and setting aside 100MHz of spectrum per MNO in the 3.5GHz range and 400MHz bandwidth per MNO in the 26GHz range.
Saudi Arabia		• "3-year Outlook for Commercial and Innovative Use of the Spectrum in Saudi Arabia[14]" released in 2021, and outlining the plan to allocate or improve access to more than 23GHz of spectrum in a large range of frequencies.
UAE		• 'UAE 5G' released in 2018 outlining objectives and steps to accelerate the launch of 5G. • UAE Spectrum Outlook (2020–2025)[15] published in 2020 to support future wireless connectivity needs. The TDRA expects MNOs to achieve full national 5G coverage (including inhabited areas of the country) by the end of 2025.
France		• ARCEP's roadmap (5G: an ambitious roadmap for France[16]) published in July 2018, and outlining plans for allocating radio frequencies, for supporting the development of new use cases and of infrastructure roll-outs, for ensuring transparency about safety regulation regarding 5G deployment.

Source: Analysys Mason, 2022

5.4 Governments have backed technological development and incentivised investments in network infrastructure, though rarely specific to 5G

Regulatory bodies have set up national strategies and introduced policies to encourage technological development, and create suitable conditions for investment. The publication of policies encouraging economic differentiation and development suggests that governing bodies support the deployment of new technologies, although the emphasis on 5G and its direct benefits is rarely explicit in most markets. France is the only country among the six countries reviewed to have offered direct funds as part of its national strategy to accelerate the development of 5G and next-generation technologies.

Figure 5.3: Government backing and infrastructure build-out facilitation developments by country

Country	Comments
Kuwait	• In January 2017, the Government of Kuwait unveiled the country's Vision 2035 and National Development Plan, branded as 'New Kuwait', though no specific plan for 5G technology development or communications infrastructure was included

13 https://www.cra.gov.qa/-/media/System/1/0/3/E/103E058FFA1757C58B0757330EB081B0/Preliminary-Frequency-Bands-Plans-for-5G-Mobile-Services.ashx

14 https://www.cst.gov.sa/en/ntn/Documents/SpectrumOutlook.pdf

15 https://tdra.gov.ae/-/media/About/regulations-and-ruling/AR/fileUAE-Spectrum-Outlook-2020-2025-v1-0-pdf.ashx#:~:text=The%20%E2%80%9CUAE%20Spectrum%20Outlook%E2%80%9D%20is,sector%20over%20the%20coming%20years.

16 https://www.arcep.fr/fileadmin/reprise/dossiers/programme-5G/Roadmap_5G_-_VA.pdf

Country	Comments
Oman	• In 2020, the government of Oman launched “Oman Vision 2040”, identifying national priorities and providing a reference for economic and social planning for the period of 2021–2040. • No direct reference to 5G included in the document, although many investments in mobile networks in the country are connected to Oman Vision 2040.
Qatar	• Limited investment in 5G technology development from the government, although it has invested significantly in fibre (via Qatar National Broadband Network), a key enabler to 5G connectivity
Saudi Arabia	• Limited public information is available on direct 5G investments; the government is developing ICT strategies within “Saudi Vision 2030” to create investment conditions. • Saudi Vision 2030 was launched in April 2016 and included several strategic objectives that would be achieved through collaboration between Saudi Arabia’s public, private, and non-profit sectors.
UAE	• Limited visibility on direct investment in 5G technology development from the government, although there is significant commitment to accelerate the launch of 5G by facilitating large-scale, cross-industry collaborative test and development. • In 2010, the government published Vision 2021 that outlined six national priorities, which represented the key focus sectors of government action. Subsequently, the UAE Future Strategy was published to shape the future of sectors and verticals in the UAE.
France	• In July 2021, the French government launched an acceleration strategy for 5G and future telecoms network technologies. As part of this project, the government aims to raise a total contribution of up to EUR1.7 billion in investments by 2025. • The French government announced “France 2030” programme in October 2021. The strategy intends to support the transformation of French economy across different sectors including automotive, aerospace, digital, green industry, biotechnology, culture and healthcare. It will be worth EUR30 billion over 5 years, of which EUR3–4 billion will be spent as soon as 2022.

Source: Analysys Mason

6. Recommendations for policymakers

5G deployment is already well under way in leading countries in MENA, but the lack of availability of 5G spectrum combined with the lack of government's roadmap and initiatives to promote 5G deployment have denied Morocco the opportunity to reap the economic benefits of 5G. A delayed 5G launch means also that Morocco risks damaging investment in other areas of telecoms/ICT and in other verticals.

