

Why

telecoms
matters

VOLUME

01



A Trillion Euro Opportunity

Why Telecoms Matters

Connectivity and digitalisation can be a potent force multiplier for every part of Europe's economy and society. Europe can lead in the era of the industrial internet - if it can improve the investment climate for 5G and digital infrastructure.

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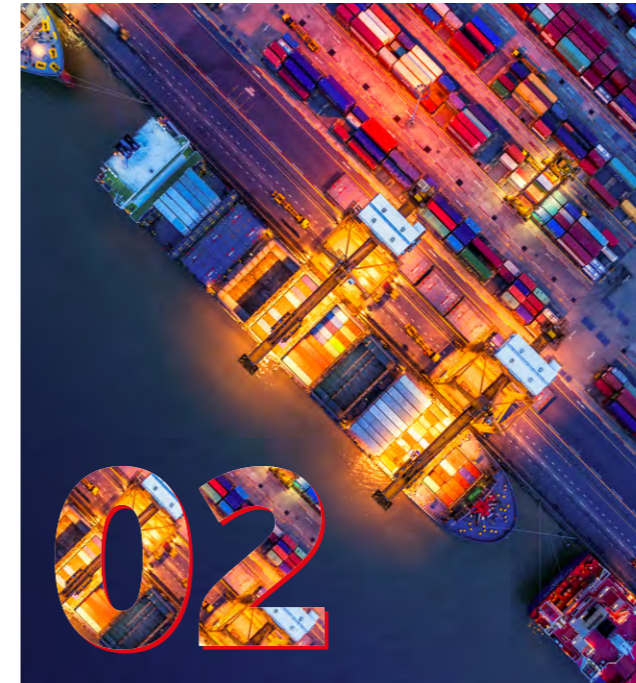
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EXECUTIVE SUMMARY



Europe faces economic stagnation and declining competitiveness

Annual GDP growth is now barely 1%, the EU's share of global output is set to fall to below 14% by 2028 and the number of European companies in the Fortune Global 500 has almost halved between 2005 and 2021.



Productivity is the key to long-term sustainable competitiveness

The EU has been falling behind the US in Total Factor Productivity and capital deepening. Competitiveness can be achieved through reversing the productivity gap, chiefly through innovation.



The combination of connectivity and digitalisation is a potent force multiplier for every part of the economy and society

By boosting innovation, efficiency gains in both industry and public services. If the EU met its Digital Decade targets it would mean the equivalent of adding another Netherlands to its economy.



Connectivity can boost the rural economy and opportunities in rural areas

It will make farming more efficient and profitable, boost productivity for SMEs and increase remote and flexible working opportunities in rural communities.



Europe suffers from a shortage of digital skills

The Commission estimates that 9 out of 10 jobs will require digital skills by 2030 but barely half of Europe's workforce possesses the necessary digital capabilities. This skills shortage holds up businesses' take up of AI, big data and the cloud. Investing in supporting the workforce and future generations to develop the necessary digital skills to thrive in future labour markets will be a key differentiator for competitiveness.



5G unlocks the industrial internet as 4G unlocked the consumer internet

It will transform machine to machine communication and will allow the Internet of Things to scale up. Unlocking AI's potential depends on a high performance 5G Standalone network.



The digitalisation of industry represents the 'fourth wave' of the industrial revolution

The digital transformation of manufacturing operations drive productive efficiency and enable innovation around new products and services. Its impact on global manufacturing is estimated to be up to \$2 trillion each year. Its effect on key sectors will be transformational. It matters particularly to SMEs but, while larger businesses have the resources to invest in bespoke IT solutions, SMEs would benefit hugely from affordable packaged products.



In medicine, connectivity can deliver immediate returns

Patient care can be improved through telemedicine and remote patient monitoring. AI applications can revolutionise diagnostics and care, while smart factories can transform medical technology operations.



Digital connectivity offers solutions can cut global greenhouse gas emissions by up to 20% by 2030

Digital connectivity can provide smart connectivity applications, such as smart meters, smart grids and smart city platforms that can lower consumption of energy by reducing demand, make the supply of energy more reliable with better grid management and reduce strain on supply by shifting consumption to the most efficient time periods.



The EU is falling behind the US and China on AI

73% of large models are being developed in the US with another 15% in China, while no EU country yet hosts its own general purpose AI system. European businesses also lag in their take up of cloud computing and 5G.



Europe still has the opportunity to lead in the era of the industrial internet

It is not too late. Europe has a strong legacy of skills across all aspects of industrial digitalisation. The key is for Europe to reverse its poor investment climate for digital infrastructure.

Digitalisation offers a €1 trillion opportunity for the EU – equivalent to adding another Netherlands to European economic output. In today's world, digitalisation is now becoming one of the most potent drivers and multipliers of competitiveness.

FOREWORD

Europe faces many challenges, from wars and instability on its borders to climate change, an ageing population, and a cost-of-living crisis for many of its citizens.

These challenges are accentuated by the continent's long-term fading global competitiveness and, more recently, the energy crisis that has triggered concerns about deindustrialisation in the EU. Over the last 50 years, annual GDP growth has fallen from nearly 4% to barely 1%. European labour productivity growth has halved since the 1990s¹ and GDP per capita has flatlined for the past decade. Over the same period, US GDP per capita increased by nearly 50% and many emerging economies are steadily closing the wealth gap.

Falling European competitiveness comes at a real cost. It puts in jeopardy the continent's future prosperity, hurts citizens and businesses, undermines efforts to tackle socio-economic, security and environmental challenges, and reduces the EU's ability to protect and promote its interests globally. In today's divided, geopolitical world, it is more important than ever for Europe to stand strong and united. Yet, worryingly, it is heading in the opposite direction.

Change is long overdue. This will require a significant refresh of the Single Market, the key to unlocking greater European competitiveness. It is also essential for accelerating digital transformation across the continent.

This report examines the role that modern connectivity - and the digital goods, services, and applications it enables - plays in improving European competitiveness.

The report's first section looks at Europe's faltering growth and shows how digitalisation can revolutionise Europe's productivity and spearhead a new wave of innovation across the whole economy. In aggregate, digitalisation offers a €1 trillion opportunity for the EU – equivalent to adding another Netherlands to European economic output. In today's world, digitalisation is now becoming one of the most potent drivers and multipliers of competitiveness.

The second section of the report provides a deep dive into the use of digital technologies to respond to some of the EU's greatest and urgent needs: strengthening its industrial base, reversing the widening SME productivity gap, revitalising post-COVID healthcare, securing energy supplies, combating rural-urban divides and training workers with the digital skills they need. These case studies show the tangible opportunities that Europe can seize. As these case studies confirm, modern connectivity and digital solutions can transform Europe into a stronger, more productive, and more prosperous continent – one that can help close the many divisions within, and between, its Member States.

Change is long overdue. This will require a significant refresh of the Single Market: the key to unlocking greater European competitiveness. It is also essential for accelerating digital transformation across the continent.



The report's third and final section explains how these opportunities could grow exponentially in the coming years with the advent of 5G stand-alone networks powering real-time generative AI, an explosion in Internet of Things (IoT), mass adoption of cloud applications and more. We are on the cusp of a new era of the industrial internet. This will be as transformative for businesses of all sizes, public services and the broader economy as the 4G-enabled internet smart phone was for consumers during the last 5-10 years.

Other parts of the world are moving quicker and more decisively to unlock the full potential of hyperconnected modern digitalisation, and Europe risks being left behind. The report concludes with an assessment of Europe's current fitness to take full advantage of digital transformation.

This report is the first in a series. Subsequent reports will explore how Europe has fallen behind in the race to exploit these crucial technologies and how the digital ecosystem has evolved beyond the EU's policy framework. We will also show how Europe can regain leadership by creating the right market and regulatory structure to drive more investment and homegrown innovations in digitalisation, while using the Single Market to reap the benefits for all Europeans.

But firstly, we set out why modern connectivity and digital solutions offer a unique opportunity to arrest and reverse Europe's decades-long relative decline, and how digitalisation can deliver vital gains across a wide range of economic sectors.

Europe's annual GDP growth rate alone has plunged from nearly 4% a year to barely 1% over the last 50 years. European labour productivity growth has halved since the 1990s and GDP per capita has flatlined.



THE COMPETITIVENESS CRISIS THREATENING EUROPE

EUROPE'S FAILURE TO KEEP PACE WITH GLOBAL COMPETITION

Although Europe's economy has expanded steadily for 50 years and standards of living have risen as a result, the reality is that its rate of growth has been sluggish for decades. Worse still, the EU has found itself outperformed. Unsurprisingly, many emerging economies have maintained higher growth as part of catching up in their economic development, with China the biggest example. While China is still far behind European per capita income, its economy is now – in absolute terms – bigger than the EU's.

More worryingly, Europe has also persistently failed to match the growth of many countries with similar economic maturity, such as the United States. Where the EU and the US were comparable in economic size and wealth some 40 years ago, the EU's economy has become relatively smaller with time. It was 81% the size of the US' around 15 years ago and by 2022 it had shrunk to 73% (Figure 1). The gap between EU and US economic output is ever widening.

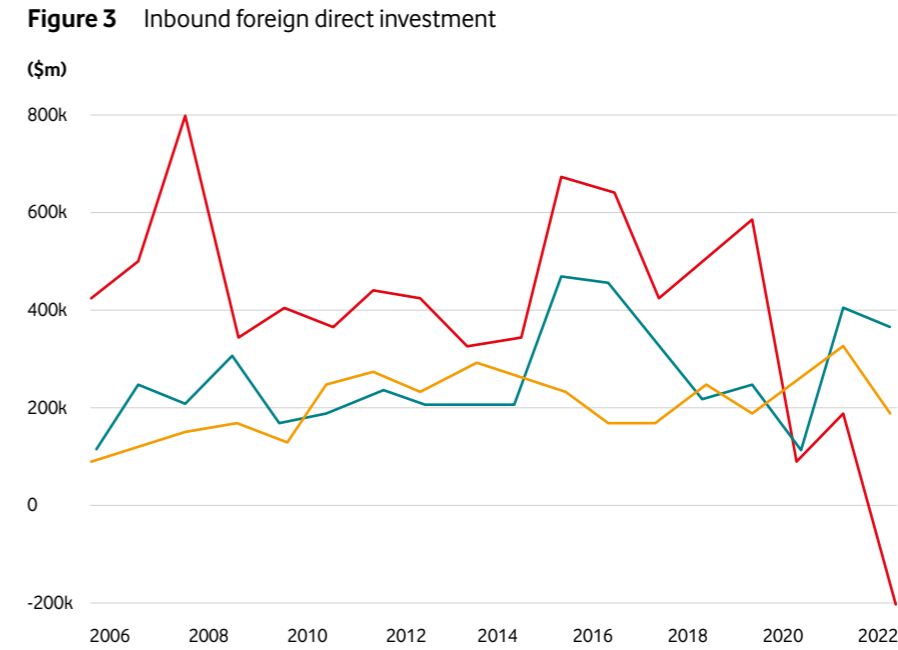
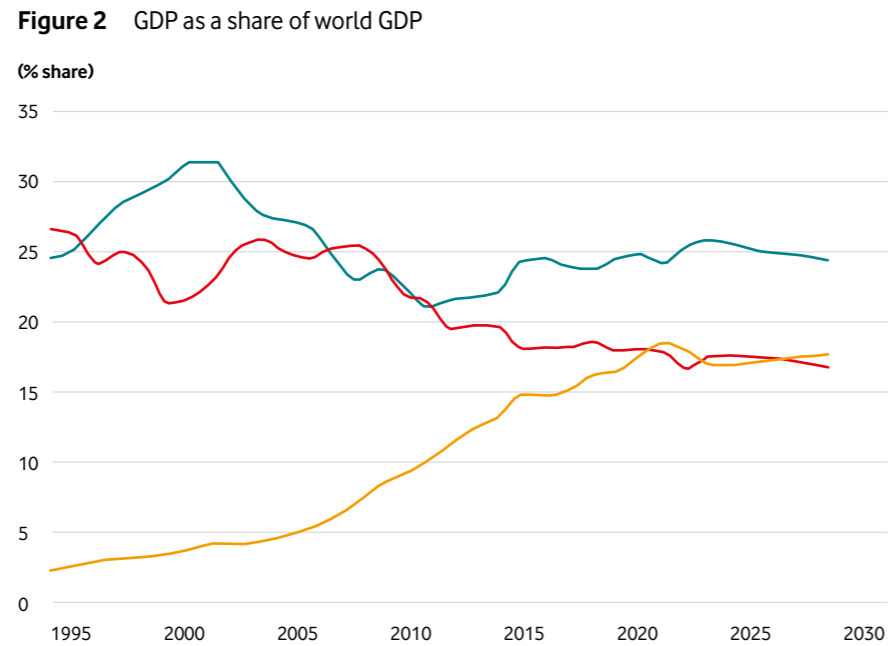
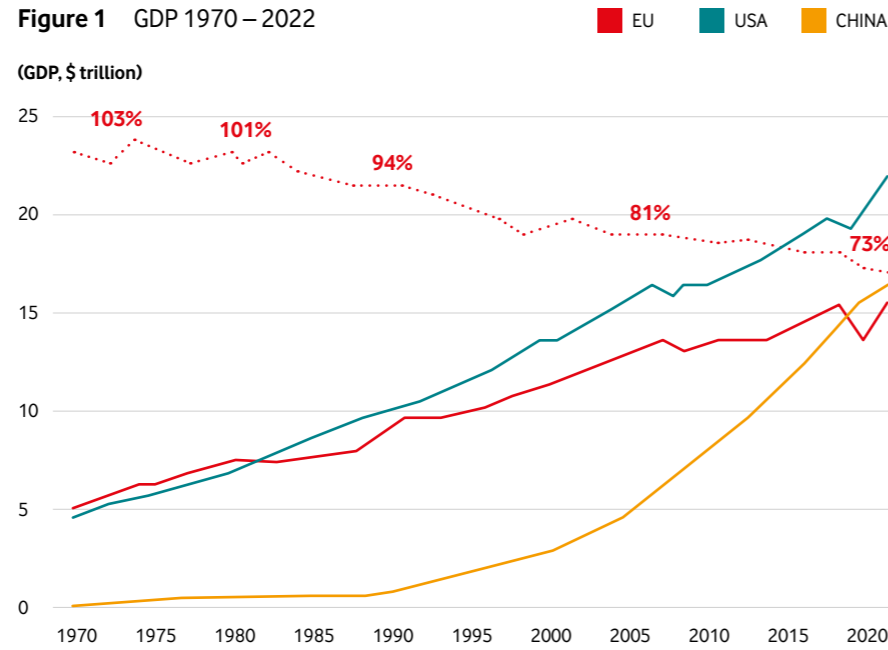


OUTPACED
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OUTPACED
BY ITS GLOBAL COMPETITORS

It should therefore come as no surprise that the long-term trend shows Europe's share of global GDP continuously falling, while the US and China have either maintained or grown theirs (see Figure 2). Just 15 years ago, Europe's share topped the US and was nearly five times that of China. Today, the EU's economy is marginally smaller than China's and 44% smaller than the United States'. The IMF predicts this trend will continue, with the EU's share of global output set to fall to below 14% by 2028.²

This trend is also reflected in the number of EU companies in the Fortune Global 500.³ The EU saw its share almost halved between 2005 and 2021, a much more significant drop than US or Japan. In the meantime, China has increased its share by more than eight times and by revenue now has a greater number of globally successful companies than the EU, UK and EEA combined.

