4th 5G Observatory Stakeholder workshop

20 October 2022

CNECT/2021/OP/0008 European 5G Observatory, Phase III

LS telcom
Smart Spectrum Solutions

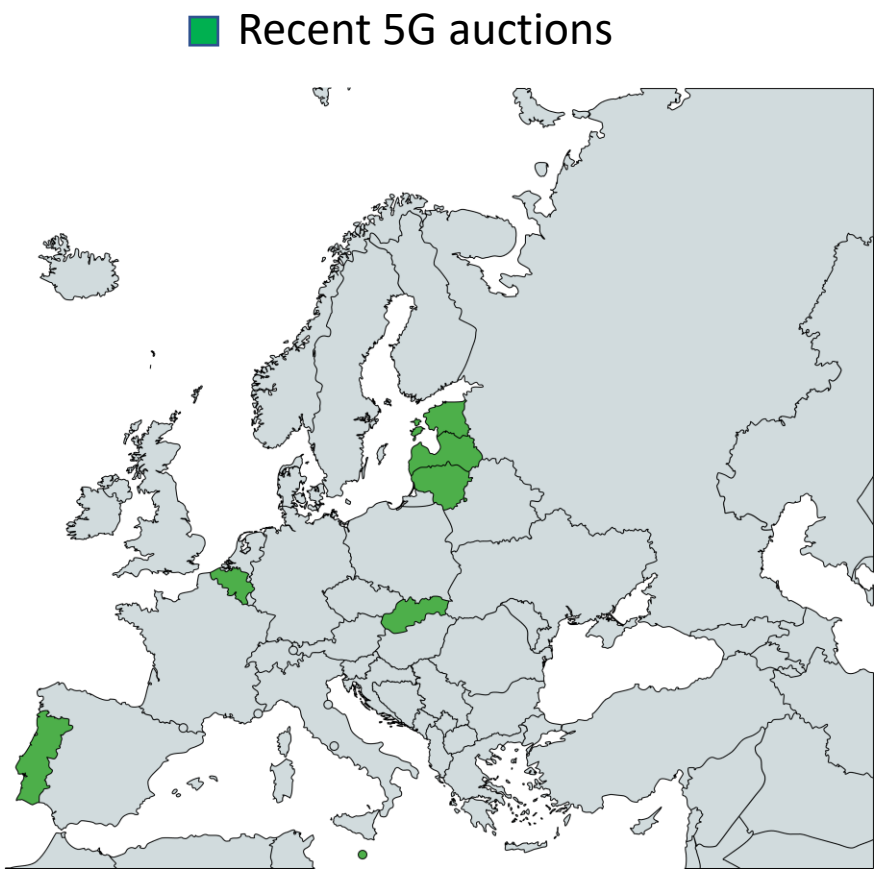
PolicyTracker
Spectrum news, research and training

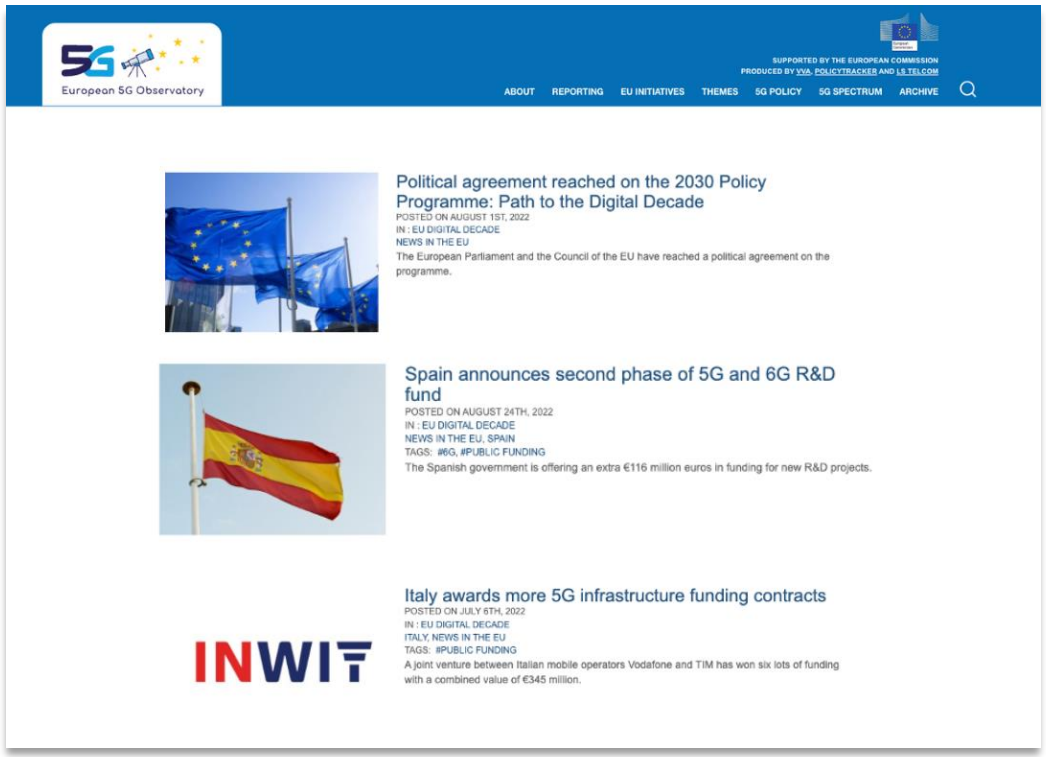
VVA
Valdani Vicari & Associati

Recent developments: Spectrum policy

- A plethora of pioneer band auctions took place.
- Several 26 GHz auctions planned: Portugal, Spain, Austria
- Local 5G licensing models continue to be proposed

Date	Country	Spectrum awarded
Oct. 2021	Portugal	700 MHz 900 MHz 1800 MHz 2.1 GHz 2.6 GHz 3.6 GHz
Nov. 2021	Malta	3.6 GHz
Dec. 2021	Latvia	700 MHz
May 2022	Slovakia	3.6 GHz
Jul. 2022	Belgium	700 MHz 1800 MHz 2.1 GHz 3.6 GHz
Aug. 2022	Estonia	3.6 GHz
Aug. 2022	Lithuania	700 MHz 3.6 GHz

