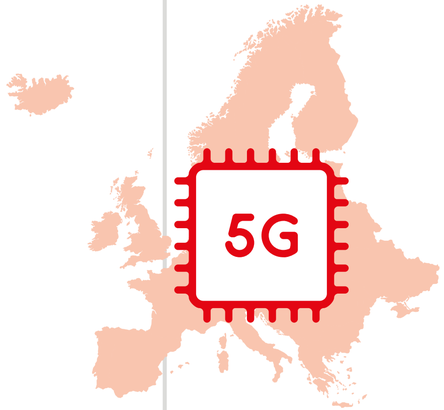
5G in.European businesses

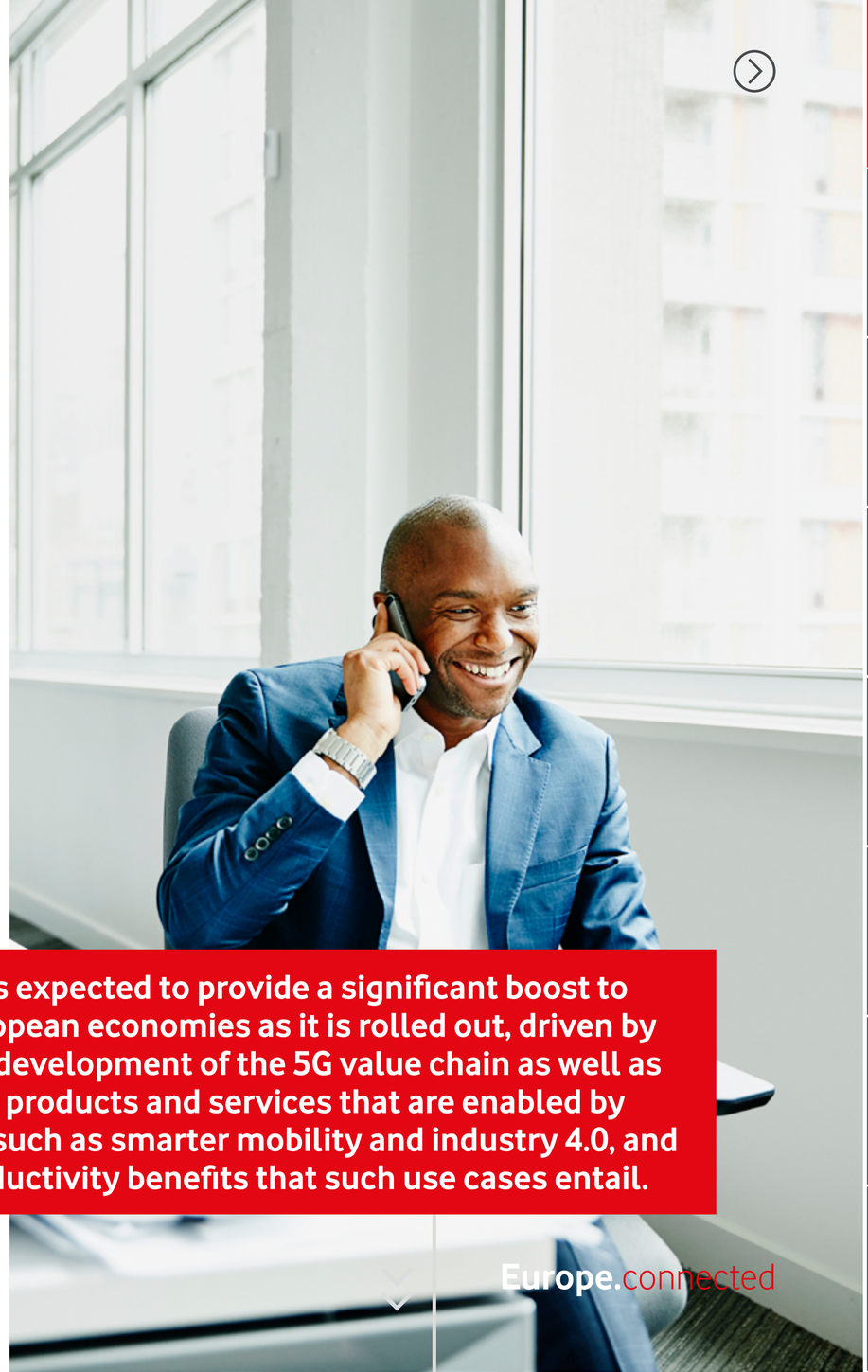
A review of 5G use cases conducted by IHS Markit estimated that global rollout of 5G could enable an approximate €11 trillion increase in global cross-sector output by 2035.. A key driver of this is expected to be the impact of 5G-enabled use cases on sectoral productivity and the value created by the sale of new 5G-enabled products and services. This is estimated at around 2% - 6% of output of key sectors such as manufacturing, public services, transportation and wholesale and retail trade in 2035. The drivers of this impact are use cases such as industrial automation, smart cities, autonomous vehicles, smart agriculture, remote health monitoring and smart grids. While these estimates demonstrate the overall value of 5G, they are dependent on the specific use cases identified, take-up of these, and overall 5G deployment timeframes.