More recently, investor confidence in Europe has collapsed relative to its competitors. Since 2018/19, there is a very steep decline in inbound foreign direct investment (see figure 3) and the latest ERT confidence survey shows that an alarming 84% of CEOs see Europe's competitiveness weakening.⁴



Among the factors highlighted by European CEOs for this negative outlook were the EU's complex regulatory environment, high energy prices, exposure to geopolitical tensions and competing jurisdictions' industrial policies, including the Inflation Reduction Act in the US. This is putting in doubt one of the few remaining sources of strength for Europe's economy – its ability to leverage the size of its Single Market to attract investment, notwithstanding its internal growth challenges. The majority of European CEOs surveyed by ERT did not believe any real progress was being made on Single Market

integration, with many expressing significant concerns about the state of European competitiveness.

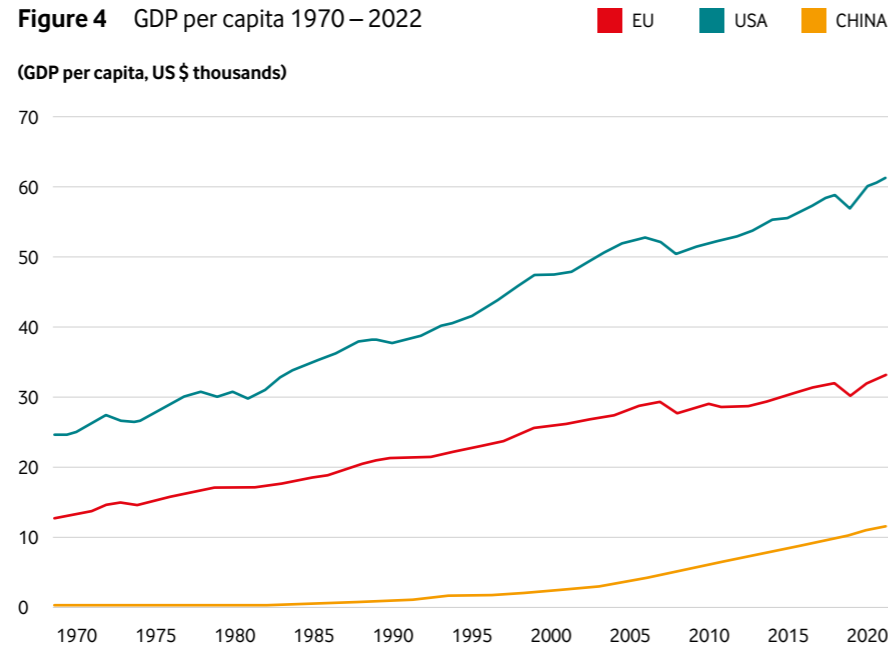
This matters. It is not a desirable position from which to assert Europe's sovereignty or open strategic autonomy. And European citizens have become poorer relative to their peers in the US. Even when adjusting for differential population growth, GDP per capita between US and EU still shows an increasing gap (Figure 4). The divergence in prosperity between Europeans and Americans was as large as 82% in 2021 and growing.⁵

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It could be tempting to try to explain away these gaps with Europe's choice of a different – and possibly more humane – form of European social capitalism. However, a recent analysis by the McKinsey Global Institute estimates that only 40% of the gap in GDP per capita between the EU and the US is due to some of Europe's most popular social policies,⁶ which include retirement ages and parental and annual leave provision.

Instead, the analysis found that over 30% of this gap arises from divergent economic performance between the EU and the US, with another 30% resulting from disparities between higher and lower performing EU Members States. In simple terms, over 60% of the prosperity gap between EU and US citizens cannot be attributed to the social or labour policies that Europeans choose as part of their way of life.

Another fallacy would be to claim that progressive EU enlargements - whereby less mature economies were allowed into the Union - is the main reason for the relatively poor performance of the EU as a whole compared to the US. Rather, newer EU member states have grown significantly, although from a lower starting point. Instead, it is the EU14, which represent the bulk of the EU's economy, which have faltered. As highlighted in a recent ECIPE report, "France and Germany were as rich as the 36th and 31st US states in 2000, but twenty-one years later, French



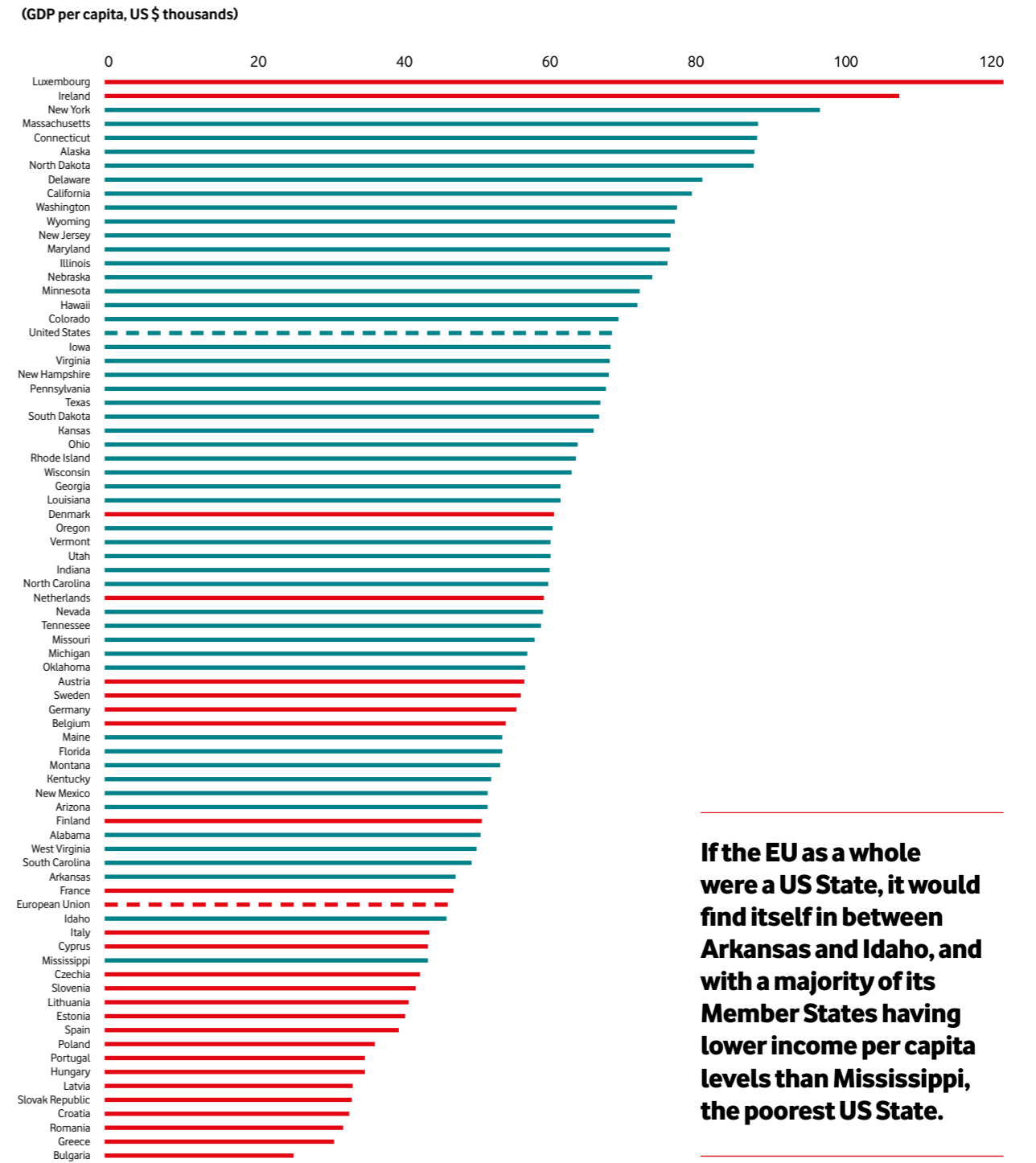
GDP per capita was lower than the 48th poorest US state, Arkansas, while German GDP per capita had fallen to become as prosperous as the 38th US State, Oklahoma.⁷ Although the GDP picture is better than at first glance when exchange rate fluctuations are taken into account, and although central and eastern European member states have made impressive progress since they joined the Single Market, weaker performance, particularly but not uniquely in south Europe, holds the EU back.

In fact, if the EU as a whole were a US State, it would find itself in between Arkansas and Idaho, and

with a majority of its Member States having lower income per capita levels than Mississippi, the poorest US State (see figure 5). Vice-versa, if the US were part of the EU, it would be Europe's third richest EU Member State in terms of prosperity per capita.

Tackling these longstanding European deficiencies in delivering economic growth and citizens' prosperity is crucial to Europe's future, and essential to preserve the European way of life. At its heart lies understanding the essential role of boosting EU productivity for future competitiveness.

Figure 5 Income per capita⁸



If the EU as a whole were a US State, it would find itself in between Arkansas and Idaho, and with a majority of its Member States having lower income per capita levels than Mississippi, the poorest US State.

Europe's longstanding decline has been recently accentuated by a drastic drop in investment inflows, a toughening macroeconomic environment and rising energy prices.

THE IMPORTANCE OF PRODUCTIVITY AND INNOVATION FOR EUROPE'S COMPETITIVENESS

A critical priority for the EU and its Member State governments must be reversing its lack of competitiveness in the coming years. Europe's longstanding decline has been recently accentuated by a drastic drop in investment inflows, a toughening macroeconomic environment and rising energy prices. This means the EU is running out of time and options to get serious about generating sustainable growth, creating good jobs and improving living standards. With greater global competition and geopolitical tensions, Europeans will see their governments increasingly struggle to sustain the current level of economic opportunities, European values and Europe's comparatively generous welfare systems that have come to define the European way

of life — unless the EU quickly finds a way to regain competitiveness. To do so, it will need to focus on rebooting its productivity.

Decreased European competitiveness will lead to:

A weaker labour market with fewer job opportunities, higher unemployment, underemployment, or a shift towards lower paid and less secure jobs.

Deteriorating living standards arising from poorer economic conditions and the erosion of public services. This can widen socio-economic inequality if industries or regions less affected by the decline continue to prosper, while others fall further behind.

Social and political instability as people become dissatisfied and disillusioned. This can lead to unpredictable changes in policy direction, further harming Europe's ability to boost competitiveness

Public budget constraints, weakening governments' ability to invest in, or respond to, critical priorities, including education, healthcare, and housing.

At its core, the foundation of long-term sustainable competitiveness is productivity: the efficiency with which goods and services are produced in the economy.

The state of Europe's productivity growth is stark. Labour productivity growth has fallen from over 5% in the early 1970s to roughly 1% since the early 2000s.⁹ This rate of growth is now less than half the US' and barely one fifth of China's.¹⁰

Of course, productivity is much more than having a more effective work force. It also includes capital deepening, i.e. the amount of capital per worker, and Total Factor Productivity (TFP). TFP refers to productivity by diffusing new technology and innovation into the production of goods and services without adding new capital and labour to the economy. Figure 6 illustrates that the contribution of capital deepening and TFP to growth is substantially larger in the US than in the Euro Area.

As a result, it is no wonder that between 2014 and 2019, European firms grew on average 40% slower than their US equivalents.

To maximise Europe's ability to compete globally and maintain its ability to invest in what makes European society so valuable, it is essential to tackle these productivity gaps across the EU.

Overall productivity – especially through the contribution by TFP – is often significantly improved by innovation, which can streamline processes, introduce more efficient methods of working or create new products that meet market needs more effectively. Improving productivity through innovation creates a virtuous feedback loop in the economy. More innovation increases productivity of labour and capital, whereby the additional resources and capabilities can fuel further productivity and generate more innovation.

But Europe's current innovation performance is unlikely to reverse its poor competitive position. In the years 2014-19, European companies spent 40% less on R&D than their US competitors. The US also generates far more patents than Europe. This has been the case for the long period within computing and machine learning/AI. But more recently, the US has also overtaken EU in areas of technology where in the past Europe traditionally has had strong competitiveness and outperformed the US.¹¹ Patent application data (figure 7) show how the US has gradually widened the gap with Europe. Strikingly, over last 10 years, China now dwarfs both.

This is indicative of the wider trend captured by European Innovation Scorecard reports, which show Europe in the middle of the pack among key economies in 2023 and with equally average improvements since 2016.¹² In contrast, the US, as well as countries like South Korea and Canada, have extended their lead (figure 8).

Similarly, China's recent innovation performance means it is set to soon overtake Europe, placing China in an even stronger position to improve its productivity and capture Europe's share of global GDP. To avoid falling further behind, Europe must focus on accelerating its productivity by innovating.