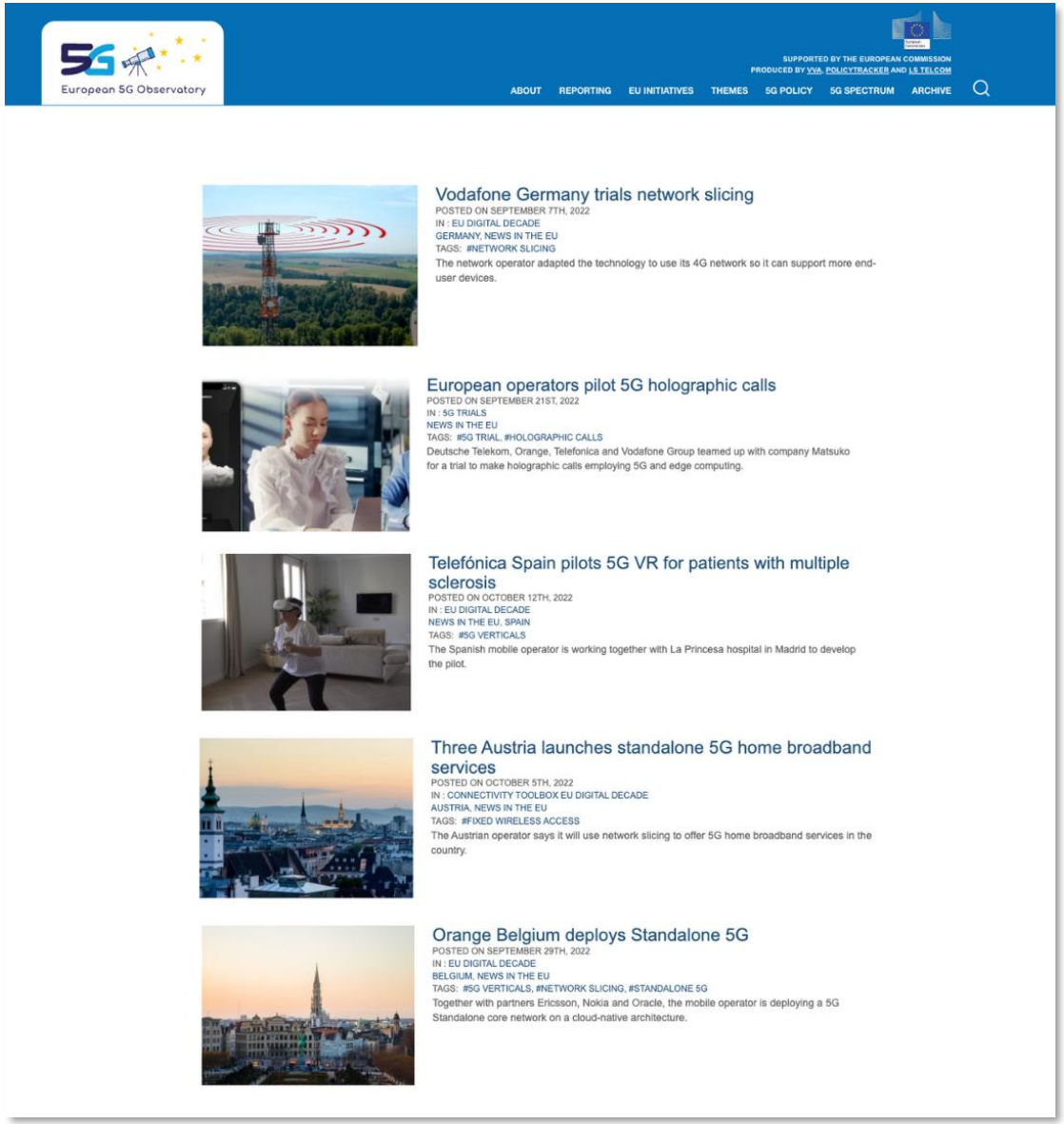




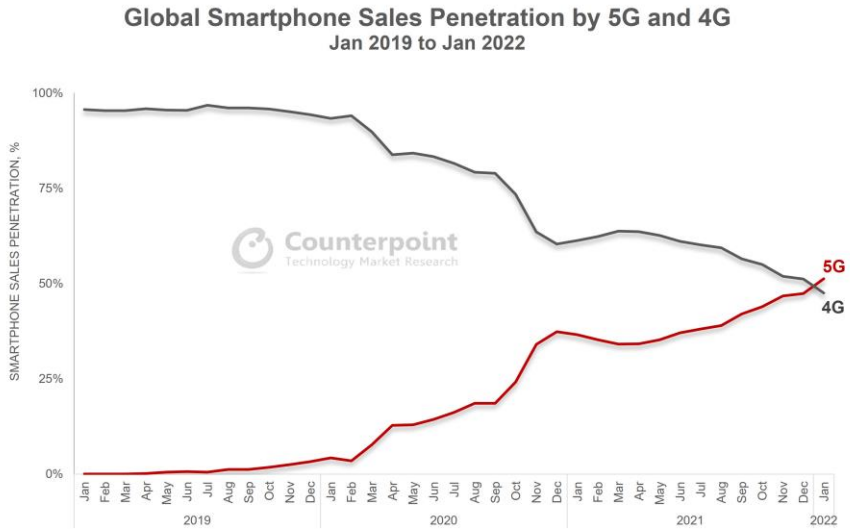
- Sept 2021: European Commission launches ’Path to the Digital Decade’
  - Concrete plans to achieve previously announced targets in the Digital Decade
  - New report to monitor progress to be produced
  - Political agreement reached in July 2022.
- Both the European Commission and Member States have announced funding initiatives for 5G & 6G projects
  - 5G for Smart Communities under CEF 2
  - Recovery & Resilience fund
  - Italy: €2bn in incentives for 5G infrastructure
  - Spain: €116 million for new 5G R&D projects
  - Germany & France: €17.7m to fund joint 5G projects

Recent developments: Commercial

- Since January 2022: Commercial 5G now launched in all 27 Member States
- Operators are increasing coverage and investing in new technologies
  - Telefonica Germany 50% coverage (July 22)
  - Cosmote Greece 70% coverage (July 22)
  - Cyta Cyprus 100% coverage (May 22)
- Extensive trials being conducted using 5G network slicing
- 5G private network market is growing

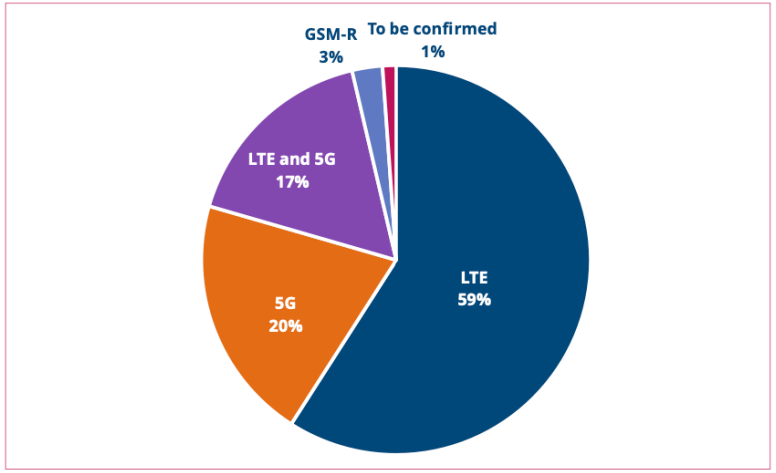


- Significant 5G spectrum auctions are still taking place internationally:
  - Brazil 700 MHz, 2.3 GHz, 3.5 GHz, 26 GHz auction (Nov 2021)
  - USA 3.45 GHz (Nov 2021) and 2.6 GHz auction (Sept 2022)
  - India multi-band auction (Aug 2022)
- 5G device support growing: According to Counterpoint research global 5G smartphone sales surpassed 4G sales for the first time in March
- GSA: 37% of private mobile network deployments use 5G
- Concerns over interference delays 5G launch in the United States
  - 5G services have now launched, but there are still restrictions near airports
  - In Europe, C-band 5G does not operate as close to the altimeter band



Source: Counterpoint's Global Monthly Handset Model Sales (Sell-through) Tracker, Jan 2022

Figure 2. Deployment of private mobile networks by technology (base: 794 catalogued customers deploying private wireless networks)