We have identified several levers to be considered by policymakers to accelerate the development of 5G in Morocco.

Figure 6.1: Recommendations for policymakers in Morocco

Enabler	Comments
Spectrum	• Identify the most suitable bands for deploying 5G in Morocco as a matter of priority and plan a roadmap for spectrum assignments that will deliver enough capacity and coverage for high-quality 5G services. Policymakers should also consider the following: — Assign 100MHz of contiguous mid-band (3.5GHz) spectrum to all operators in the country. This might require spectrum refarming, which should be carried out urgently. — Consider lower mid-band spectrum bands, such as the 1.8GHz, 2.1GHz and 2.6GHz bands, that are currently assigned for previous technologies, as complementary capacity bands to 3.5GHz for supporting 5G services. Operators already have access to this spectrum and enabling operators to use these bands on a technology-neutral basis could accelerate the launch of 5G. These bands are also widely supported by the vendors and manufacturers. — Consider the 2.3GHz band as a complementary capacity band for 5G services. This band is not currently allocated in Morocco, so the assignment process could potentially be concluded in a timely manner and enable operators to quickly have access to 5G-suitable spectrum. — Assign low-band spectrum. The 700MHz spectrum band has not yet been allocated in Morocco and will be ideal to support the wide coverage requirement of 5G services. — Discuss the assignment of high-band spectrum in order to complement low- and mid-band assignment with high-capacity spectrum. — Consider setting aside the upper 6GHz band (6.4–7.1GHz) for future 5G spectrum needs. Review regulatory decisions that other countries make in relation to this band, and plan a consultation for future allocation.
	• Consider simplifying regulations to encourage collaboration between stakeholders to streamline decision-making processes. The allocation of temporary licences should also be considered as a lever to speed up initial launches.
	• Plan for releasing additional capacity as 5G networks expand and more capacity is needed to scale services. Discuss the allocation of additional bandwidth as a priority. — For example, the possibility of supporting new harmonised bands to help 5G services to expand over the longer term, such as the use of 6GHz band, should be taken into consideration sooner rather than later because WRC-23 and international regulatory decisions are due soon. — In many countries, such as China (including Hong Kong) and Japan, consultation and discussion on the matter are already underway.

Enabler	Comments
	• Design a spectrum assignment process where spectrum fees (reserve prices, annual fees) are set at reasonable levels, to avoid negatively affecting network roll-out and quality and driving up the cost of services. • Consider the possibility of benefiting operators and accelerating 5G roll-outs by offering easier 5G spectrum payment terms.
	• Adopt a service- and technology-neutral framework and create conditions that accelerate refarming of spectrum used for 2G, 3G and 4G technology to allow a phasing in of the newer technology in line with increasing mobile broadband demand while at the same time supporting legacy users.
License obligations	• Encourage investments and promote more efficient usage of spectrum by imposing obligations when assigning 5G spectrum: network deployment obligations generally include requirements for minimum population or geographical coverage (or in terms of number of sites), and may also contain QoS requirements (for example, minimum end-user speed, such as in Germany or Saudi Arabia). • Monitor the deployment of 5G by MNOs to ensure that obligations are met on a timely basis.
Roadmap	• Produce a formal 5G roadmap setting out a clear vision for 5G in terms of technology development, regulatory framework and network deployment. It is crucial both for MNOs and enterprises to have access to clear information on the path towards 5G introduction, as well as action points and next steps to plan trials and commercial roll-out. 5G roadmaps also raise awareness at an international level about the country's level of development and digital ambition. • Ensure that a 5G roadmap includes a clear target for 5G adoption (for example, 5G's share of mobile connections, penetration of 5G-based FWA).
Government policies	• Take a proactive approach to 5G deployments by encouraging infrastructure developments such as small cells, as well as broader policies to streamline planning processes relating to macro sites. • Open access to public infrastructure to MNOs for 5G site construction, and ensure that any fees are charged using a cost recovery method.
	• Consider allocating public funds to accelerate research and 5G projects that are expected to stimulate demand for services and promote industry collaboration. • Consider allocating public funds to improve coverage in areas where there is evidence that commercially led solutions are not viable (for example, in hard to reach, remote locations).

Source: Analysys Mason

7. About the authors

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