Figure 6 Contributions to growth in GDP/hour worked

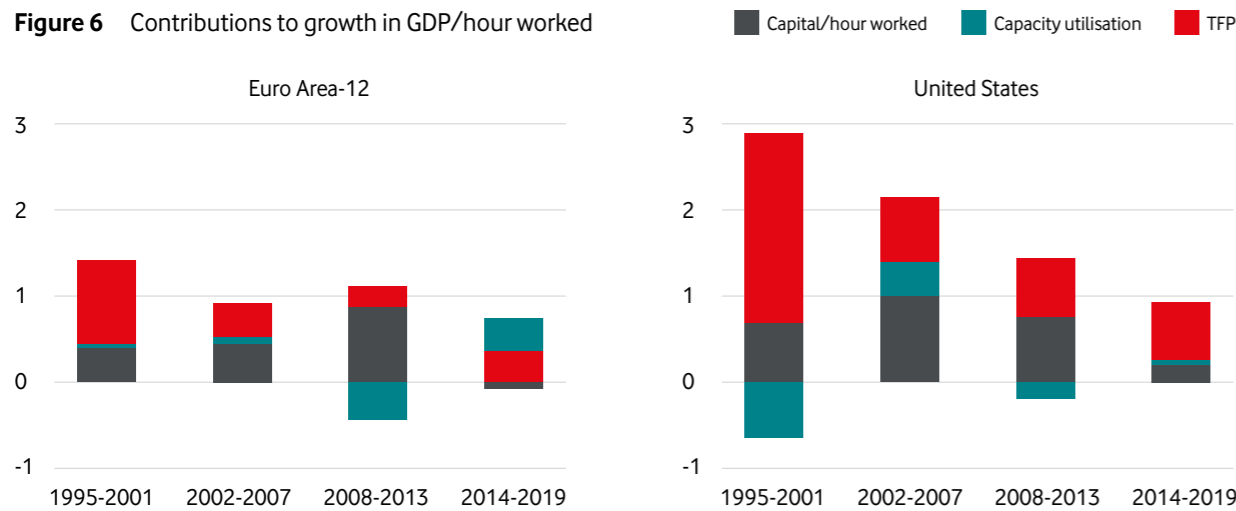


Figure 7 Patent applications 1980 – 2022

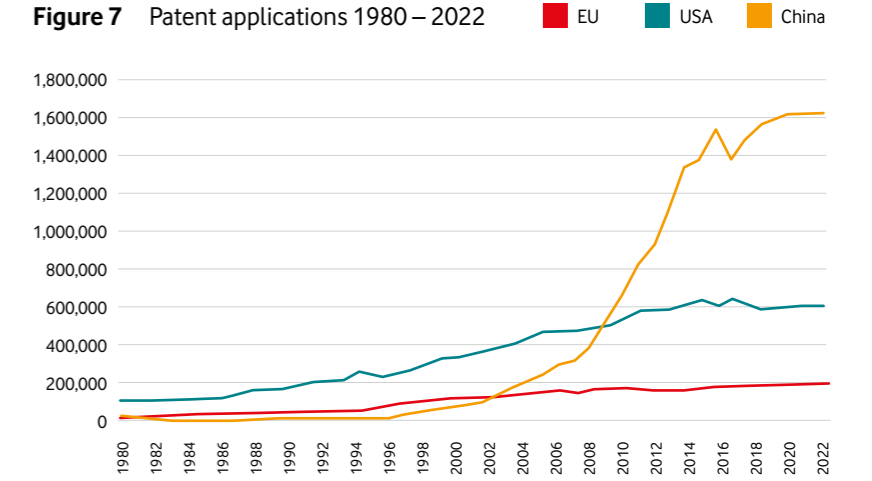
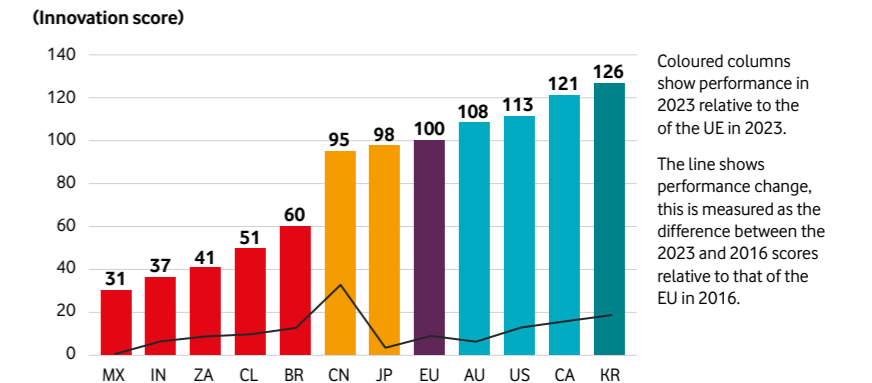


Figure 8 Performance of Global Competitors (2016-2023)



China's recent innovation performance means it is set to soon overtake Europe, placing China in an even stronger position to improve its productivity and capture Europe's share of global GDP.

Sluggish productivity growth and innovation capacity can trigger a downward spiral, whereby Europe's gradual loss in attractiveness as a place to invest, innovate and do business slows down productivity and innovation even further. To make things worse, it must try to break this

vicious cycle while grappling with an ageing population, a growing skills gap, shortages of critical raw materials, rising costs and energy generation that until recently relied on imported fossil fuel. The current combination of these structural challenges make restoring European competitiveness a daunting task.

The EU and its national governments often seem to lack policy levers to arrest economic decline, beyond macroeconomic stimulus. But digital transformation is one of the greatest, most effective, and readily available opportunities for the EU to get European competitiveness back on track.

Europe's digital industry is a major driver of economic growth. We want to increase its competitiveness and continue to deliver prosperity.

Margherita Della Valle, CEO, Vodafone

DIGITALISATION: THE KEY LEVER TO GREATER PRODUCTIVITY AND INNOVATION

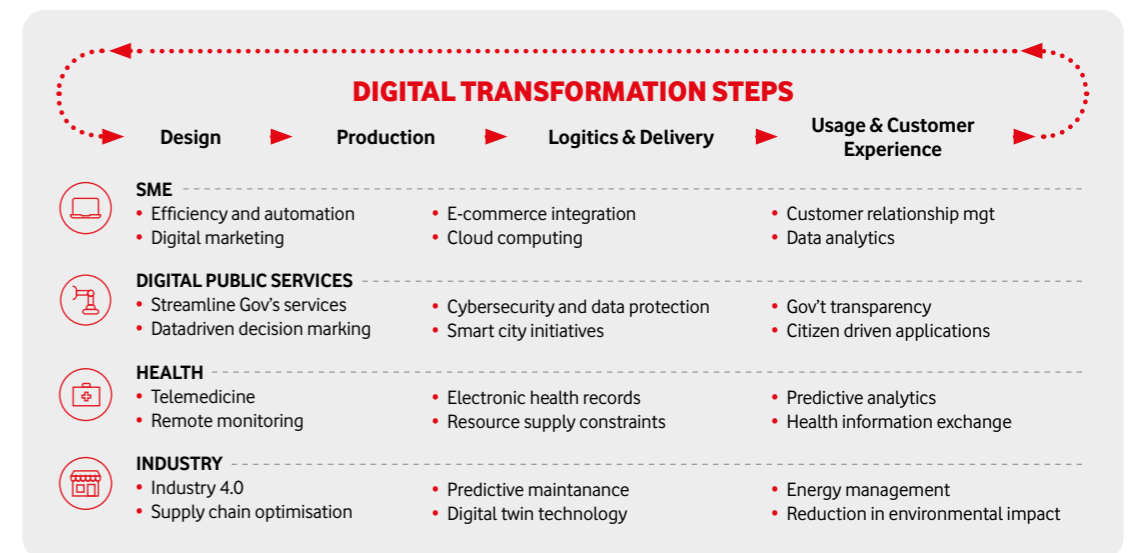
Digital transformation fundamentally rewires the way organisations operate, public services are delivered, and resources are managed. It is enabled by the adoption and implementation of digital technologies at every stage of production and delivery.

As such, **digitalisation directly and materially improves Total Factor Productivity**, as well as

promoting broader innovation. In 1995-2001, the ICT (information and communication technology) revolution was one of the main contributors to a significant jump in TFP in Europe, and even more so the US. History can repeat itself: we are now at the cusp of a similar potential productivity boost from modern next generation connectivity, digital services and the emerging digital technologies they enable.

In an era when everything and everyone can connect to digital networks, the data collected and processed by digitalisation provides insights previously unattainable or unimaginable, particularly to SMEs that cannot afford expensive, propriety equipment or solutions. This transforms the way businesses, governments and other organisations operate (see figure 9).

Figure 9



The results are dramatic – raised efficiency and productivity, boosted resilience and agility and greater innovation.

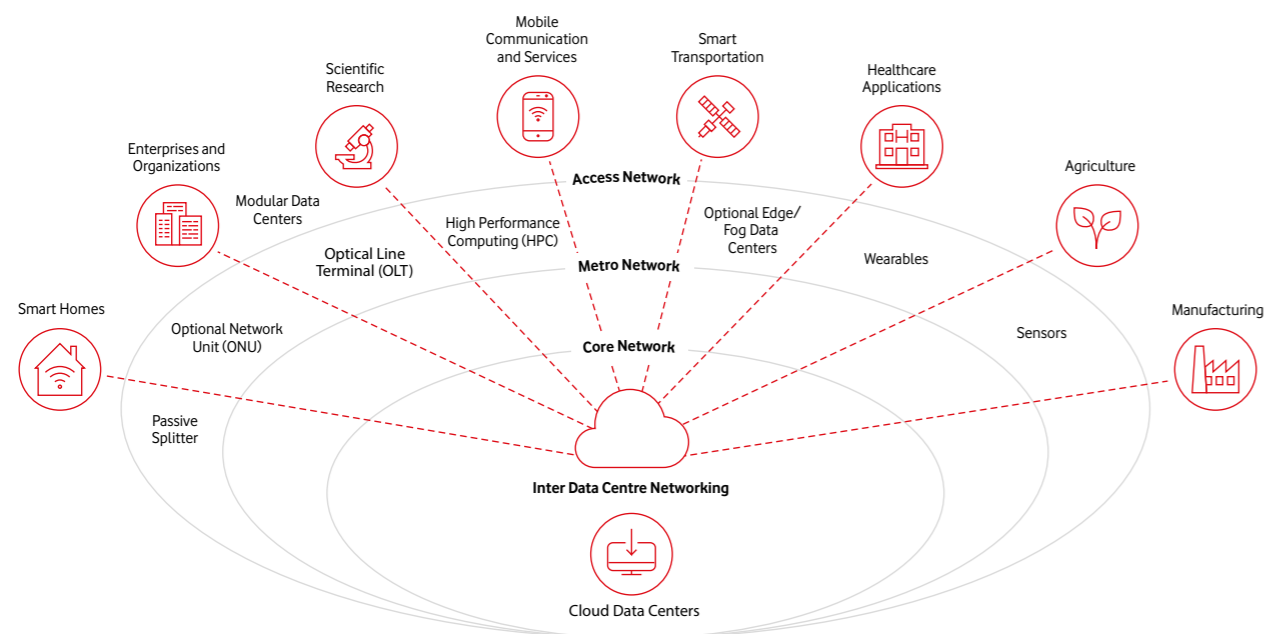
Modern and secure connectivity infrastructure – especially 5G, but also fibre, super Wi-Fi and, in the future, satellite – sits at the heart of this new era of digital transformation. As more goods and services are digitalised, the volume of data transmitted increases exponentially, driving the demand for best-in-class connectivity and cloud infrastructure. For this to work effectively, Europe needs high-quality, always-available, near-ubiquitous connectivity. (See figure 10 for an illustration of network connectivity supporting digitalisation across multiple sectors.)

Emerging technologies such as artificial intelligence (AI) bring this demand sharply into focus. AI often relies on transferring enormous datasets, so AI's utility and growth depends on parallel improvements in connectivity – mission-critical AI applications, like autonomous vehicles, healthcare monitoring and smart grids, often need real-time data processing for their efficacy and safety.

As this report goes on to show, with technologies such as IoT, near-zero latency 5G connectivity and 'network slicing', telecoms operators are accelerating digital transformation by providing bespoke, ultra-secure, high-quality services.

Modern and secure connectivity infrastructure – especially 5G, but also fibre, super Wi-Fi and, in the future, satellite – sits at the heart of this new era of digital transformation.

Figure 10 Network connectivity supporting digitalisation



“Globally we find ourselves in a landscape of uncertainties. And Europe must come at these multiple crises from a position of strength. We urge the next European Commission and European Parliament to put the business case for EU industry and its competitiveness at the core of its actions.”

Dr. Martin Brudermüller, Chairman, BASF

CONNECTIVITY AND DIGITALISATION: THE €1 TRILLION OPPORTUNITY

The EU's own Digital Decade goals recognise the role of connectivity and digitalisation in building competitiveness. The European Commission rightly prioritises world-class connectivity, the digitalisation of businesses and public services, as well as the development of digital skills, as one coherent package that can drive forward Europe's prospects.¹³

Achieving the targets set by this EU framework would deliver enormous benefits for Europe. Cross-border digital services and data flows would strengthen the Single Market, alongside an upskilled, future-proofed labour market. Public services would become more efficient and accessible, and open digital sovereignty enhanced through a rejuvenation of Europe's digital infrastructure and homegrown innovations in digital applications, platforms, and technologies.

Most importantly, European citizens would prosper through enhanced economic activity and growth. Research commissioned by Vodafone quantifies these huge opportunities, including:¹⁴

- a 10% increase in any Member State's Digital Economy and Society Index (DESI) score leads to **0.65% higher GDP per capita**;¹⁵ and
- if all EU Member States achieve a DESI score of 90 by 2027, GDP per capita across the EU would be **7.2% higher – an overall increase in EU GDP of over €1 trillion**.

To put this in perspective, this is **the equivalent of adding another Netherlands to the EU economy**.



The EU has an exciting opportunity to pioneer the digital transformation of industry, B2B data-driven business models, and Generative AI for business. To fully realise this potential, it's imperative that Europe completes the Digital Single Market and invests in state-of-the-art connectivity, a secure and scalable cloud infrastructure, and digital up- and reskilling.