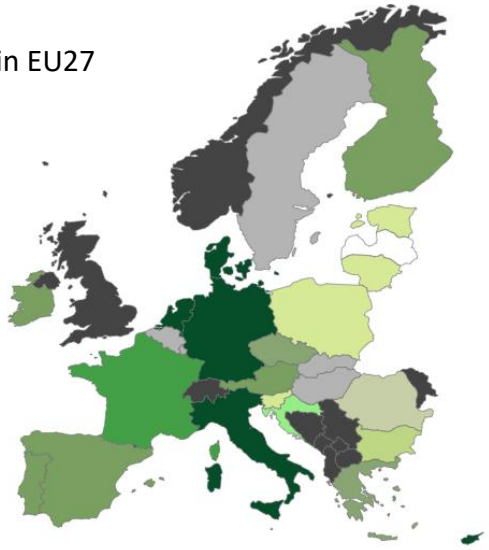
Source: GSA

EU Scoreboard

5G deployment & coverage

72% population coverage achieved in EU27

+23% increase since January

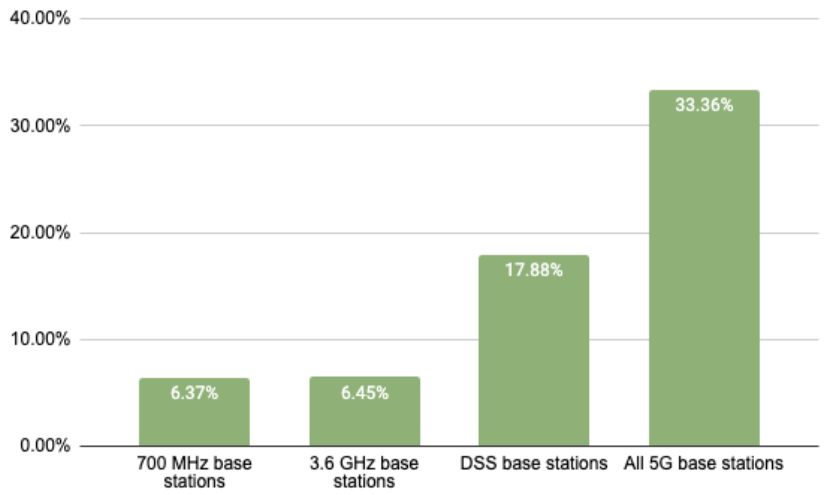


Non-EU country

Darker green indicates higher coverage

252,920 5G base stations total by end of 2021 in EU27

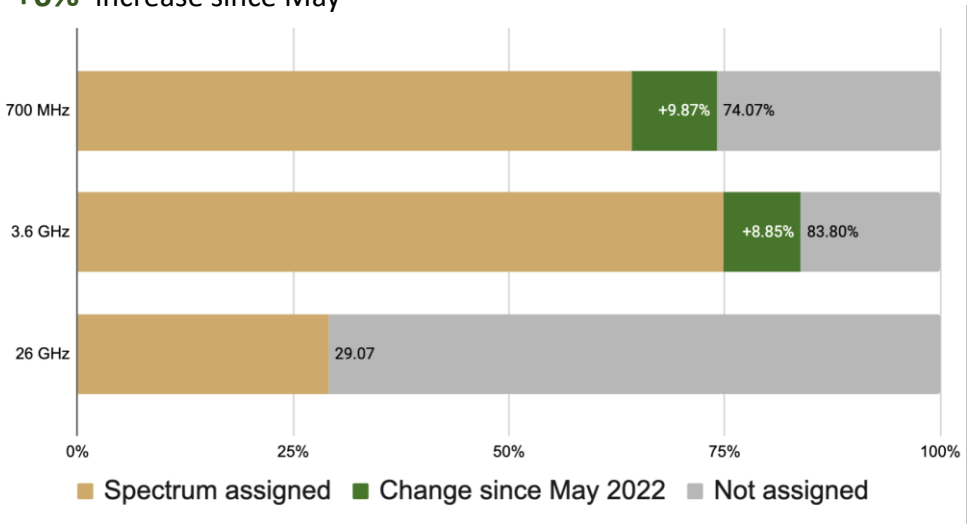
5G base stations as a percentage of existing 4G base stations