If these sectoral impacts of 5G are felt in those sectors in which the EU has the opportunity to lead, for example manufacturing and transportation, the productivity benefits could translate into improved EU competitiveness on the international stage. In this context, the rollout of 5G in the EU, and development of 5G applications, could lead to an average 5% increase in output of these key sectors, which is equivalent to €290bn current gross value added.[3] Whilst an illustrative estimate, this highlights the value on the table arising from the EU taking a global leadership role in the use and development of 5G-enabled technologies. Delays to 5G investments and the development of capabilities that depend on this investment could result in the EU capturing a lower share of the global opportunity.

These benefits are forward looking, and whilst the impact of 5G will take several years to develop, investment now will allow significant implementation of these use cases during the present decade. This will then enable full realisation of the benefits of 5G moving into the future.

[3] GVA data from Eurostat.



5G is expected to provide a significant boost to European economies as it is rolled out, driven by the development of the 5G value chain as well as new products and services that are enabled by 5G, such as smarter mobility and industry 4.0, and productivity benefits that such use cases entail.

business case uses

A number of studies have pointed to the potential economic benefits 5G can bring European countries. For example, a **study for the European Commission** focusing on the automotive, healthcare, transport and utilities sectors in Europe assessed that 5G would deliver first-order benefits of €62.5bn per annum in 2025, with €50.6bn in second-order benefits arising from 'knock-on' impacts from the use of goods and services. Similar benefits have been found in other studies as well, such as **Vodafone UK and WPI** research on the UK. As with any forecast, these estimates are subject to uncertainty particularly around specific deployment scenarios and timeframes; nevertheless, they point to the significant potential of 5G for boosting productivity and efficiencies across a number of sectors and use cases.

Manufacturing & industry:

5G has the potential to drive greater efficiency and productivity through the use of more data from sensors, mixed reality aids for workers, automation and computer vision to aid quality assurance and early defect detection. Through a mix of use cases, a study found that 5G could increase global manufacturing GDP by 4% in 2030.

Entertainment:

New applications and usages will be brought to life by 5G, such as in-car entertainment and holographic displays. Immersive and new media will reach unprecedented scale, generating more than $67bn annually around the world by 2028 (the equivalent to the value of the entire global mobile media market in 2017).

Agriculture:

By optimising data collection and real-time analysis across a large estate, while enabling the remote connectivity of machinery, 5G technologies have the potential to deliver higher yields, lower costs and provide greater resilience and sustainability in agriculture, benefitting rural communities subject to support for 5G rollout in these areas. A recent study found that improved connectivity could enable a mix of use cases that deliver a 4-9% productivity improvement, depending on agricultural sub-sector.

Health:

STL Partners estimates that 5G could bring global savings of $90bn to healthcare in 2030, by using AI / robotics to support doctors in their work, enabling individualised treatments and using digital twins to test therapies virtually in advance.

Case study:

5G MPN's role delivering connected and digital hospital

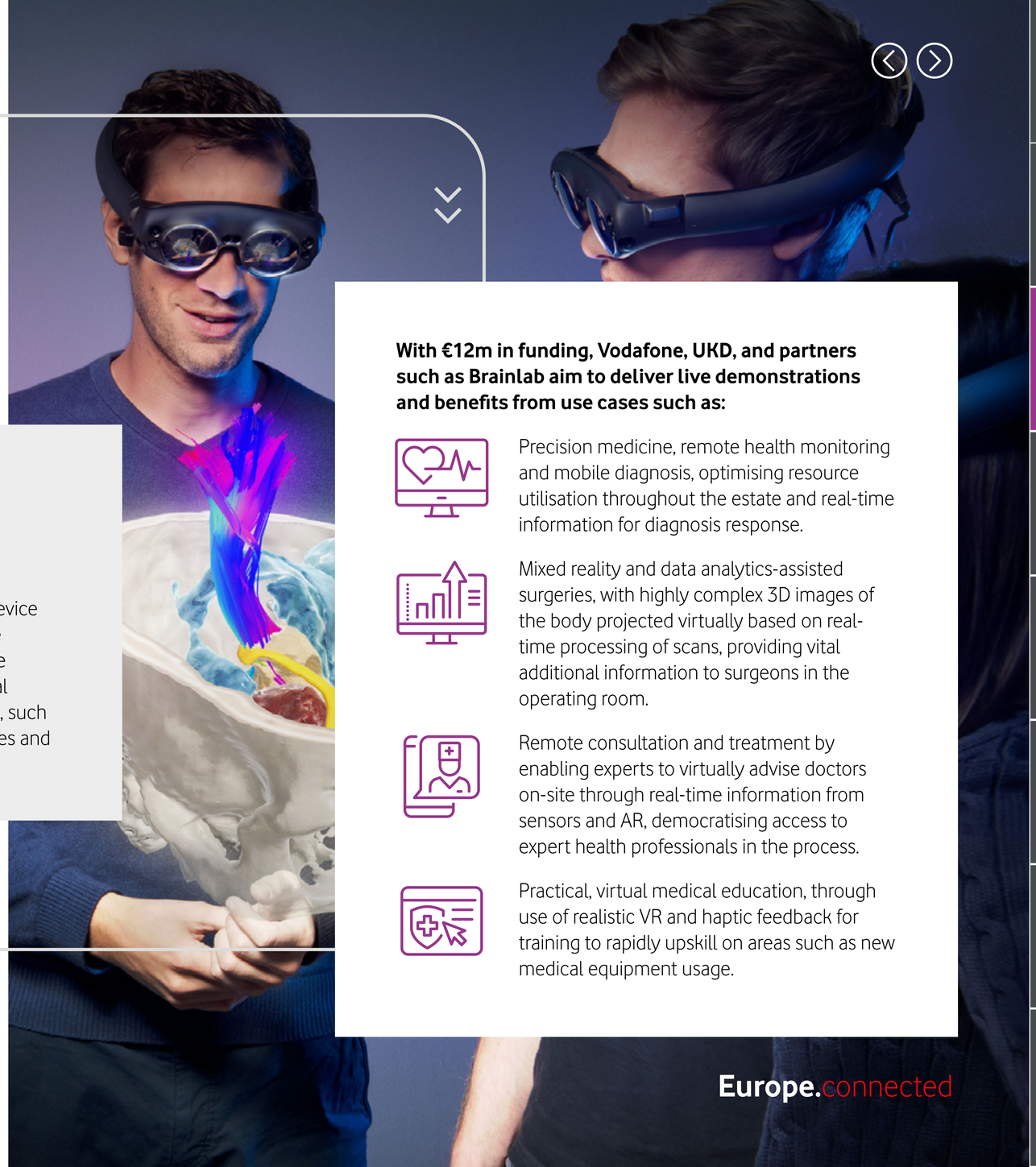
Demand for healthcare is likely to increase with the aging of the European population. Given this and the need to ensure safe, effective and efficient health services, decentralisation and digital technologies are likely to play a bigger role in European healthcare. 5G is expected to be a key enabler of this transition, enabling a variety of new health use cases, such as:

AR and robotics to aid surgeries and remote expert support, enabled by real-time data analytics and haptic, tactile, audio and visual feedback.

Wearable or implanted monitoring devices to enable clinicians to remotely track patient health to improve chances of early intervention, therefore lowering costs and providing better quality of care.

Similarly, large-scale device connectivity within the hospital can enable the monitoring and optimal allocation of resources, such as beds, medical devices and even hospital staff.

To support investment in 5G applications in healthcare facilities, Vodafone is working with the University Clinics Düsseldorf (UKD) to establish a pilot 5G MPN, combined with technologies such as MEC, AR and VR, as a blueprint for the use of 5G in clinics and hospitals. This will deliver optimal coverage within the clinic, with 5G to enable real-time data transfers and MEC for real-time processing close to devices throughout.