Christian Klein, CEO of SAP



Given what is at stake, European industrial leaders across a broad set of sectors – such as the European Round Table for Industry – have pushed the EU to support the digital transformation of industry and the economy at large. Other civil society and professional organisations have also argued that Europe must take advantage of the opportunities arising from digitalisation to modernise healthcare, stimulate the rural economy and improve the environment, including through smart city solutions to preserve energy and combat air pollution.

Whether through efficiency gains in industry, improved public services or innovation to deliver planet-saving initiatives, **the combination of connectivity and digitalisation is a potent force multiplier for every part of the economy and society.**

Europe must realise this €1 trillion digitalisation opportunity if it is to transform its competitiveness and secure its prosperity and sovereignty for decades to come.

THE OPPORTUNITY FOR THE EU: POTENTIAL OVERALL INCREASE IN EU GDP

1tn



DIGITAL TRANSFORMATION FOR EUROPEAN COMPETITIVENESS

REVITALISING EUROPE'S INDUSTRIAL BASE

THE CHALLENGE

As a critical component of European economic growth, a vibrant industrial sector is essential for improved competitiveness. But accelerating deindustrialisation across Europe threatens this keystone of productivity growth and innovation.

As the EU Commission's 2020 New Industrial Strategy for Europe notes, "Industry is central to Europe's future progress and prosperity. It makes up more than 20% [23.5%] of the EU's economy and employs around 35 million people, with many millions more jobs linked to it at home and abroad. It accounts for 80% of goods exports and is a key reason behind the EU's position as a top global provider and destination for foreign direct investment."¹⁶

The manufacturing sector is one of the strongest drivers of European productivity, punching above its weight to ensure consistent overall year-on-year growth rates. Although Europe averaged 1% annual productivity growth during the previous decade, manufacturing achieved a growth rate of 1.7%.¹⁷

The manufacturing sector is also the biggest single driver of innovation in Europe. Just over half of all R&D spending by European companies is in this sector. These innovations help ensure that Europe's economy can grow and prosper.¹⁸

But European manufacturing – and its competitiveness – is under threat. The output of this sector, in terms of industry's share in gross value added (GVA), has shrunk from 20% in 1995 to just 16.5% in 2021.¹⁹

Because of higher costs for energy and raw materials, European deindustrialisation has recently accelerated. There is an increasingly urgent need for a step change in industrial productivity, innovation, and overall competitiveness.

MANUFACTURING IN THE EU: IMPORTANCE FOR THE ECONOMY

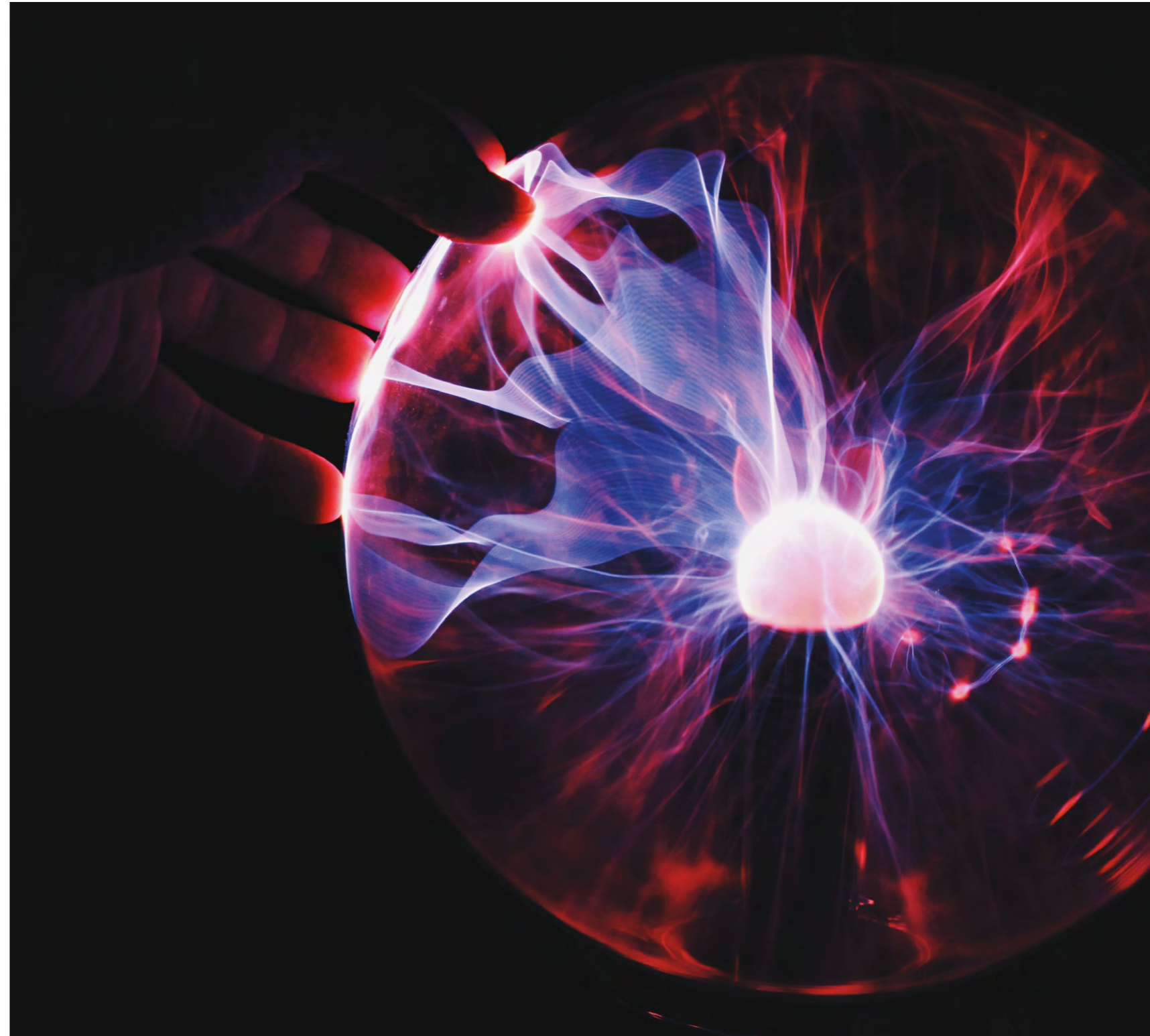
20%

ANNUAL PRODUCTIVITY GROWTH RATE

+1.7%

SHARE IN GROSS VALUE ADDED (GVA) (1995-2021)

-3.5%

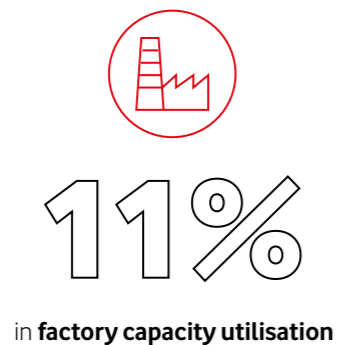
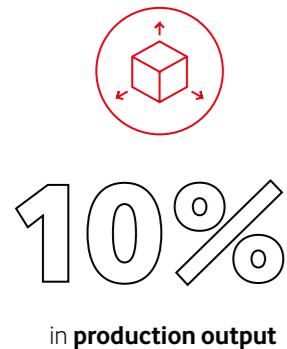


CONNECTIVITY AND DIGITALISATION ARE KEY ENABLERS OF INDUSTRIAL REJUVENATION

The impact of digitalisation on the global manufacturing sector is estimated to be up to \$2 trillion each year, and Internet of Things (IoT) could deliver upwards of \$12.6 trillion in value across all sectors globally by 2030. With smart factories accounting for the highest proportion of potential economic value, digital connectivity offers an incredible opportunity to accelerate productivity and restore global economic competitiveness.

The digitalisation of industry represents the 'fourth wave' of the industrial revolution, following mechanisation, electrification, and computerisation. 'Industry 4.0', as it is characterised, is centred on the digital transformation of manufacturing operations that drive productive efficiency and enable innovation around new products and services.

A successful shift to digitalised manufacturing can rejuvenate industrial activity and rebuild Europe's competitiveness. Other economies are already embarking on this transition with strong results. A 2019 study on digitalised manufacturing found that over the previous three years, US firms that invested in smart factory initiatives had seen average increases of:



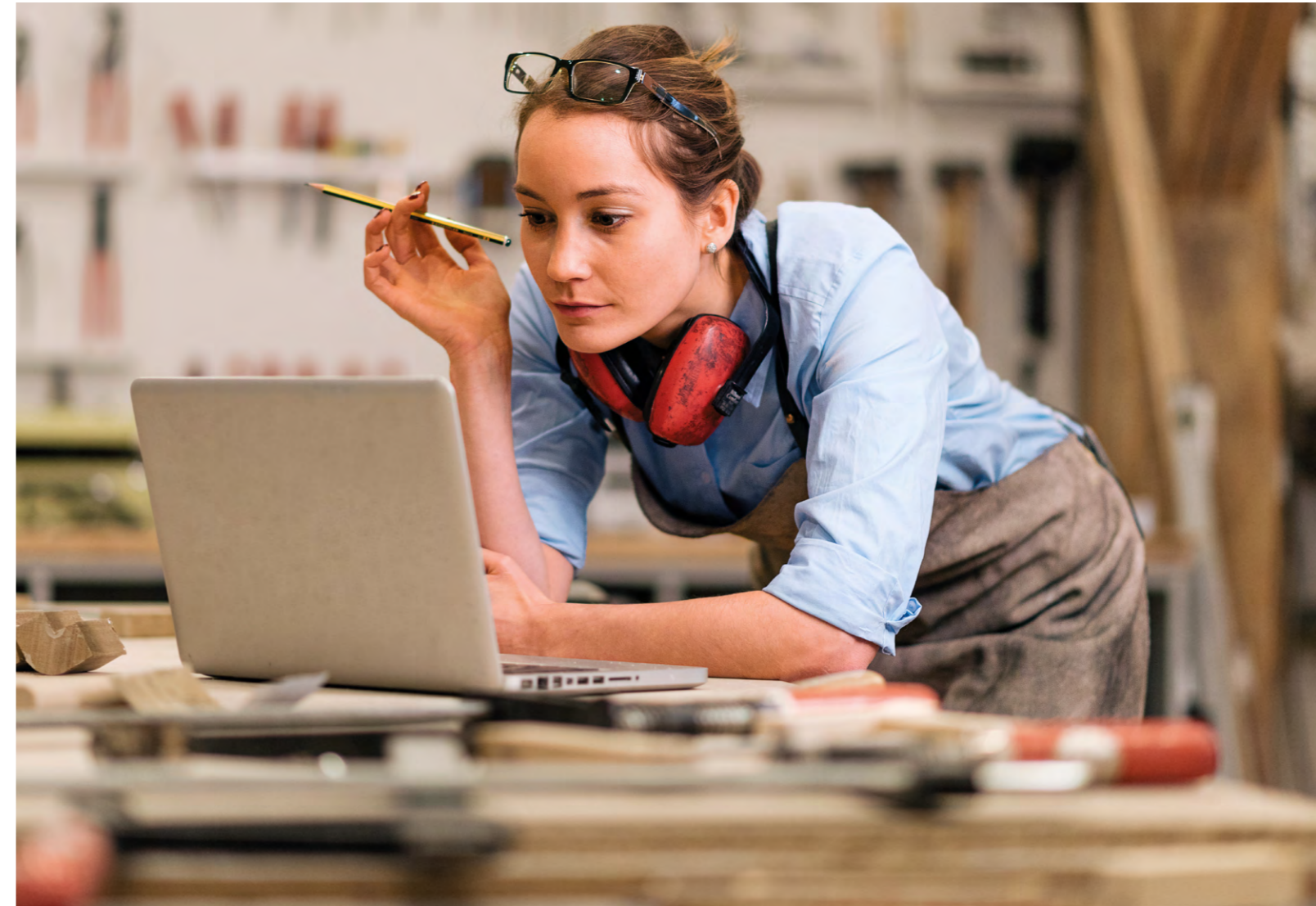
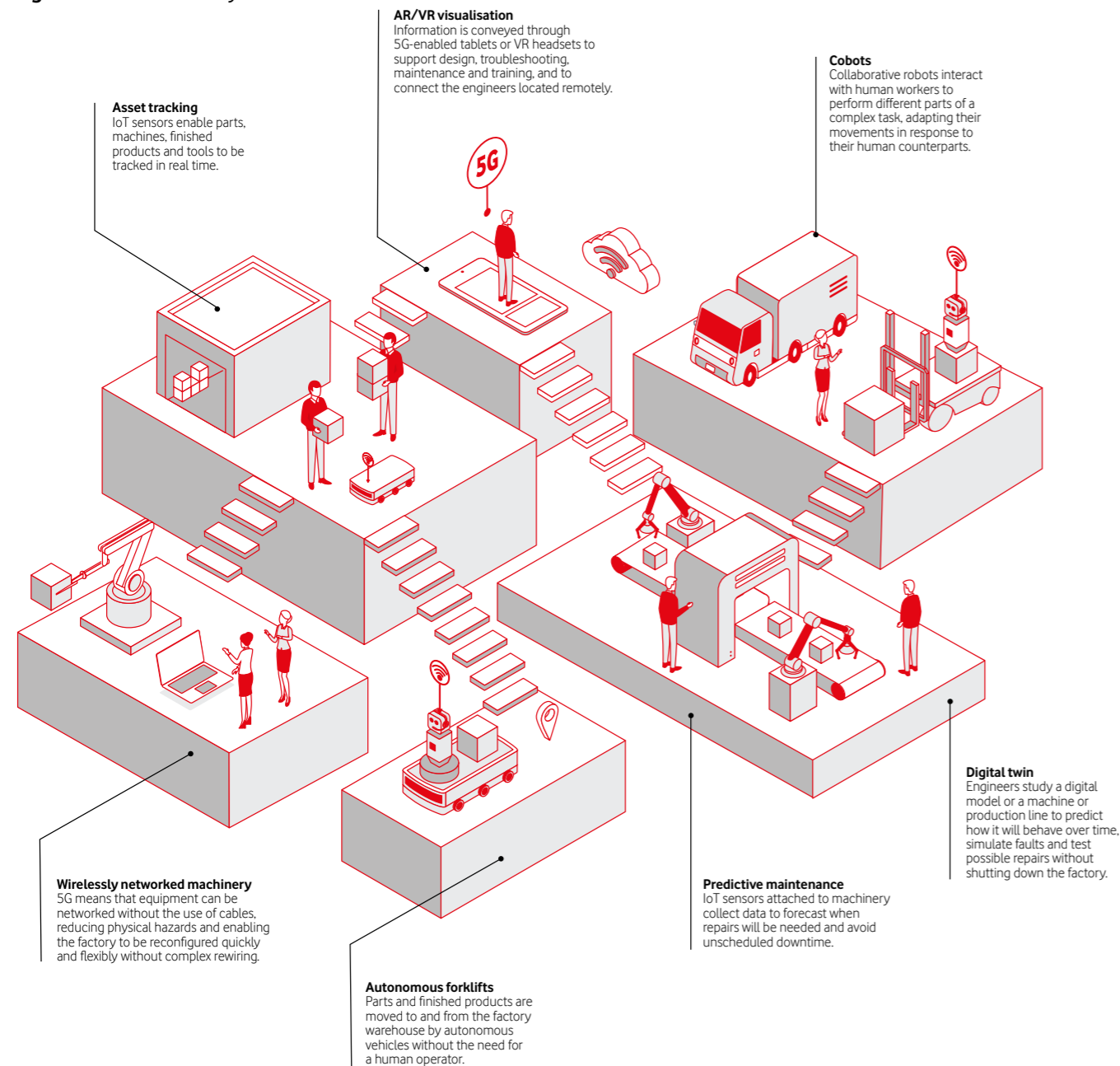
“We can create a future that works for all if we unlock the power of connectivity, software innovation and deep domain expertise. The time to act is now – and industrial IoT is the clear way forward.”