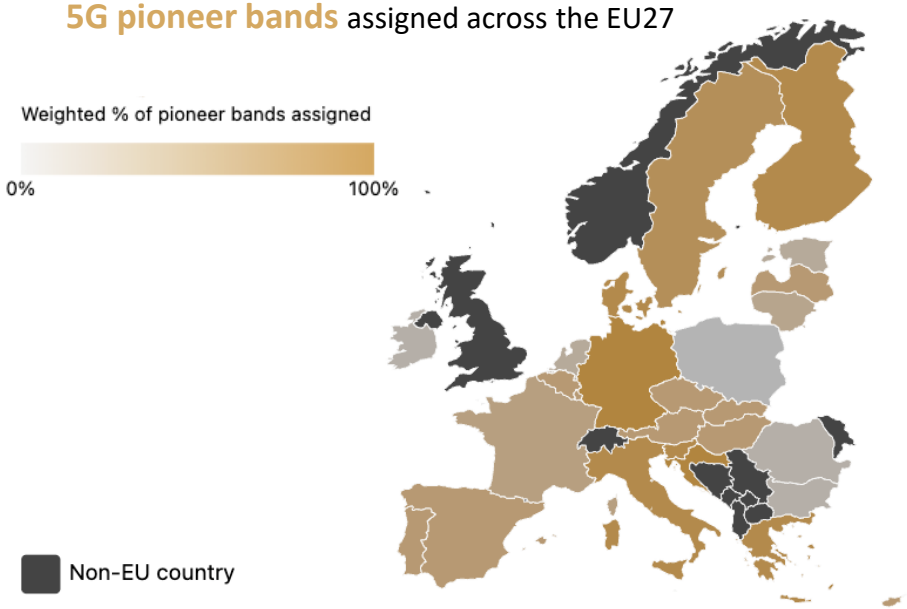
5G spectrum assignments

62% of pioneer bands assigned on average in EU27

+6% increase since May



5G pioneer bands assigned across the EU27



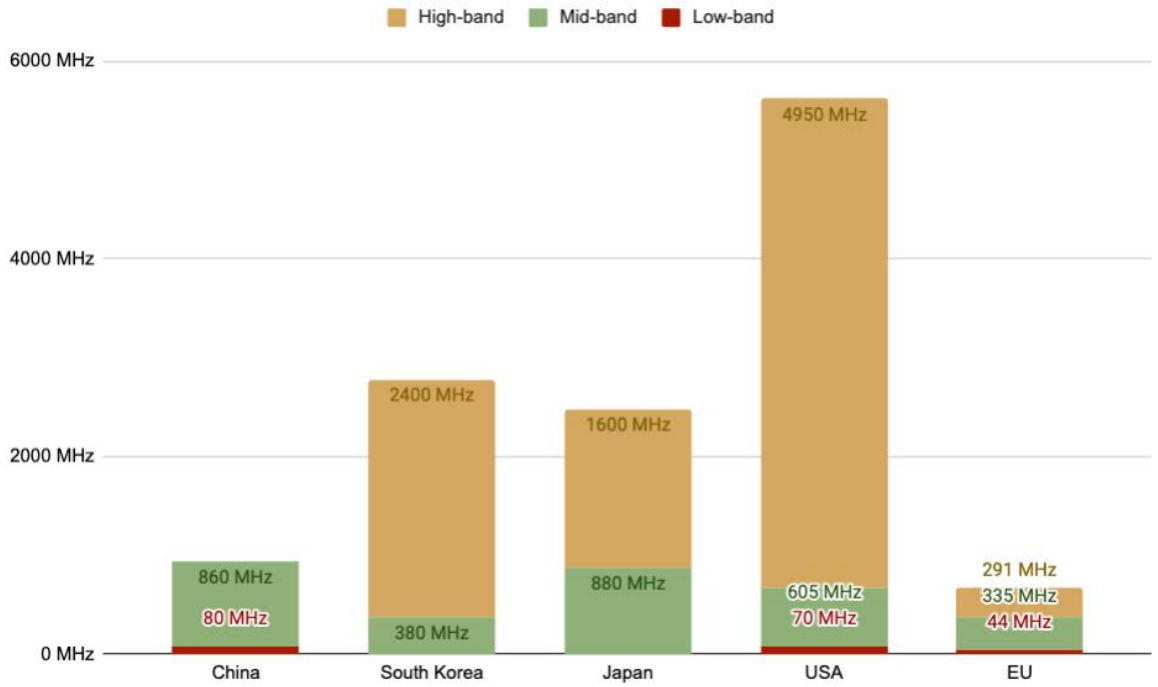
5G rollout

Comparison of 5G rollout in international markets

	China	South Korea	Japan	USA	EU
5G Mode	NSA/SA	NSA/SA	NSA/SA	NSA	NSA/SA
Approximate number of 5G base stations	916,000	162,000	50,000	50,000	147,308
Total country population	1,402,000,000	51,780,000	125,800,000	329,500,000	447,706,000
5G base stations per 100,000 inhabitants	65	313	40	15	33
Indicative 5G subscribers	**357 million** (source: Ericsson 2022)	**25 million** (source: Ministry of Science and ICT)	**14.19 million** (source: Japan times)	**79 million** (including Canada; source: Ericsson 2022)	**31 million** (including all of western Europe; source: Ericsson 2022)

5G spectrum

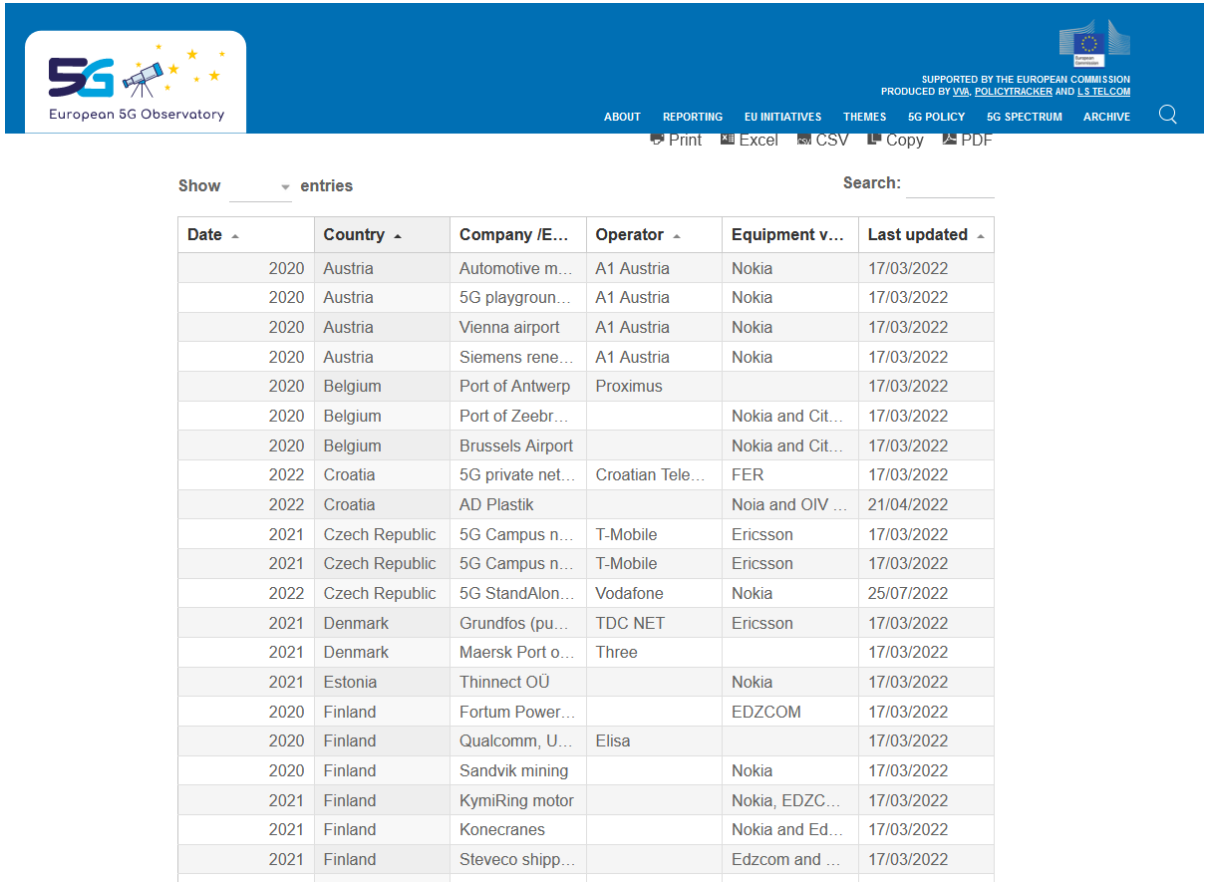
Assigned 5G spectrum in international markets (EU data represents average spectrum assigned)



Assigned 5G spectrum bands in international markets

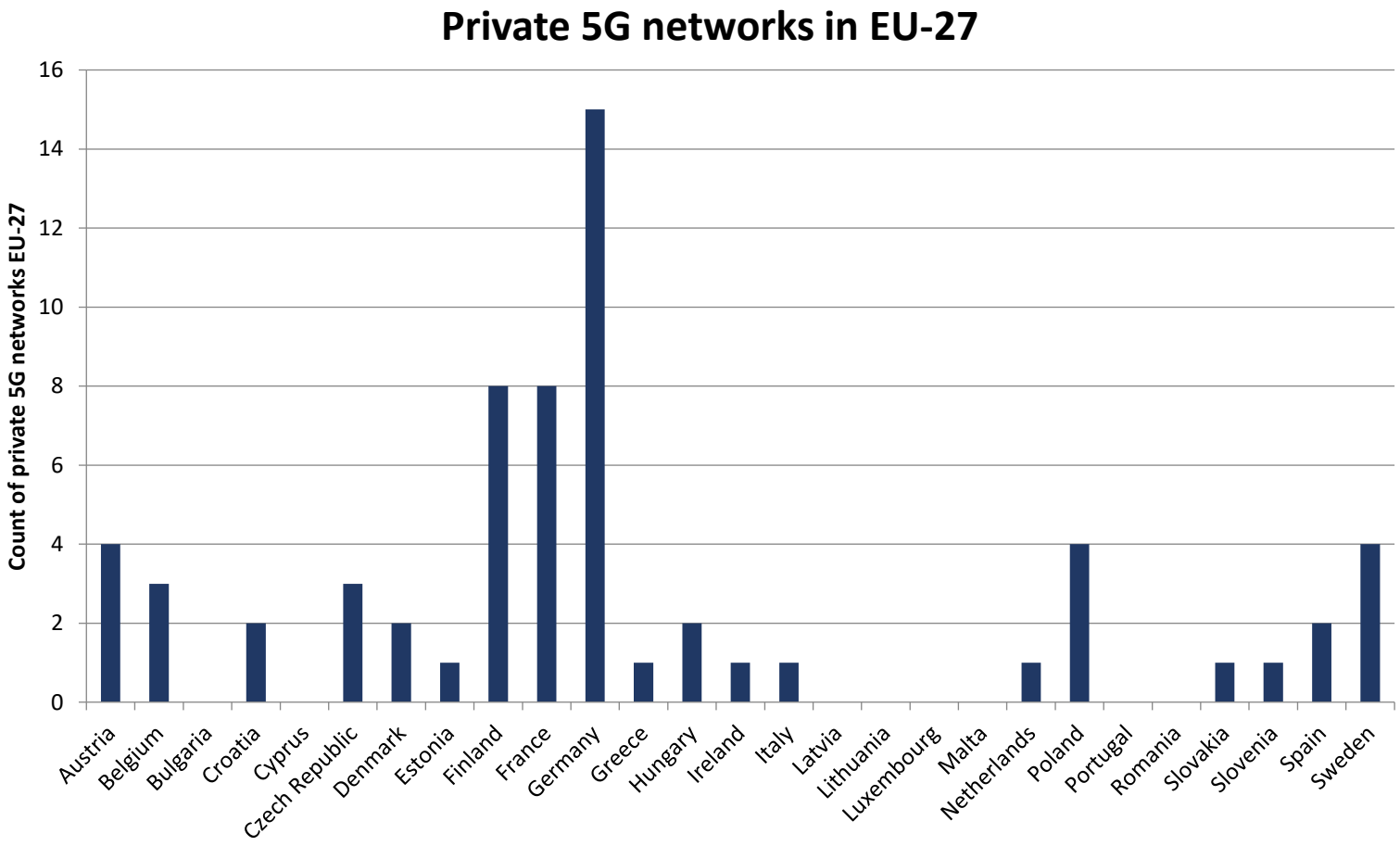
Country	Low-band (<1 GHz)	Mid-band (1 - 6 GHz)	High-band (>6 GHz)
China	700 MHz	2.6 GHz 3.6 GHz 4.9 GHz	-
South Korea	-	3.6 GHz	28 GHz
Japan	-	3.6 GHz 3.7 GHz 4 GHz 4.5 GHz	28 GHz
USA	600 MHz	2.5 GHz 3.45 - 3.55GHz 3.5 - 3.7 GHz 3.7 - 3.98 GHz	24 GHz 28 GHz 39 GHz 47 GHz
EU	700 MHz	3.6 GHz	26 GHz