With €12m in funding, Vodafone, UKD, and partners such as Brainlab aim to deliver live demonstrations and benefits from use cases such as:

Precision medicine, remote health monitoring and mobile diagnosis, optimising resource utilisation throughout the estate and real-time information for diagnosis response.

Mixed reality and data analytics-assisted surgeries, with highly complex 3D images of the body projected virtually based on real-time processing of scans, providing vital additional information to surgeons in the operating room.

Remote consultation and treatment by enabling experts to virtually advise doctors on-site through real-time information from sensors and AR, democratising access to expert health professionals in the process.

Practical, virtual medical education, through use of realistic VR and haptic feedback for training to rapidly upskill on areas such as new medical equipment usage.

Case study:
5G-powered collaborative robotics

ABB, a global technology company, wanted to leverage analytics and automation to improve the productivity of its manufacturing plant near Milan while keeping local workers involved. A consortium, including ABB and Vodafone, developed the collaborative robot YuMi, which encompasses 5G-powered 3D vision devices and leading-edge analytics for an augmented partnership between human and robot.

For ABB, the collaboration with Vodafone was essential in implementing an ultra-low latency connectivity around YuMi, as Vodafone was owning the multi-edge computing processes and infrastructure."

Michele A. Pedretti, Robot Business Development Manager at ABB Italy

Benefits and use cases delivered included:

Collaborative robot "Cobot" YuMi:
A vision device enables YuMi to capture its environment in 3D, sending data about its activity to a data centre on-site. This means the robot can picture what the human is doing and adapt to it in real-time, facilitated by ultra-low latency and edge cloud computing that are integrated into the connectivity equipment.

Improved control and flexibility over manufacturing process:
Stable connectivity provides ABB with real-time visibility over robot and worker movements. The absence of cables, thanks to 5G, allows for greater flexibility in organising machinery in the future, making production lines much easier to change.

Augmented collaboration:
Workers will soon be able to further leverage the "Cobot" capabilities via 5G-powered IoT wearables displaying Augmented Reality holograms of what the robot tasks consist of at all times. As a result the worker will be able to focus on the most value-adding tasks in a safer work environment.

mind the 5G Gap: Europe falling behind

A crucial factor for Europe to achieve the benefits of 5G is continued investment and deployment, allowing businesses to experiment with new and, unforeseen, use cases. This can help ensure Europe has the capability to lead in the development of the new innovations and technologies built on 5G infrastructure, particularly in sectors with significant first-mover advantages.

1%

the share of 4G sites that have been upgraded to 5G across the EU27, compared to 98% in South Korea and 7% in the US.

12

the number of Member States that have 5G roadmaps.

25.5%

the share of 5G spectrum that has been released in Europe.

9%

Western Europe's share of global investment in 5G by 2025 compared to South Korea's 7%, the US's 23% and China's 45%.

However, Europe to date appears to be lagging other international markets, despite more than €12bn spent so far by public network operators in 5G auctions for licences in the 3.4-3.8 GHz band, and an expected investment of €56bn in 2020 for the radio network and transmission links. The European Commission (EC) has estimated that a total of €500bn is needed to deliver the expected benefits and meet the EC's 2025 connectivity targets, including 5G coverage in all urban areas.

Given the size of the ask, this suggests a need for coordinated focus and partnership on rollout, particularly to ensure Europe does not lag globally. European governments need to partner with operators in investing in a fit-for-purpose 5G network, working together to meet coverage targets, close the international connectivity gap, and deliver a network for businesses to be able to invest in productivity-boosting usages.

Vodafone investments in European 5G

In this context, Vodafone has invested around €5 billion in 5G spectrum across the EU, and is rolling out 5G services in over 100 European cities across several Member States. It is also investing in crucial 5G deployment use cases that can deliver real benefits to businesses and enable Europe-based innovations in various sectors.
In particular, Vodafone has been looking to demonstrate how 5G managed private networks (MPNs), paired with new technological developments such as multi-access edge computing (MEC), can be applied and deliver value in a variety of sectors.

Paired with the real-time transfer of data enabled by 5G, MEC is therefore critical for sensor-rich, real-time use cases, including autonomous warehouse, delivery bays and machinery, as well as factory-floor AI requiring substantial real-time data processing.

With wide area coverage, distributed MEC also enables use cases such as real time hazard warnings through V2X technology for connected vehicles, computer vision for front line workers' body warn cameras, and drone detection and control. Distributed MEC also enables more sophisticated graphics to be rendered on mobile devices, enabling new mixed reality, gaming and holographic experiences in the field.