Erik Brenneis, CEO, Vodafone IoT

A smart factory is a digitised manufacturing facility that uses connected devices, machinery, and production systems to continuously collect and share data, which is then used to improve processes

and address any issues that arise. Digitalised manufacturers can build 'smart factories' that embed digitalisation at every stage of production:

Figure 11 Smart factory



Digital transformations are reshaping how goods and services are produced and delivered. They also generate new market opportunities by stimulating product innovation.

This process of industrial digitalisation depends on connectivity between the assets, processes, people, and devices in a factory. Reliable and high-quality connectivity spanning both suppliers and customers is critical.

Without this connectivity, there is no digitalisation and no Industry 4.0. Enabled by high-bandwidth, low latency connectivity and increasingly optimised through AI, manufacturing robotics has enormous potential to increase both production efficiency and quality, leveraged through innovation in product design. Cross-sectoral studies have shown that a 1% increase in industrial robot density is correlated with a 0.8% increase in productivity, with up to

5% productivity improvements in industries adopting robotics for the first time.²¹

In addition to improving efficiency and productivity, solutions such as automation, robotics, and IoT will also make European industries more competitive on the global stage, countering the cost advantages of labour arbitrage in less developed countries.

MANUFACTURING

CASE STUDY

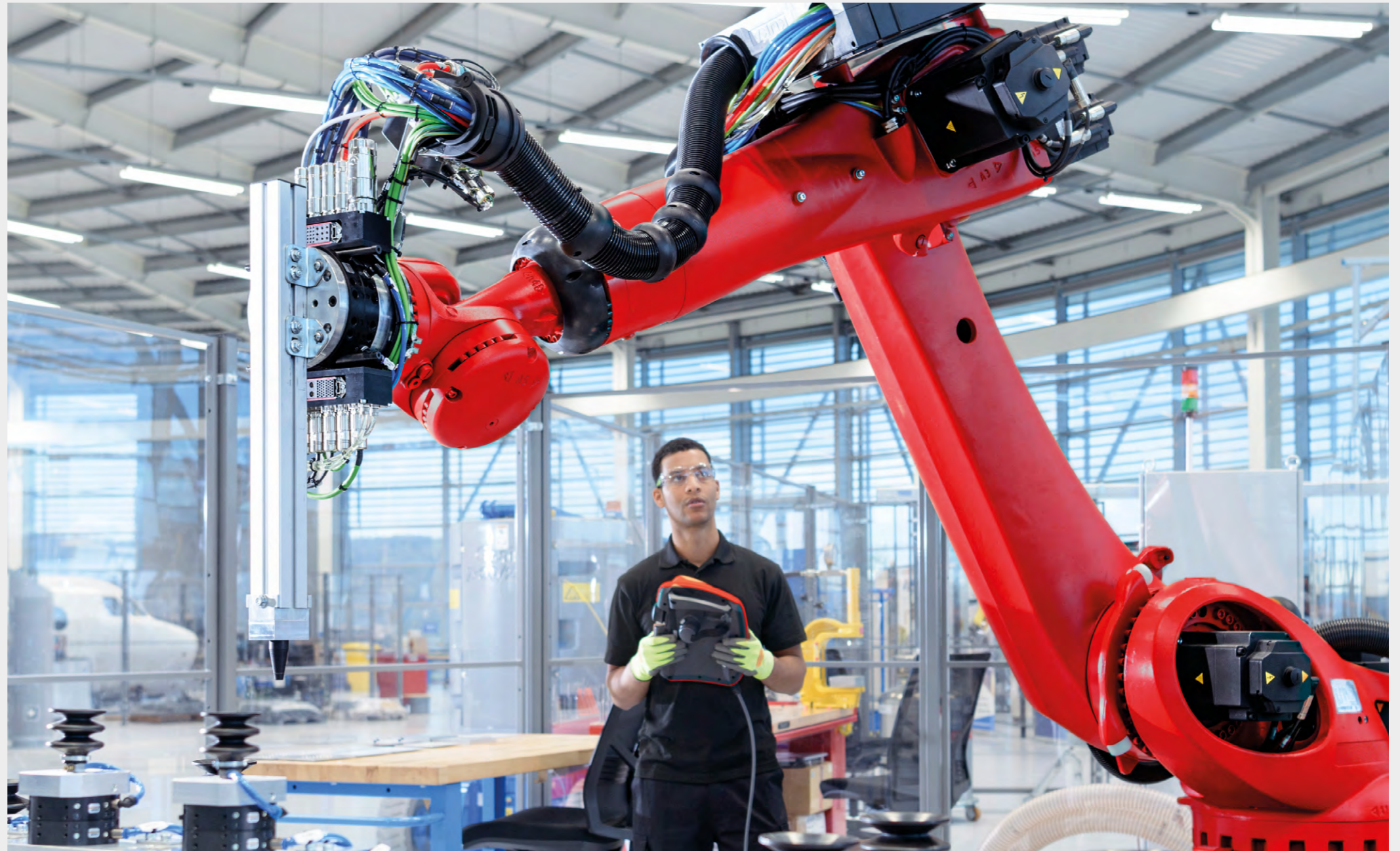
AUGMENTED AND VIRTUAL REALITY

German manufacturer Bosch has leveraged AR to both upskill new workers and to assist workshop technicians in carrying out intricate repair processes. Using Bosch's in-house Common Augmented Reality Platform (CAP), information is overlaid on real-time images the technician observes, including fault identification and step-by-step repair instructions. A Bosch field study identified time savings of 15% for repairs, whilst simultaneously reducing staff training costs.

Augmented and Virtual Reality has huge potential for industry, enabling workers to be trained in immersive risk-free environments, or rapid simulation and prototyping that allow manufacturers to innovate and develop new products whilst minimising design flaws.

Source: Bosch Augmented Reality applications now also work with the new Microsoft HoloLens 2 - Bosch Media Service Netherlands (bosch-press.nl)

Augmented and Virtual Reality has huge potential for industry, enabling workers to be trained in immersive risk-free environments.



AUTOMOTIVE

CASE STUDY

CONNECTED AUTONOMOUS VEHICLES

Port Antwerp recently launched its 'D-Hive drone-in-a-box' solution, in which a 120km2 area is covered by just six autonomous connected monitoring drones that help port authorities manage, inspect and supervise the large area quickly and effectively. Ericsson estimates that drone surveillance will decrease theft at ports by 75%, improve staff safety and goods security, and lower costs through decreased insurance premiums.

Connected Autonomous Vehicles use a combination of sensors, software, and communication technologies to gather and share data through cloud connectivity. These technologies have the potential to transform European industry and logistics by improving safety, efficiency, and productivity, reducing costs and environmental impacts at the same time.

Source: Building for safety and more efficiency with port automation - Ericsson.



CASE STUDY

DRIVING INNOVATION WITH ŠKODA AUTO

In Mladá Boleslav, Škoda Auto has one of the largest car production plants in the Czech Republic.

Experimenting with a 5G mobile private network (MPN), Škoda Auto is becoming more flexible and efficient – starting with automated car parking.

It currently needs drivers on site to move the manufactured cars to the parking lot. Using MPN, it will be able to do this without driver intervention using only automatically controlled

trolleys. Making its robots, machines and sensors able to communicate across the factory, the manufacturer will also be able to improve its processes and minimise machine downtime further with predictive maintenance and optical inspections during body construction.

In the future, Škoda Auto plans to use the technology to create a real-time digital twin, where teams can communicate using 3D objects in augmented reality.

INDUSTRY

Only 27% of European SMEs enjoy high levels of digital intensity, compared to 54% of larger businesses. They are more likely to fall behind, which risks further cementing productivity gaps.

BRIDGING THE GAP BETWEEN SMES AND LARGER BUSINESSES

THE CHALLENGE

Employing nearly 100 million Europeans, SMEs are the beating heart of Europe's economy and society. But they face a productivity gap compared to larger companies that is amplified by a growing digital divide. Without the benefits of increased digitalisation, SMEs will fall further behind, which will further exacerbate regional socio-economic disparities.

As President von der Leyen stated in her 2022 State of the Union Address, SMEs are "the backbone of Europe's long history of industrial prowess" and one of the critical pillars to Europe's economy, providing jobs and driving economic growth. Comprising more than 99% of all businesses in the EU, SMEs employ around 100 million people, account for more than half of Europe's GDP and are adding value in every sector of the economy.²² As such, their success is essential for Europe's competitiveness.

SMEs also play a broader role in improving socio-economic

conditions in society. They provide important upskilling of younger workers: for example, in Germany, 82% of apprentices undertake their vocational training in an SME.²³ In rural economies, small businesses account for three-quarters of all employment. With every European having an SME owner in the family or neighbourhood, they are essential for economic resilience, social cohesion, and the green transition.

However, SMEs in Europe are on average 40% less productive than larger companies, driving a productivity gap depending on firm size in the economy. In Central and Eastern Europe, this disparity

reaches 70%. SMEs are also less digitalised than their larger peers. Many SMEs do not employ people with the necessary transformation or IT skills to provide expertise or the ability to manage digital solutions and migrations. A lack of financial resources, combined with a lack of digital skills, can also hold back the adoption of new digital infrastructure and technology.

As a result, only 27% of European SMEs enjoy high levels of digital intensity, compared to 54% of larger businesses.²⁴ They are more likely to fall behind, which risks further cementing productivity gaps.²⁵



CONNECTIVITY AND DIGITALISATION ARE CRUCIAL TO SME COMPETITIVENESS

Connectivity and digitalisation help SMEs access new markets, reach new customers, attract talent, and innovate. Digitalised SMEs experience an average of 26% higher revenues compared to non-digitalised counterparts - ensuring that they are connected and adopt digital tools is essential for their future success and the success of the communities they support.

Connectivity acts as an essential enabler for small businesses in several ways:

<p> Finding and Keeping Customers</p> <ul style="list-style-type: none"> • E-commerce • Customer management • Business intelligence <p>35% of businesses who responded to our survey cited 'new sales channels' and 'expansion into new markets' as core areas for their digital expansion</p> <p>CORE COMPONENTS</p> <ul style="list-style-type: none"> • eCommerce: online store; payment methods; website creation • Customer management: CRM; email management • Business intelligence: dashboard creation & management; database integration 	<p> Healthy & Productive Workforce</p> <ul style="list-style-type: none"> • Web & presence • Social networks • Virtual office <p>Digital marketing was popular with SoHo respondents in our survey — it was seen as the most appealing solution in this space after software and hardware</p> <p>CORE COMPONENTS</p> <ul style="list-style-type: none"> • Web & presence: web creation; digital presence; ratings creation • Social networks: community management; performance monitoring; social network planning • Virtual office: collaboration tools; flexible working 	<p> Cost Control & Business Efficiency</p> <ul style="list-style-type: none"> • Process management • Digital billing • Virtual office <p>Cost efficiencies was rated as the top benefit SMEs and SoHos hoped to achieve in their digital journey, in 8 of 11 markets surveyed</p> <p>CORE COMPONENTS</p> <ul style="list-style-type: none"> • Process management: accounting & finance; portal notifications; admin services; payroll management • Digital billing: invoicing; certification; digital signatures; cloud backup • Virtual office: digital signage; collaboration tools 	<p> Cyber Security and Resilience</p> <ul style="list-style-type: none"> • Cyber security basic • Cyber security advanced • Safe communications <p>Cyber security is one of the top 3 most appealing product categories in 10 of 11 markets surveyed</p> <p>CORE COMPONENTS</p> <ul style="list-style-type: none"> • Cyber basic: software protections; firewall, web security • Cyber advanced: secure audit; technical support; online support; threat analysis; software protections; web security • Safe communications: threat detection, Secure Digital Communication • Communications: threat detection, Secure Digital Communication
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94% of SMEs would cope better with future risks if investment was made in SME digitalisation, which leads to improved financial performance, increased productivity, access to new customers and innovation.²⁶

While larger businesses have the resources and scale to invest in bespoke IT solutions, **SMEs would benefit hugely from affordable packaged ('plug and play') products.** These allow for immediate connectivity and digital tooling

that do not rely on either end-user expertise or a significant investment of time to implement. These products must also be reinforced with **skills development** if SMEs are to take full advantage of the benefits on offer.