- Deployment of 5G private networks has continued to increase across EU countries in the past 12 months.
- Demand for these private networks are based on the need for dedicated secure services to private enterprises such as factories, plants, large campuses, ports and airports.
- The Observatory maintains a non-exhaustive list of private 5G networks which is based on research of publicly available information.
- The Observatory team endeavour to obtain as much information on published private 5G network deployments as possible. The analysis from last quarterly report can be found on the website here.
- An overview of 5G private networks featuring a searchable table (See right) of major private network projects in the EU can be found here.



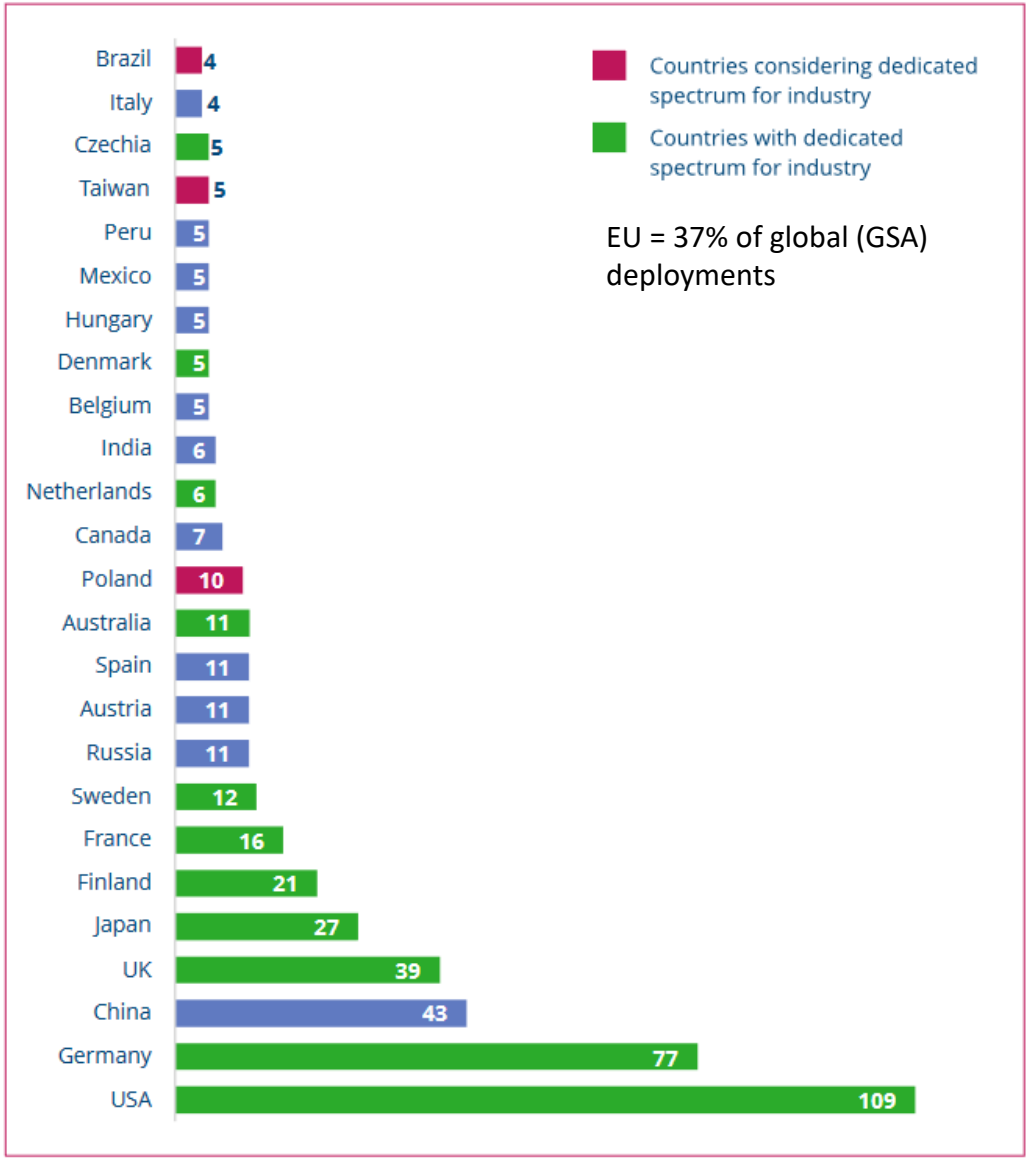
Date	Country	Company /E...	Operator	Equipment v...	Last updated
2020	Austria	Automotive m...	A1 Austria	Nokia	17/03/2022
2020	Austria	5G playgroun...	A1 Austria	Nokia	17/03/2022
2020	Austria	Vienna airport	A1 Austria	Nokia	17/03/2022
2020	Austria	Siemens rene...	A1 Austria	Nokia	17/03/2022
2020	Belgium	Port of Antwerp	Proximus		17/03/2022
2020	Belgium	Port of Zeebr...		Nokia and Cit...	17/03/2022
2020	Belgium	Brussels Airport		Nokia and Cit...	17/03/2022
2022	Croatia	5G private net...	Croatian Tele...	FER	17/03/2022
2022	Croatia	AD Plastik		Noia and OIV ...	21/04/2022
2021	Czech Republic	5G Campus n...	T-Mobile	Ericsson	17/03/2022
2021	Czech Republic	5G Campus n...	T-Mobile	Ericsson	17/03/2022
2022	Czech Republic	5G StandAlon...	Vodafone	Nokia	25/07/2022
2021	Denmark	Grundfos (pu...	TDC NET	Ericsson	17/03/2022
2021	Denmark	Maersk Port o...	Three		17/03/2022
2021	Estonia	Thinnect OÜ		Nokia	17/03/2022
2020	Finland	Fortum Power...		EDZCOM	17/03/2022
2020	Finland	Qualcomm, U...	Elisa		17/03/2022
2020	Finland	Sandvik mining		Nokia	17/03/2022
2021	Finland	KymiRing motor		Nokia, EDZC...	17/03/2022
2021	Finland	Konecranes		Nokia and Ed...	17/03/2022
2021	Finland	Steveco shipp...		Edzcom and ...	17/03/2022

- A total of 64 networks with Germany (15), France (8) and Finland (8) as leading MSs
- Research latest public announcements of private 5G networks in EU countries
- Public search yields announcements from major vendors (e.g. Ericsson, Nokia), telco involvement or verticals themselves
- The 5GO list of networks include short summary including main applications being supported



DISCLAIMER: There are more 5G private networks deployed in practice, noting the data is based on search of publicly announced deployments and subject to continuous change.