Combining these deployment approaches and processing technologies with 5G can mean businesses are able to benefit from higher-quality and more-reliable connectivity that supports mission-critical applications, real-time data driven decision-making and high bandwidth use cases.

Vodafone is working with various industry and technology partners to put into practice these technologies, demonstrating the potential productivity and efficiency benefits for businesses.

Europe.connected

what is 5G?

5G is the latest generation of wireless technology. In addition to being much faster than previous generations, it also offers a mix of greater bandwidth, reduced latency and more energy efficiency.

Key advantages of 5G:

Enhanced mobile broadband (eMBB) offers higher speeds and a seamless user experience in dense or high-mobility environments; supporting high-bandwidth services such as Augmented and Virtual Reality apps.

Massive machine-type communication (mMTC) enables the connection of a very large number of devices, supporting low-power, low-energy devices, e.g. in large-scale IoT deployments across sectors.

Ultra-reliable low latency communication (uRLLC) enables applications that are heavily dependent on low latency and high reliability. This is important for mission-critical applications in transport, healthcare or energy where even millisecond delays in communication and processing time matter, for example hazard avoidance in connected vehicles.

5G in numbers:[1,2]

10 Gbps speeds:
Peak download rates
10 - 100x higher to 4G's
100Mbps to 1 Gbps

1-4 ms latency: Delays are 5x lower than 4G, enabling applications that require ultra-reliable real time connectivity

1m devices per square km:
Connection density is up to 100x higher than 4G, which means less congestion and better quality

Up to 500km/h:
Support for high mobility with low interruption time

The speeds quoted here represent the limits of 5G technology.

[1] https://5gobservatory.eu/about/what-is-5g/
[2] https://www.gsma.com/wp-content/uploads/2019/04/The-5G-Guide_GSMA_2019_04_29_compressed.pdf

5G 101

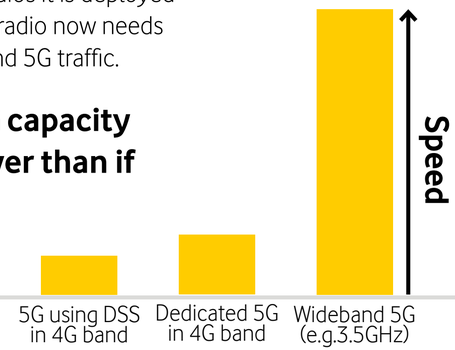
What is Dynamic Spectrum Sharing?

DSS (Dynamic Spectrum Sharing) is a way of enabling 5G in radio by sharing available spectrum between 4G and 5G (that is without dedicating the spectrum fully to 5G). For example, where a high bandwidth 5G spectrum band (e.g. 3.5GHz) is not available, then DSS is a way to launch 5G relying on 4G spectrum by dynamically allocating the radio capacity between 4G and 5G. DSS still requires operators to invest in 5G capable radios in order to expand their 5G capacity and coverage.

However, DSS reduces the efficiency of the radios it is deployed on (reducing both capacity and speed) as the radio now needs to support signalling overheads for both 4G and 5G traffic.

20-30% lower

In Radios with DSS activated, 5G capacity and speed is at least 20-30% lower than if the band was dedicated to 5G.



So whilst DSS plays a role in 5G deployments, on its own it will neither bring the full benefits of 5G (high bandwidth, high speed, low latency), nor enable many of the novel use cases of 5G. Instead, this requires '5G built right' maximising the use of 5G dedicated spectrum bands (e.g. at 3.5 GHz) and deploying Massive MIMO.

Timely release of the relevant spectrum for 5G is therefore essential.higher speed and lower latency with the wireless connectivity that is needed to enable the many B2B use cases that will deliver the greatest impact for European economies.

What are MPNs?