CASE STUDY DIGITAL TOOLKITS

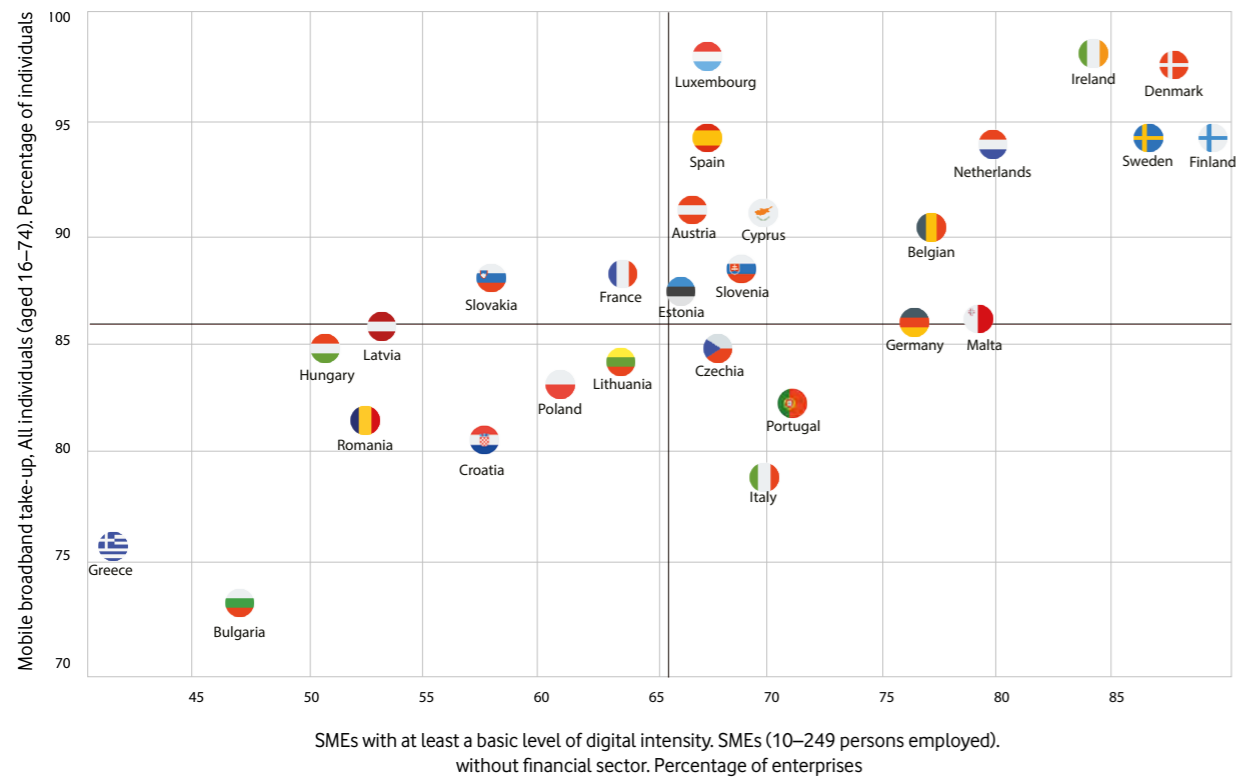
To address this challenge, Vodafone has focused on building the best 'Digital Toolkits' to meet the needs of SME customers. Vodafone's Digital Toolkits contain a broad range of solutions, including digital marketing, e-commerce, cyber security, digital business solutions and smart-working solutions to appeal to SMEs in different stages of their digitalisation journey.

EU Commission data shows the positive effects of SME mobile broadband take up on their basic level of digital intensity (seen in Figure 12). The more connected SMEs are, the more they tend to adopt other digital tools and solutions.

Better development of digital infrastructure has huge potential, especially as around 1.2 million European SMEs have yet to take advantage of these opportunities. Unlocking the digital potential of just 100,000 SMEs could **raise total turnover by €148 billion – an average of €1.4 million per firm.**²⁷



Figure 12 DESI Period; 2023



Even before the pandemic, growing access to connectivity and digital services had already reshaped many industries, business models and supply chains. The pandemic further accelerated these digital trends and, as a result, organisations of all sizes rely more heavily on digital operating

and business models to create new value and experiences. The World Economic Forum estimates that 70% of new value created over the coming decade will be based on digitally-enabled platform business models.²⁸

But progress is slow, and funding is a key barrier to SME digitalisation. Government support schemes, for example in the form of vouchers, can help bridge such financial gaps for SMEs. Under the EU recovery and resilience funds, with 26% of €672.5 billion going towards digitalisation, all 22 National Plans include measures relevant to SMEs. However, the relative success of such schemes depends on how they are implemented. Spain's SME Digitalisation Plan 2021-2025 is a transformational example. Spain has an entire NRRP component worth €4.9 billion dedicated to SMEs of which €3 billion is dedicated to the Digital Toolkit. It provides SMEs with the necessary tools and knowledge to open new sales channels and to digitise processes and operations.

CASE STUDY BUSINESS.CONNECTED

During the height of the COVID-19 pandemic, Vodafone launched the 'Business.Connected' programme, which has helped more than 230,000 SMEs enhance their digital skills and increase their resilience. This complements Vodafone's V-Hub solution, which is detailed later in this section.

Source: Vodafone, Business.Connected

ENSURING A HEALTHY EUROPE

THE CHALLENGE

As Europe rebuilds after the pandemic, it faces the looming – yet long standing – challenge of an ageing population, continued shortages of healthcare professionals and persistent budget constraints that stifle quality publicly funded care. Deteriorating healthcare systems also have knock-on effects on the economy, ranging from workforce productivity losses to rising social inequality. Ensuring Europe’s future competitiveness will require mitigating these serious risks.

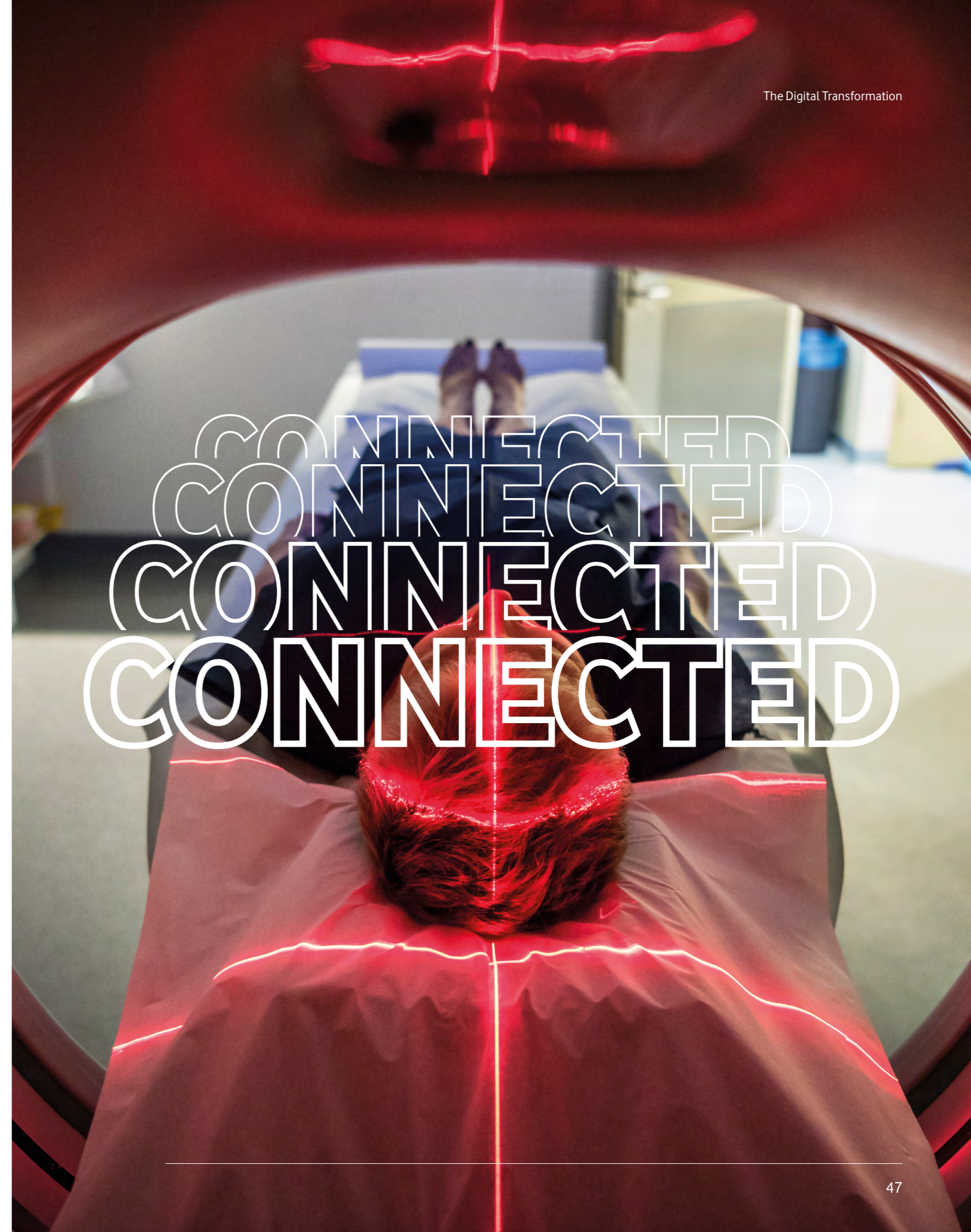
More than a fifth of the EU-27 population is over 65 years of age and this demographic is expected to make up nearly 30% by 2050. Rates of chronic diseases across Europe have grown, with obesity and diabetes increasing two- or three-fold in the past 30 years alone.

The COVID pandemic has put already-stretched health care systems under extraordinary distress, with significant resources needed to combat the impact of the virus and its side-effects. Emerging medical conditions, such as ‘long-COVID’ or post-COVID symptoms and mental health conditions especially among the young, add to the burden faced by health care systems. The pandemic also disrupted health services for other non-COVID diseases, especially cancer care and elective surgery,

with 16% less surgical interventions during the pandemic compared to before. All this has created a significant backlog in treatments, leading to longer waiting times, lack of early diagnosis and treatments and further risks for citizens’ health.

Despite having more doctors, nurses, and primary care workers than ever before, Europe faces a paradox: the shortage of health workers is growing, is larger than it has been in decades, and is still worsening. The shortage of healthcare professionals could amount to 4.1 million in by 2030.²⁹ The enormous strain caused by COVID also means that many professionals in the sector themselves struggle with burnout and mental health. This is compounded by a lack of funding compared to growing needs.

Rates of chronic diseases across Europe have grown, with obesity and diabetes increasing two- or three-fold in the past 30 years alone.



CONNECTIVITY AND DIGITALISATION ARE KEY TO MITIGATING THESE CHALLENGES

Connectivity can deliver direct and immediate returns by improving access and efficiency of patient care through telemedicine and remote patient monitoring. Additionally, AI applications can improve diagnostics and care while smart factories can revolutionise medical technology operations. It is estimated that these types of digital healthcare technologies could save up to €120 billion annually for the entire EU.

Digital connectivity is one of the positive lessons from COVID, improving health outcomes and reducing pressure on scarce health resources by enabling remote consultations, telemedicine solutions and virtual monitoring. If widely adopted, the impact of digitalisation in the healthcare system would be even greater. A five-percentage point

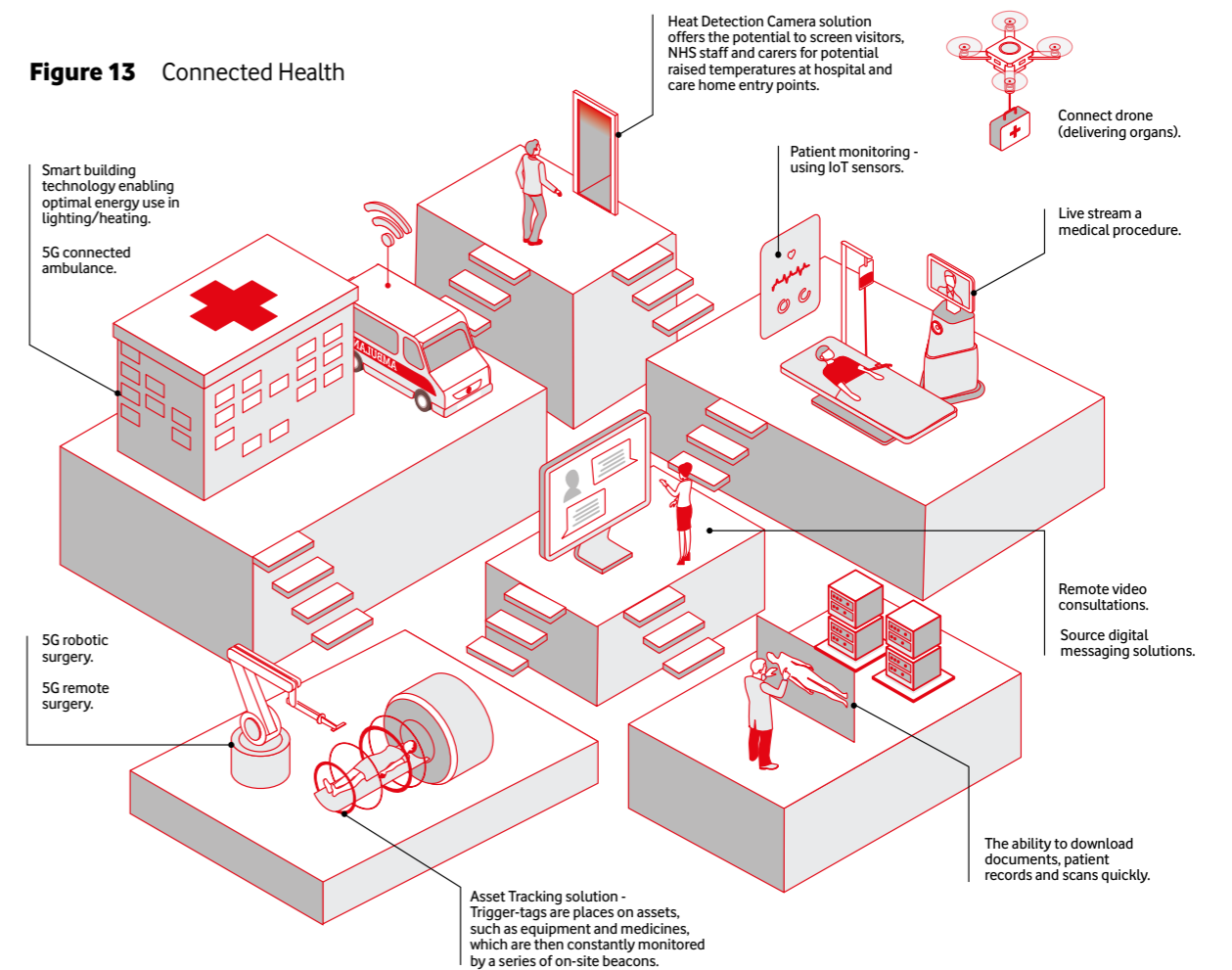
increase in telemedicine consultations in the EU has been associated with a **3.7% reduction in healthcare costs and a 3.6% fall in mortality**.³⁰

Looking ahead, digital solutions such as remote surgery, smart hospitals and medical supply delivery with drones can provide further benefits. Just as smart factories can reshape and revitalise the manufacturing

industry, connectivity can help the increasingly complex medical system become more reliable and robust, and ultimately deliver better patient care. 5G-connected hospitals already allow doctors to provide remote expert guidance on medical procedures, including surgery, through augmented reality. 5G-connected ambulances can link paramedics working with a patient in transit to a hospital clinician to share



Figure 13 Connected Health



medical records and live clinical data (see Figure 13 for an illustration of the benefits of 5G and IoT for patients and healthcare professionals).