- Outside of the EU countries including Japan, UK, China and the USA have a large proportion of total 5G private networks globally (Source: GSA)
- Our research indicates that 5G private networks are being deployed in dedicated spectrum (e.g Germany) or shared spectrum
- Some current 4G networks will be upgraded to 5G in due course
- Many of the applications being deployed include:
  - High definition video links
  - Low latency comms for vehicle control
  - Industry 4.0 applications
  - Secure, predictable and accessible wireless digital infrastructure
- A key attribute is 5G private networks are independent of loads on public or unlicensed networks



Source: Private Mobile Networks, August 2022, GSA Total Global deployments = 498

- Nokia and Ericsson are the main vendors deploying 5G private networks in the EU
- Telcos deploying 5G Private networks include Vodafone, Deutsche Telekom, Telefonica, T-Mobile, A1 Austria, Proximus, Orange, TDC Net and Three
- In most of the telco deployed networks MNOs are using their 5G spectrum (mostly in 3.4 – 3.8 GHz), in some cases the initial deployment is using 4G and equipment is '5G-ready'

5G Deployment Forecasting progress towards 2025

Analysis Mason, Costs and benefits of 5G geographical coverage in Europe, 2021. Scope: EU 27 – QR 14

- Building on a previous study conducted in 2020, 5G investment in Europe and associated costs and benefits were modelled under three deployment scenarios and for 13 different use cases.
- The 13 use cases are as follows:
  - urban high-capacity locations (‘urban hotspots’)
  - construction
  - broadband into homes and offices delivered via 5G fixed-wireless access (FWA)
  - agriculture
  - road
  - rail
  - smart factories
  - mining
  - ports
  - airports
  - energy and utilities
  - healthcare and hospitals
  - municipal buildings

5G Deployment Forecasting progress towards 2025

Analysis Mason, Costs and benefits of 5G geographical coverage in Europe, 2021. Scope: EU 27 – QR 14

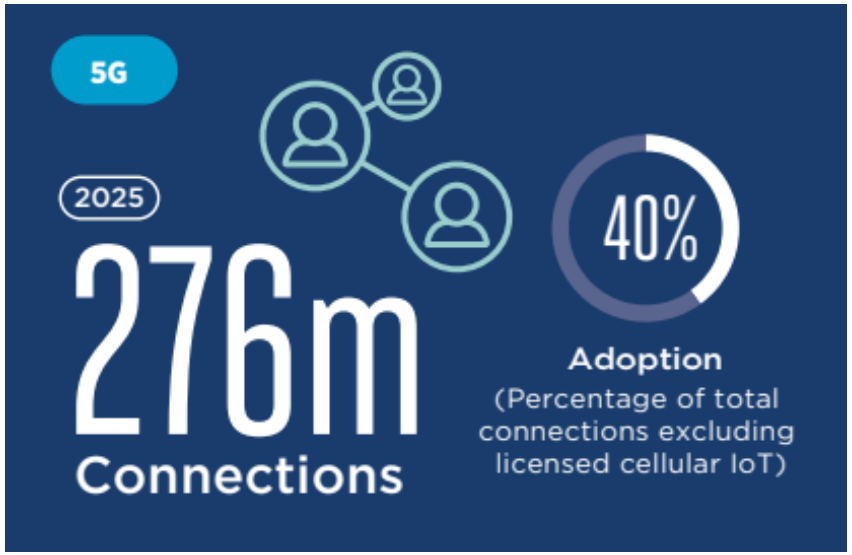
Scenario	Approach	Summary outcome
A	The cost and extent of commercially led 5G enhanced mobile broadband (eMBB) roll-out in different European markets (using a combination of new 5G pioneer plus legacy mobile bands), referred to as the 5G 'base case'	Enhanced mobile broadband (eMBB) roll-out by multiple Mobile Network Operators (MNOs) will total EUR 4-10 billion per network in the largest markets. Across Europe as a whole, the investment will be around EUR 150 billion. The modelling suggests that MNOs will deploy 3.5 GHz on a commercial basis to achieve c.30-60% population coverage by 2026
B	The additional investment needed to deliver near-universal geographical coverage using a low-frequency 5G layer (700MHz), referred to as the 'low-frequency 5G case'	Extending 5G coverage to near-universal geographical coverage using 700MHz might result in an additional single network cost of EUR 4 billion (as a best-case estimate, featuring cooperation between industry and policy makers to achieve a roll-out structure minimising duplication of network)
C	The additional investment needed to extend 3.5GHz mid-band coverage beyond the base case to cover road, rail and rural use cases (including fixed wireless access into homes and businesses, and smart agriculture), referred to as the 'full-5G mid-band coverage case'	A total additional investment of EUR 20 billion across Europe needed to cover road, rail and agricultural areas (also providing coverage for fixed-wireless access [FWA] and construction use cases). This assumes that the same 3.5GHz 5G infrastructure can be shared by different use cases (while meeting the specific requirements of each use case) and that a single multi-use case network would be shared by operators outside of commercial areas. 26GHz deployment alongside 3.5GHz will be especially useful for 5G FWA use.

5G Deployment Forecasting progress towards 2025

GSMA, The Mobile Economy Europe Report, 2021. Scope: Europe – QR 15

- By the end of 2025, Europe will feature 276 million 5G connections, with the Nordic and Western Europe recording the highest adoption rates. In Europe, the 5G adoption (percentage of total connections) in 2025 is expected to be 40%.

- Operator investment to support 5G rollout will total EUR 145 billion by 2025.



Source: GSMA, The Mobile Economy Europe Report, 2022

5G Deployment Forecasting progress towards 2025

ERICSSON, Mobility Report, 2022. Scope: Global – QR 17

Western Europe

- 5G subscriptions grew from 5 million in 2020 to 31 million in 2021. This number is expected to significantly increase reaching 150 million subscriptions by the end of 2023, while the penetration is foreseen to reach 82% by the end of 2027, counterbalanced by a decline in 4G subscriptions.