MPNs are bespoke mobile networks dedicated to particular users. They can be run on dedicated infrastructure at particular sites or over wide area networks (for example over a network slice) or can be a mix of both. Dedicated MPN infrastructure, for example at an enterprise campus site, can be run independently or with operational support from a mobile operator, and can deliver a number of benefits for businesses, such as:

Configuring and adapting the network to optimise performance and coverage for the site

Having control over network deployment timetables to coordinate with operations and other investments

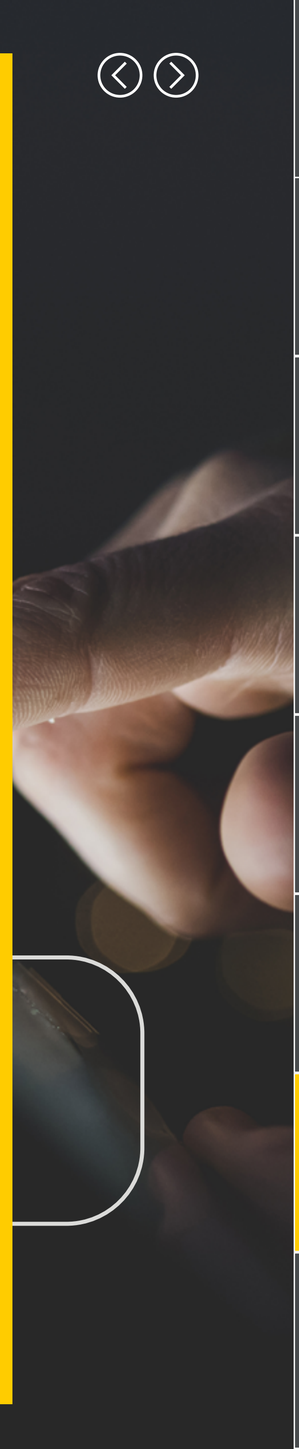
Being able to respond faster to any network issues

Ensuring a more secure network with greater control of user access and data flow

The Mobile access can be run on 4G or 5G, with some industrial applications of the former already in place. However, MPNs utilising 5G capabilities increase the potential for more advanced use cases, such as automation, precision robotics, autonomous vehicles and computer vision, particularly where these use cases require real-time (i.e. ultra-low latency), high-bandwidth connectivity.

What is MEC?

MEC effectively places a mini-distributed cloud inside the telecom network, so that primary processing for customer applications can be moved closer to the end-user devices. This effectively enables real-time processing in places that are not possible now.



network.futureproofing

If Europe wants to maintain and improve its competitiveness in the global digital economy, and to build technological sovereignty, **a faster transition to 4G and 5G is needed** to keep pace with other regions. 2G and 3G networks are not best suited to supporting the digitalisation of the economy.

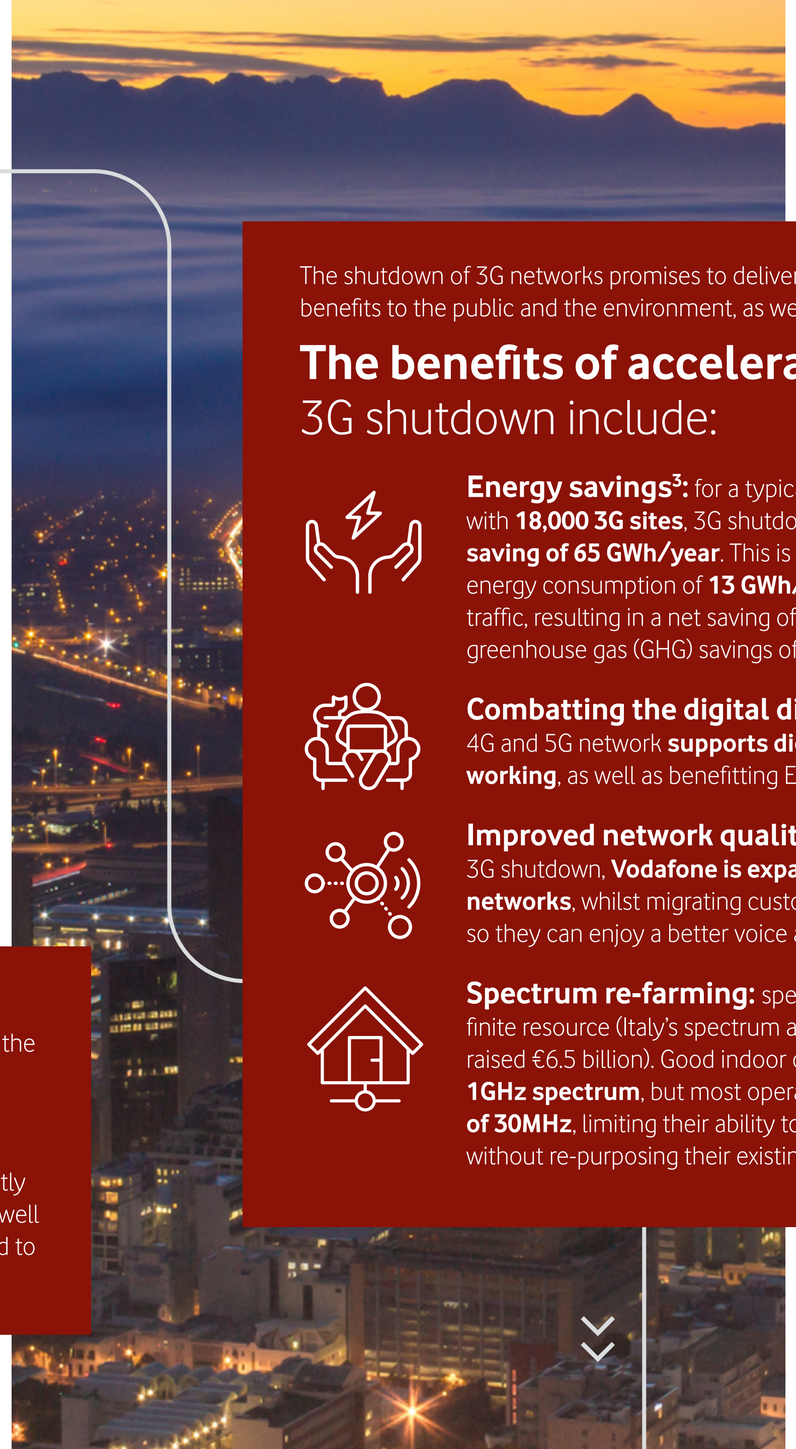
This acceleration will help put Europe at the forefront of the global race to digitise economies, and governments need to support network operators in effecting this transition before the end of legacy networks' economic life. It is increasingly in the public interest to accelerate the transition to the latest generation of networks as society requires fast and reliable connectivity and Europe, as a whole, falls behind in global digital leadership. Governmental support is therefore required to ensure this shift occurs faster than anticipated when earlier generation networks were deployed, and therefore faster than market-based outcomes will deliver.