Innovative AI-enabled decision-making is already improving the performance of healthcare systems while reducing costs. Connected IoT devices are improving chronic disease monitoring through glucose sensors, heart rate monitoring devices and ingestible sensors.

Vodafone's AR HoloLens, for example, helps paramedics in Italy access patient medical records and other critical information.³¹

A recent study estimated that similar AI applications could help save more than 300,000 lives every year in the EU and free up more than 330 million healthcare professional hours.³² This is the equivalent of 80,000 additional full time healthcare workers.

Powered by high-bandwidth and low-latency networks, AI technology learns from large data sets (often sourced from mobile patient monitoring) and gives healthcare professionals the tools they need to make better decisions and deliver treatment faster, even in remote locations.

Digital connectivity significantly improves the creation of medical technologies and solutions. Based on studies of medical companies that have digitalised their processes, McKinsey has estimated that these technologies can accelerate time-to-market by more than 30% and increase the capacity of manufacturing by over 20%.³³

With the savings offered by digital healthcare technologies estimated at **€120 billion annually for the entire EU**³⁴ – the equivalent of Spain's annual healthcare budget – investment in connectivity and digitalisation is imperative.

HEALTHCARE

CASE STUDY

GETTING TO THE HEART OF THE MATTER

Working with Artiness at the IRCCS San Raffaele hospital in Milan, Vodafone has conducted a clinical trial to perform intrusive heart surgery using a remote proctoring system.

Proctoring means expert supervision: when medical devices are implanted during surgical procedures, the proctor is there to ensure it goes well. This is normally carried out in person, with the proctor in the operating theatre.

Artiness has pioneered remote proctoring, allowing real-time interaction between the doctor and the proctor. Using augmented reality (AR) visors, connected and managed by 5G and mobile edge computing, the proctor can access live medical data and a patient-specific holographic model of the heart, streamed directly from the operating room.

The surgeon, who can also interact with the 3D model, receives real-time instructions from the proctor thanks to the speed and low latency of 5G edge computing technology.

This trial opens the door to new applications for the healthcare industry and shows how easy it is for proctoring to be carried out remotely, even with complex surgery.

Proctoring means expert supervision: when medical devices are implanted during surgical procedures, the proctor is there to ensure it goes well.



Europe's transition to clean energy will mean a much higher reliance on electricity, posing its own economic challenges. It is estimated that electricity demand will double by 2050, driven mostly by the electrification of transport and heating.

ACCELERATING THE ENERGY AND THE GREEN TRANSITION

THE CHALLENGE

Europe's dependence on imported fossil fuels is environmentally detrimental and poses serious political and economic challenges. While the Green Transition can help mitigate these effects, it presents its own challenges of significantly increased electricity demand and the enhanced use of energy sources which put strain on energy grid systems.

A successful transition must flatten the rising energy demand curve by minimising energy consumption, while also expanding and making more reliable and efficient use of renewable energy supplies.

The Green Transition is a transformational overhaul of the EU energy mix.

Europe's historical overdependence on imported fossil fuels has both weakened it politically and led to environmental degradation and corollary threats.

But Europe's transition to clean energy will mean a much higher reliance on electricity, posing its own economic challenges. It is estimated that electricity demand will double by 2050, driven mostly by the electrification of transport and heating. And as more of our electricity comes from renewable

sources, such as wind and solar, the grid will be subject to much greater variability in supply.

A successful transition must flatten the rising energy demand curve by minimising energy consumption, while also expanding and making more reliable and efficient use of renewable energy supplies.

To ensure an orderly transition to clean energy, complex competing factors are in the balance. Europe must minimise the burden faced by rural and low-income households from higher energy costs and manage higher costs associated

with transitioning to greener sources and uses of energy. It must address a dearth of green investment in rural or less affluent areas and revamp its grid systems. And it must minimise the impact on the competitiveness of energy intensive sectors and industrial manufacturing by avoiding energy price increases.




THE DIGITAL TRANSFORMATION WILL BE A KEY LEVER IN DELIVERING A SUCCESSFUL GREEN TRANSITION

Digital connectivity offers solutions to tackle both energy demand and supply challenges as new technologies unlock energy and resource efficiencies across sectors including transport/logistics, energy, agriculture, building and manufacturing. It is estimated that these solutions can cut global greenhouse gas emissions by up to 20% by 2030.



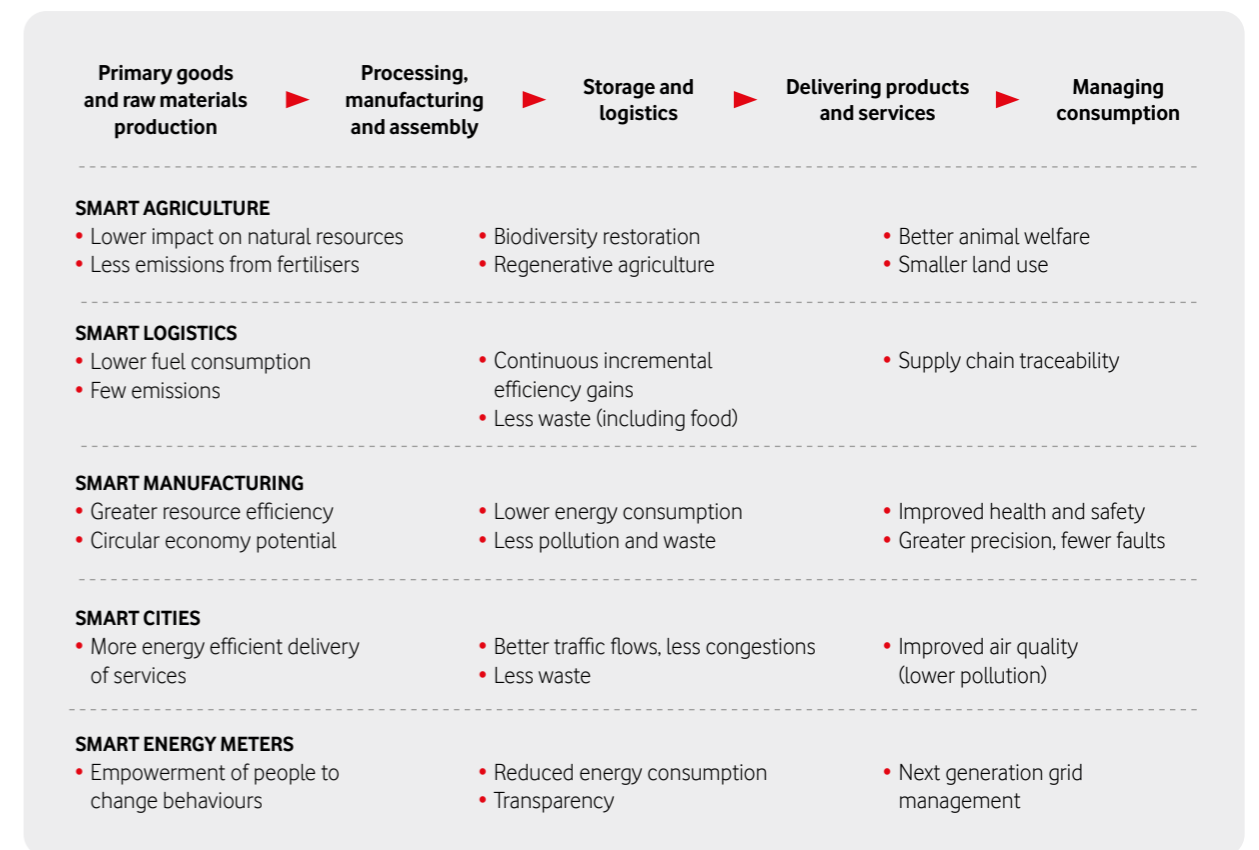
Europe's Green Transition will require not only more effective ways of curbing increasing electrical energy consumption but also a smart electricity grid that can match fluctuating demand and supply in real time. The Digital Transformation will play a key role in building this energy system of the future while accelerating the decarbonising of our economy (see Figure 14).

Digital connectivity solutions largely fall into three categories, each critical to the Green Transition's success:

-  Lowering consumption of energy by reducing demand
-  Making the supply of energy more reliable with better grid management
-  Reducing strain on the supply by shifting the consumption to most efficient time periods.

Connectivity can help businesses and consumers reduce their energy consumption and their costs through smart connectivity applications, including smart meters that let households and businesses monitor energy consumption.

Figure 14 Connectivity and IoT as critical enablers to deliver green impact across value chains (non-exhaustive)



ENERGY



CASE STUDY

VODAFONE'S IOT PLATFORMS

Vodafone's IoT platforms alone connect over 20 million smart meters worldwide, helping consumers cut energy usage by nearly 10% (16.8% for commercial buildings) and saving some 1.6 million tonnes of CO2 each year. This is equivalent of the annual carbon footprint of 180,000 EU households.¹

ENERGY USAGE'S:

HOMES

-10%

COMMERCIAL BUILDING

-16.8%



CASE STUDY

SCHNEIDER ELECTRIC

Schneider Electric, a multinational company specialising in automation across more than 100 countries, connected all their energy sources via 5G IoT devices. With network systems that focused on the prediction and consequent optimisation of energy consumption they were able to reduce their CO emissions by 78 percent.

CO2 EMISSIONS:

-78%

USAGE

Sometimes described as 'smart city platforms', connected IoT technologies generate insights from energy and mobility data to revolutionise aspects of urban life, making it more efficient:

- **Intelligent Transportation Systems** use data analytics to optimise traffic flow, reducing fuel consumption and emissions. Traffic lights and public transit can be synchronised based on real-time data, thereby easing congestion and improving the efficiency of transportation networks.
- **'Smart building' technologies** like automated heating, ventilation, and air conditioning systems coupled with predictive maintenance can reduce energy consumption by roughly 20%.
- **Smart sensors and systems** in water management that detect leaks and inefficiencies in real-time can optimise water use while making water treatment and distribution more energy efficient.

One study has shown that implementing these smart city technologies could realise energy cost savings of around €876m per year across eighty major EU cities, as well as energy reductions equivalent to the entire annual energy usage of Estonia and Latvia.³⁵

ENERGY REDUCTIONS DELIVERED BY SMART BUILDINGS

20% 

ENERGY COST SAVINGS GIVEN BY THE IMPLEMENTATION OF SMART CITIES

€876m

And just as smart cities can better manage the consumption of energy, smart grids and other digital solutions can **make the supply of energy more reliable**.

These systems use advanced sensors, meters, and other digital technologies to monitor the energy flow in real-time, allowing for immediate detection and response to any changes or disruptions in the grid. Predictive maintenance tools that analyse data to predict and prevent equipment failures before they occur can also help reduce downtime and maintain a more reliable energy supply.

Digital platforms also have a vital role in efficiently matching energy supply with demand. In South Africa, Vodacom and partners including the national utility provider are deploying a new 'virtual wheeling' technology. This platform gives independent power producers a way to directly align their renewable supply with

demand from corporate end-users in real-time, with electricity transmitted via the national grid. The system will help generators tap into growing demand from corporate buyers and ultimately drive the growth of the renewables sector in Africa.

And lastly, digital solutions **make it possible to consume energy at the most efficient times** through load balancing and storage solutions that are key to managing the intermittency of renewable sources.

For example, Digital Asset Broker technology can take alternative sources of power, such as electric vehicle batteries, and feed renewable power into the grid. Not only can this improve demand usage by working out the best and most efficient times to charge, but it can also contribute to improving the supply of renewable energy by transforming the EV battery into a source for powering the grid at peak times.

“Digital technologies have the potential to revolutionise the way we move, making our mobility smarter, more efficient, and also greener.”

EU Commissioner for Transport, Adina Vălean

ENABLING RURAL AND AGRICULTURAL TRANSFORMATION

THE CHALLENGE

Europe's rural areas are home to more than 20% of the continent's population, but account for only 14% of its GDP. Generations of urbanisation have left rural areas underrepresented in terms of services and opportunities, with corresponding socio-economic outcomes. Bridging the increasing rural-urban divide can increase Europe's productivity by tapping into underused talent pools as well as improving access to rural markets and resources.



The industrial revolution pulled people into urban areas with the promise of factory jobs. More recently, deindustrialisation in Europe has shifted populations from small to medium sized urban areas, supported by one or two key industries, into service-led industries in larger conurbations.

Rural areas often lack pull factors, whether these be economic or cultural. Cities offer better job prospects and higher wages, have more educational institutions and training opportunities, and are often perceived as more modern and desirable – especially among younger generations.

However, a stronger and vibrant rural Europe is also an enabler of competitiveness. It not only has the potential to increase the continent's productivity and output, but a rejuvenation of the countryside would also ensure that the benefits of European growth are spread more equitably throughout its population.