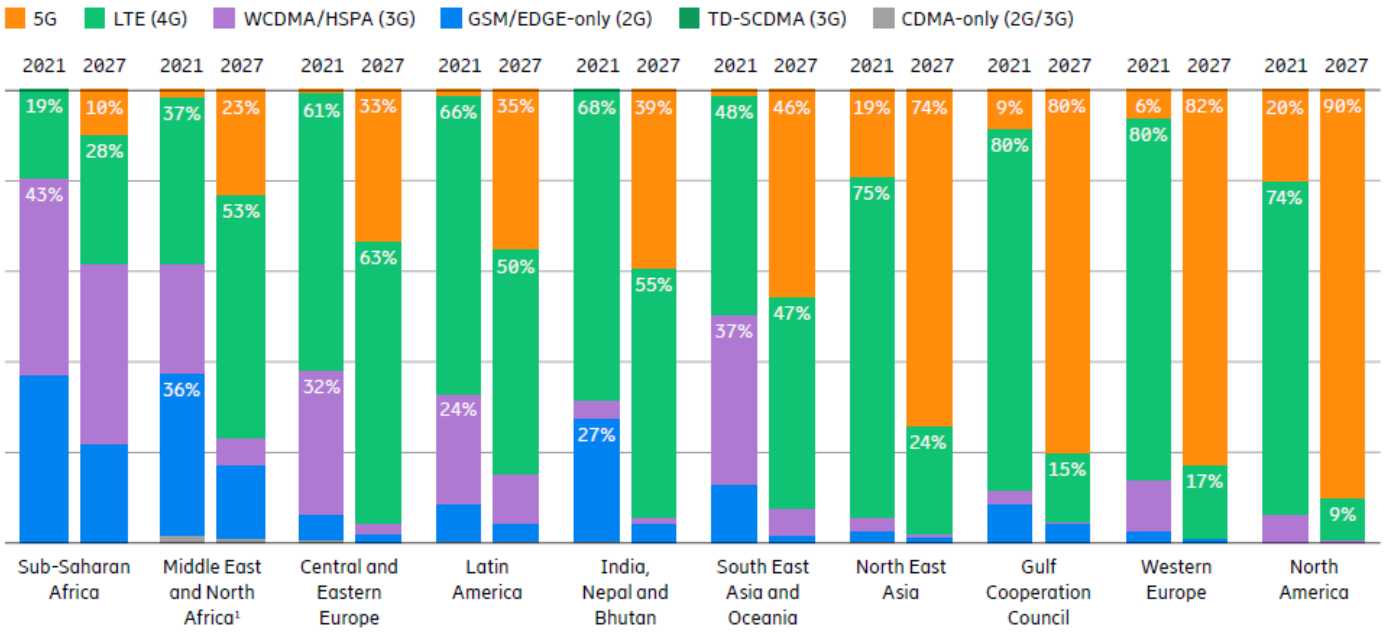
Central and Eastern Europe

- the 5G uptake is expected to be slower due to the reluctance of customers to switch to more expensive options as well as slower spectrum allocation processes. 5G subscriptions are expected to reach 33% in 2027

North America

- In 2021, 5G experienced a big growth adding 64 million subscriptions, which are expected to be around 250 million at the end of 2023. Across North America, service providers are offering an increasing variety of broadband bundles, which makes it easier for customers to find suitable 5G service offerings. By 2027, 400 million 5G subscriptions are expected, accounting for 90% of mobile subscriptions.

Figure 4: Mobile subscriptions by region and technology (percent)



Source: Ericsson, Mobility Report, 2022

5G Deployment Forecasting progress towards 2025

ERICSSON, Mobility Report, 2022. Scope: Global – QR 17

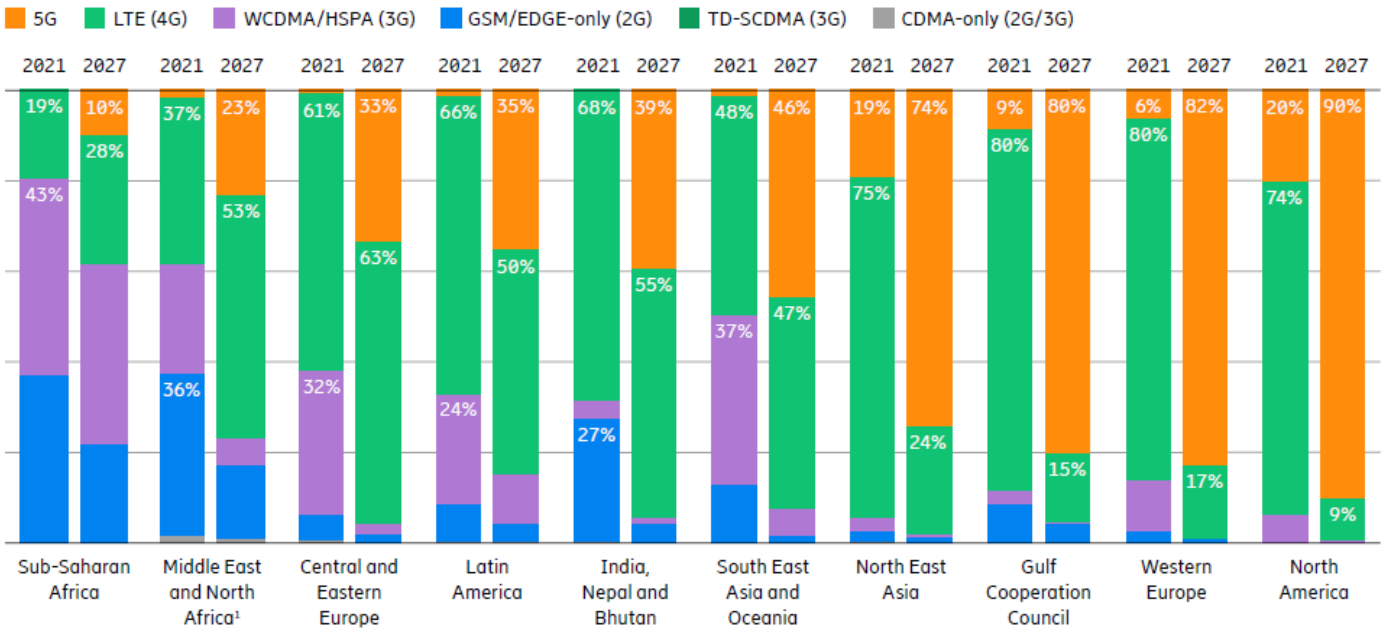
North East Asia

- In order to support the 5G subscription growth, service providers are strongly investing in 5G deployments. In 2021, 5G has a strong growth, adding around 275 million subscriptions, which are expected to reach 1 billion at the end of 2023, while by 2027 they are expected to account for 74% of mobile subscriptions.

Gulf Cooperation Council (GCC)

- In 2021, 5G had a strong growth, adding 5 million subscriptions. These are expected to reach over 65 million, accounting for 80% of total subscriptions in 2027. Currently, GCC service providers are also focusing on a range of services beyond the mobile broadband to monetise 5G, including IoT, financial services, video services and cloud gaming. Such services are expected to support and increase mobile subscriptions, data consumption and service revenues.

Figure 4: Mobile subscriptions by region and technology (percent)