Acceleration will also help bring forward energy savings from the transition to more efficient 4G and 5G network technologies. While data consumption does increases on other networks as 3G shuts down, the increased energy demand is negligible, about 4W per 4G site and 80W per 2G site, is the same as running a lightbulb. In comparison, a 3G site demands 410W.

In Hungary, the national regulator has recognised the public benefit of shutting down legacy network technologies ahead of their natural commercial lifecycle. Supported by proceeds from the 5G spectrum auction, the regulator has earmarked funds to assist in the 3G shutdown process, allocating these funds across two areas:

An extensive communications campaign to promote 3G shutdown and the need to replace 2G, 3G and non-LTE 4G devices. This campaign will be run by the regulator during 2021 and Q1 2022, with each network operator, including Vodafone, building their own campaigns alongside.

The subsidisation of new 4G/LTE and 5G devices. Work is currently underway to identify the number of 2G, 3G and non-VoLTE 4G devices in Hungary, as well as B2B devices such as point of sales terminals, online cash registers etc. that will need to be upgraded as they will no longer be supported after the shutdown.



The shutdown of 3G networks promises to deliver a range of direct and indirect benefits to the public and the environment, as well as to network operators.

The benefits of accelerated 3G shutdown include:

Energy savings[3]: for a typical large European operator with **18,000 3G sites**, 3G shutdown results in an energy **saving of 65 GWh/year**. This is offset by an increase in 2G energy consumption of **13 GWh/year**, due to increased 2G traffic, resulting in a net saving of **52GWh/year**, resulting in greenhouse gas (GHG) savings of **15,600 tonnes/year**[4].

Combatting the digital divide: a more extensive 4G and 5G network **supports digital inclusion** and **home working**, as well as benefitting EU competitiveness.

Improved network quality: in preparation for 3G shutdown, **Vodafone is expanding its 4G and 5G networks**, whilst migrating customers to 4G and 5G devices so they can enjoy a better voice and data experience.

Spectrum re-farming: spectrum is a valuable and finite resource (Italy's spectrum auction in November 2018 raised €6.5 billion). Good indoor coverage relies on **sub-1GHz spectrum**, but most operators only have a **maximum of 30MHz**, limiting their ability to provide indoor coverage without re-purposing their existing spectrum.