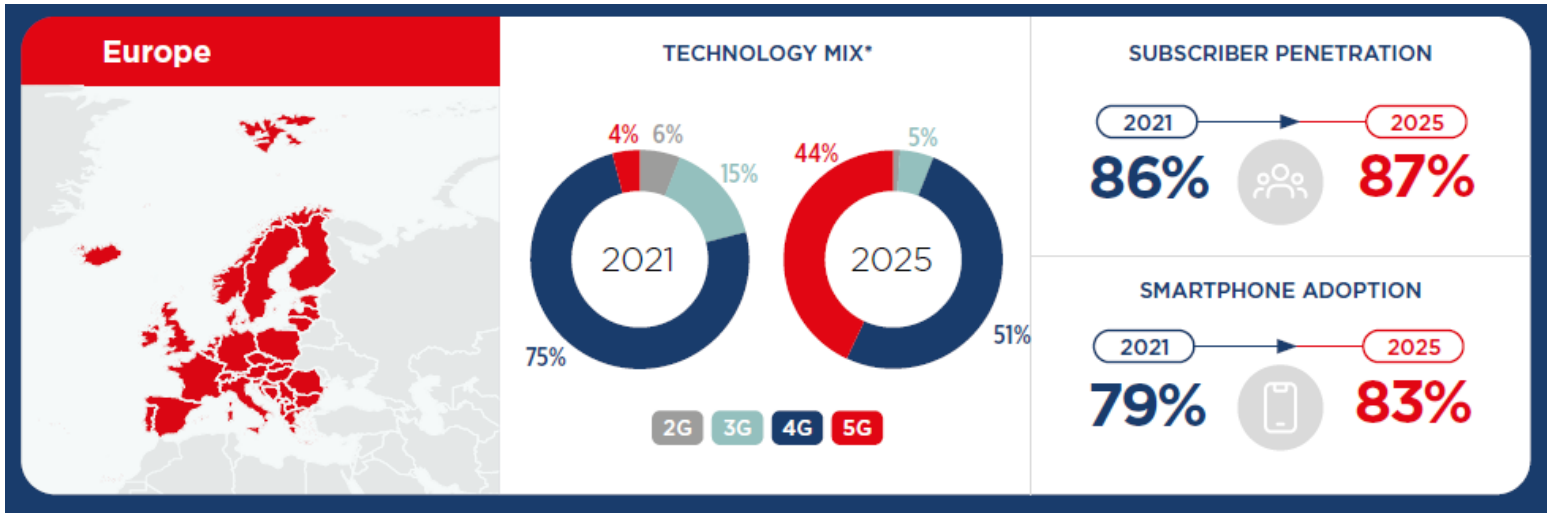


Source: Ericsson, Mobility Report, 2022

5G Deployment Forecasting progress towards 2025

GSMA, The Mobile Economy, 2022. Scope: Global – QR 17

- In 2021 5G technology comprised 4% of the market in Europe, whereas 4G was still dominant representing 75%, with 3G and 2G accounting respectively for 15% and 6%. In 2025, it is expected a 5G market share of 44%, along with a reduced 4G market share of 51%, whereas 2G and 3G will account together for 5%. Moreover, subscriber penetration is expected to slightly increase from 86% to 87% in 2025, accompanied by an increase in the adoption of smartphones from 79% to 83%.



Source: GSMA, The Mobile Economy Report, 2022

Next generation networks contribution to reaching Green Deal targets and addressing sustainability issues

Commitments taken up by the industry to reduce emissions and the role of 5G in the context of the targets set by the Green Deal

GSMA, The Enablement Effect Report, 2019, & The Role of Digital and Mobile-Enabled Solutions in Addressing Climate Change Report, 2021 – QR 14

- According to a research conducted by GSMA with the Carbon Trust in 2019, the biggest contribution the mobile sector can make to climate action is to help other sectors of the economy reduce their carbon emissions through digitisation.
    - The research underlined that the mobile sector enables carbon reductions in other sectors which are 10 times larger than its own footprint

ARCEP (Electronic Communications, Postal and Print media distribution Regulatory Authority, France) **– QR 15**

- According a study on mobile network by the Arcep's Technical Experts Committee, the energy efficiency gains achieved from 5G deployment will begin in 2023 and be clear by 2028 in the most densely populated areas, but will be far more modest in more sparsely populated areas.

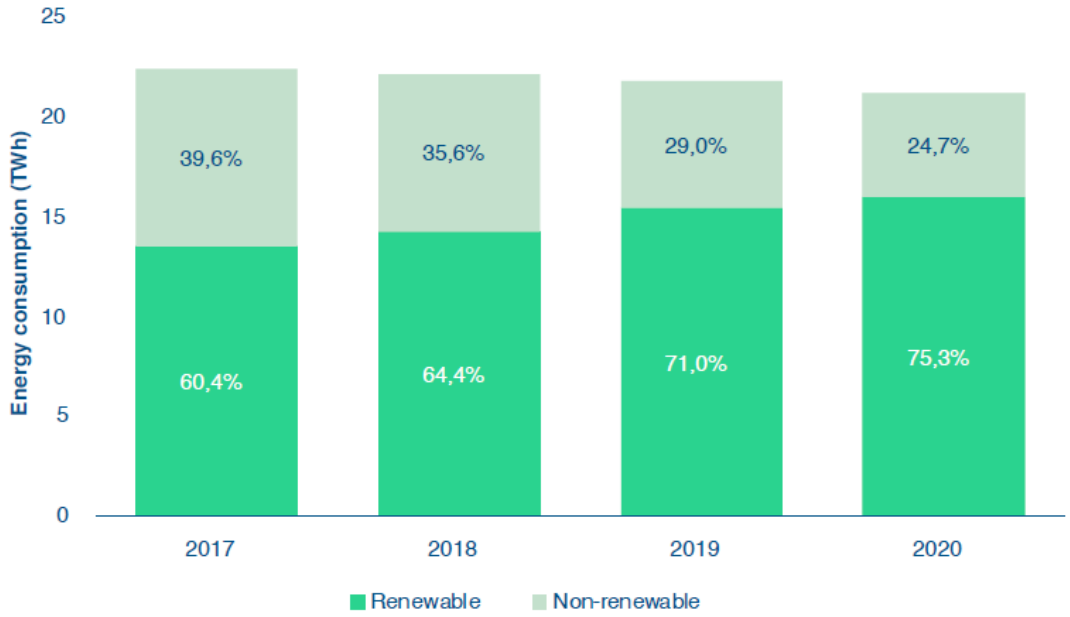
Next generation networks contribution to reaching Green Deal targets and addressing sustainability issues

Commitments taken up by the industry to reduce emissions and the role of 5G in the context of the targets set by the Green Deal

ETNO (European Telecommunications Network Operators' Association): **State of the Digital Communications 2022 – QR 17**

- The report underlines how European telecoms networks can support delivering environmental good, social inclusion and long-term economic benefits, helping to meet sustainability targets.
  - It emphasised the importance of 5G deployments in improving network efficiency in terms of power consumption, in which 5G technology can provide up to 90% more efficient transmission of mobile data for each kilowatt-hour of energy consumed than 4G LTE networks.
  - In parallel with increasing 5G deployment, at Europe level, energy consumption dropped by 4% across ETNO members, which underlines the potential of expanding telecommunication consumption via 5G without adding to energy consumption.
  - Furthermore, the proportion of energy consumption based on renewable sources kept growing.

FIG 5-2 : *Scope 1 and 2 energy consumption from renewable and non-renewable sources, ETNO members, Europe only, 2017–2020*



Source: Analysys Mason, 2021, as reported in ETNO, State of the Digital Communications, 2022

Next generation networks contribution to reaching Green Deal targets and addressing sustainability issues

Commitments taken up by the industry to reduce emissions and the role of 5G in the context of the targets set by the Green Deal

ETNO (European Telecommunications Network Operators' Association): **State of the Digital Communications 2022 – QR 17**

- In relation to carbon emissions, the different layers of the operators' approach involve
  - Reducing own emissions (*Scope 1 emissions*)
  - Reducing energy consumption / having more efficient energy consumption (*Scope 2 emissions*)
  - Reducing emissions across the value-chain (*Scope 3 emissions*)
  - Enabling carbon emissions reduction among their clients

FIG 5-5 : ***Selected Scope 1& 2 and 3 emission reduction targets, ETNO members, group level***

Operator	Target date for zero emissions in Scope 1 and 2	Target date for net zero emissions (Scopes 1,2 and 3)
Deutsche Telekom	2025	2040
TDC	2028	2030
BT	2030	2045
KPN	2030	2040
Telenor	2030[11]	
Telia Company	2020 (achieved)	2030
TIM Group	2030	
Orange	2040	2040
Telefónica	2040	2040

Source: Analysys Mason, 2021, as reported in ETNO, State of the Digital Communications, 2022

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