Agriculture and tourism are the most significant sectors that contribute to rural GDP, but they are facing increasing challenges. Agriculture alone accounts for nearly a third of the rural European economy and provides 18 million jobs³⁶, many of them in rural areas. But agriculture remains threatened by lower profitability and greater financial

Europe needs to strengthen its existing rural sectors, in addition to promote rural economic diversification. This will improve the lives and outcomes of rural populations, relieve pressures in cities associated with increasing urbanisation.

challenges, accelerating urbanisation as younger generations abandon rural life and employment in the sector.

Rural tourism in Europe is also under pressure and has yet to restore its pre-COVID revenue and visitor numbers, further compounding the challenges of life and employment outside urban environments.

Europe needs to strengthen its existing rural sectors, in addition to promote rural economic diversification. This will improve the lives and outcomes of rural populations, relieve pressures in cities associated with increasing urbanisation, and will also boost Europe's overall economic performance, making the continent more competitive and resilient.

CONNECTIVITY CAN ENABLE A REVITALISATION OF RURAL LIFE BY OFFERING ACCESS TO SERVICES, JOBS, AND URBAN COMMUNITIES WITHOUT GEOGRAPHICAL PROXIMITY.

With respect to income and employment, connectivity allows for remote working that keeps talent in rural communities, as well as supporting rural SMEs and entrepreneurs, not least farmers, by expanding income and employment opportunities, while facilitating decarbonisation.

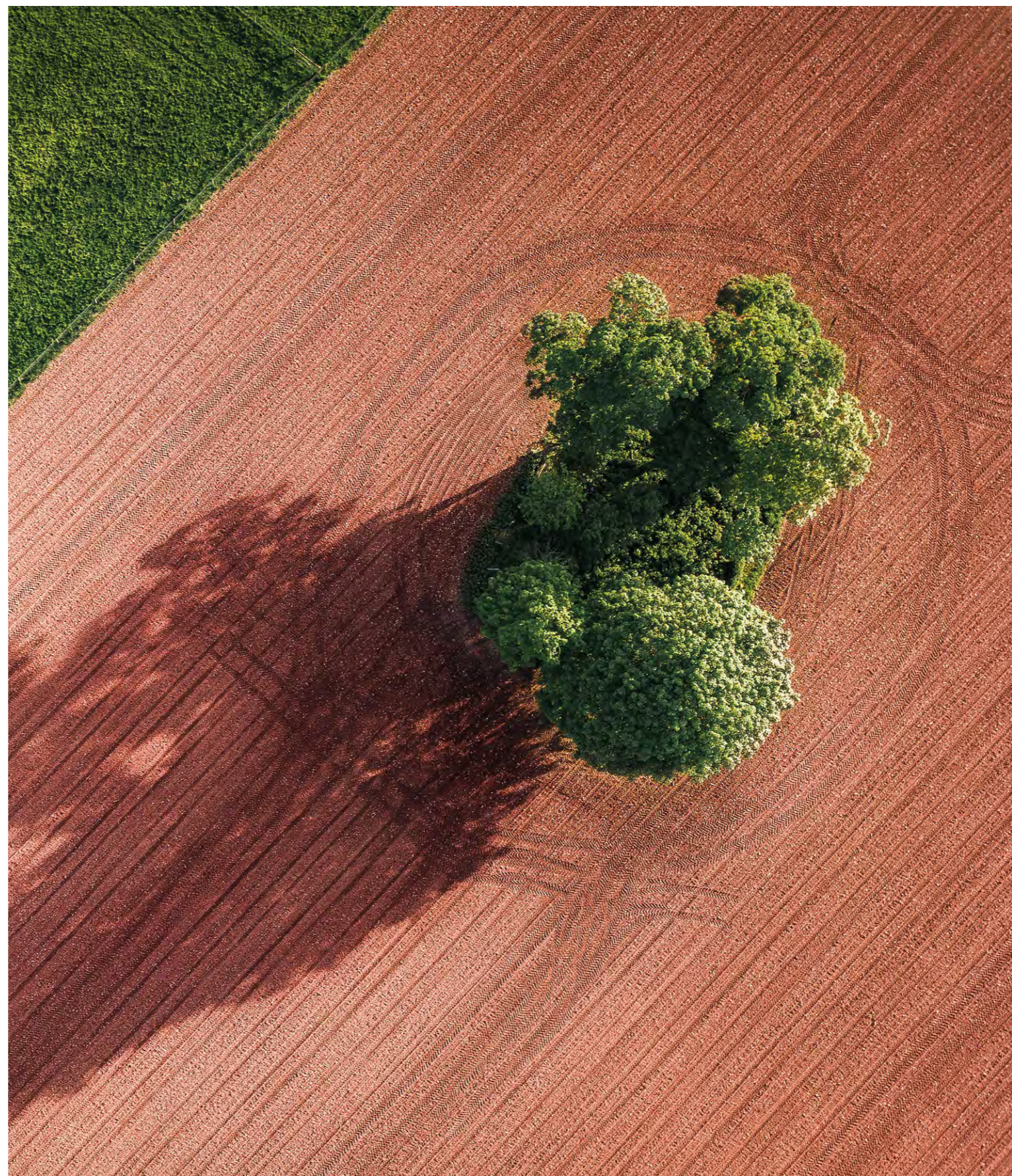
As the cornerstone of support for remote working, digital connectivity provides **wider and more diverse talent pools** with greater job market access, regardless of their physical location.³⁷ This can be especially important for rural women, for whom digitalisation can expand full time or flexible employment opportunities to complement their unique living and family situations. Opportunities that previously existed only for urbanites can now be enjoyed by broader population groups, while improved connectivity further **supports social inclusion** by providing improved and more egalitarian access to education and health services.³⁸

But many rural areas currently lack the modern connectivity (so-called Very High-Capacity Networks, VHCNs) needed for this digital transformation. While the coverage of such networks rose from 4% in 2013 to 28% in 2020, it is still less than half the EU average (59%).³⁹

Better connectivity **improves rural economic performance.**

A European Commission study that found that 80 new jobs are created for every 1,000 new broadband users in rural areas. Similarly, connecting just 20% of EU farmers to climate-smart agriculture applications could result in annual sectoral profit increases of nearly €10 billion.⁴⁰

Digital rural transition will also **enable a low carbon economy** by decoupling economic growth from resource usage, not least in the agriculture sector, which accounts for over 14% of Europe's carbon dioxide emissions. Investment in agricultural digital technologies can help both the green transition and provide a step change for rural employment, social and economic outcomes. For instance, smart livestock identification and monitoring solutions can help farmers manage resources to maximise production and efficiency.⁴¹ One study found that if 20% of European farmers adopt climate-smart agriculture applications by 2030, it could increase their collective operating profit **by between €1.9bn and €9.3bn annually.**⁴²



Opportunities that previously existed only for urbanites can now be enjoyed by broader population groups, while improved connectivity further supports social inclusion by providing improved and more egalitarian access to education and health services.³⁸

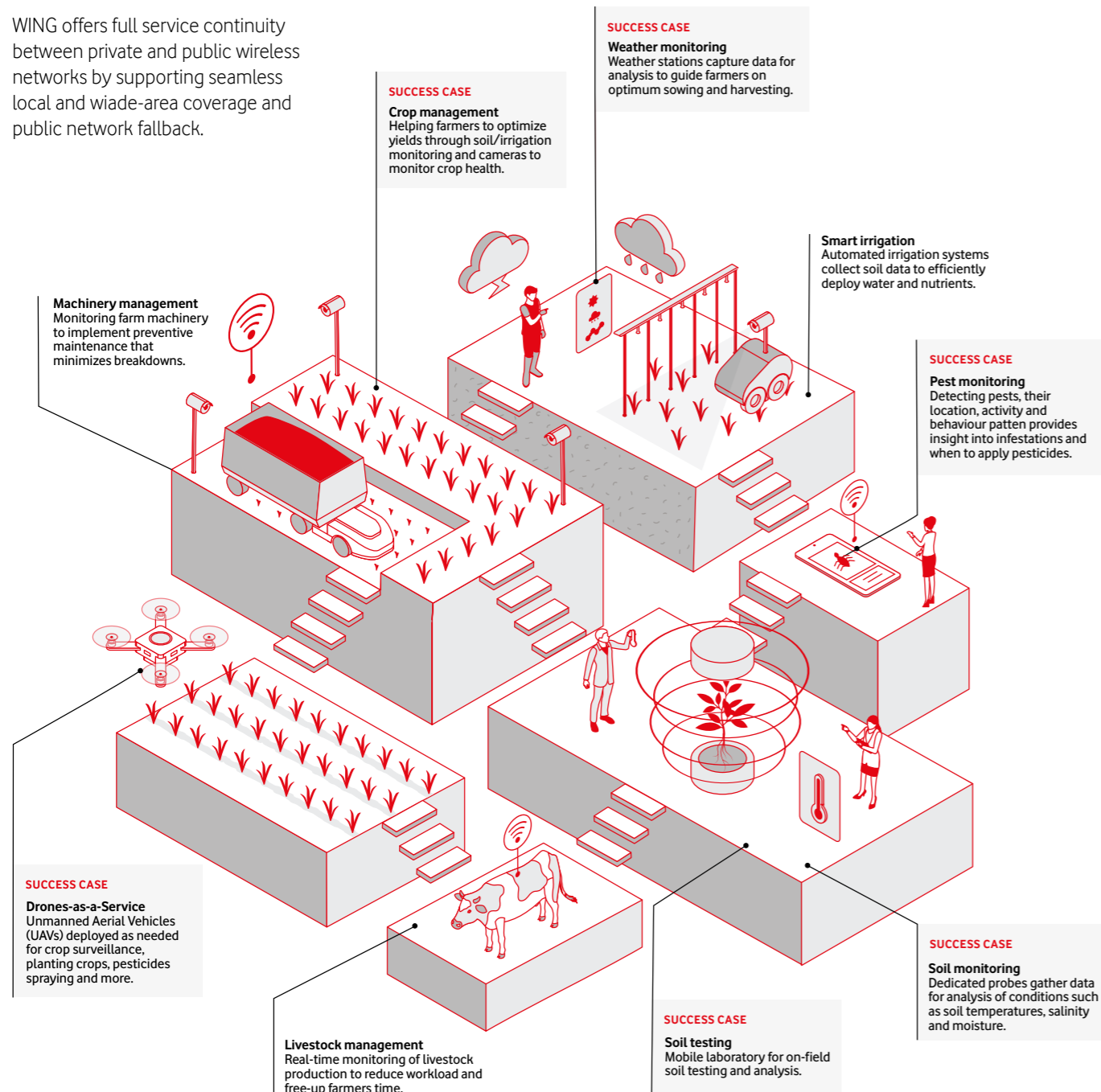
THE LUDGATE DIGITAL HUB

A joint venture in Ireland between Vodafone and ESB led to the rollout of FTTP in the town of Skibbereen, enabling the creation of the Ludgate hub which has attracted several businesses to the area, created 319 jobs and contributed €4m to the local economy. Further, a study estimated that similar digital hubs in every Irish county could generate over 1,000 new businesses and contribute €300m to the economy.

Source: The Ludgate Hub

Figure 15
WING for Agriculture:
discover the use cases

WING offers full service continuity between private and public wireless networks by supporting seamless local and wide-area coverage and public network fallback.



Also, as per the same study, precision farming depends on technologies such as digital connectivity (public satellite, public or private LTE, 5G networks), combined with IoT-like sensors, drones, machine learning, AI and analytics. Bell Labs Consulting estimates that if 25% of all farms adopted precision farming by 2030, “it would lead to yield increases of up to 300 million tonnes per year, a reduction in farming costs of up to US\$100 billion per year and a reduction of wastewater by up to 150 billion cubic meters per year.”⁴³

When the health of crops and livestock depends on autonomous machinery and mission-critical services, these types of mission-critical IoT-based solutions require high levels of network reliability and responsiveness.

HOW 5G AND IOT SUPPORT SUSTAINABLE FOOD

Farmers around the world experiment with digital solutions to cut waste and grow more sustainably. These systems monitor everything from the weather to soil quality and crop health, while technologies like the Internet of Things (IoT) and 5G give farmers the data they need to decide when to water crops, use pesticides, and much more.

Vodafone teamed up with Bayer in Germany to launch the first 5G network in a greenhouse where insecticide researchers are studying plant health and testing climatic conditions. The greenhouse data is collected using 5G and processed using AI, with findings then used for research activities and predictive models.

Although most of today’s IoT networks cannot support advanced precision farming – let alone those that rely on imagery transfer between devices or subsequent analysis – 5G networks can. This modern mobile network solves

bandwidth and connection-density challenges, potentially delivering billions of euros of additional revenues for Europe’s farmers.

Lastly, digital connectivity has enormous potential to rejuvenate and sustain vibrant rural communities, **uplifting and improving the quality of essential infrastructure and services** including health, education and transport. This, in turn, **drives better social inclusion**, creating a society that does not leave anyone behind by ensuring rural communities can participate fully and equally in economic, social and cultural life.

OPPORTUNITIES IN RURAL AREAS

Trial shows 5G could enable “per plant” farming, potentially increasing yields by 200%.

A public-private collaboration, the 5G RuralDorset project has tested how various 5G networks can increase the productivity of agriculture and aquaculture in the rural county of Dorset in southern England. The project also trialled the use of 5G to bring broadband to rural communities and to provide better facilities and increase safety for tourists and residents. The partners in the project tested various standalone 5G networks and non-standalone 5G networks in different parts of Dorset. The project explored multiple use cases and found that 5G networks could bring immense value to rural food producers and communities.

Source: 5G factory | GSMA 5G Business Accelerator Hub

PROMOTING DIGITAL SKILLS FOR BETTER EMPLOYMENT OPPORTUNITIES

THE CHALLENGE

Europe cannot fully benefit from the new technologies necessary to improve its competitiveness without a workforce equipped with the right digital skills. A growing digital skills gap will also exacerbate other overlapping challenges, including worsening inequality, regional/rural disparities, education poverty, and a digital divide that disproportionately affects the elderly, women and the poor.

As industries and society increasingly rely on digital technologies, there is a growing requirement for workers with specialised digital skills and for citizens at large to be digitally literate. However, many job seekers and individuals lack these capabilities, particularly those from older generations and rural backgrounds. While the Commission estimates that 9 out of 10 jobs will require digital skills by 2030⁴⁵, barely half of Europe's workforce possesses the necessary digital capabilities.

Europe's public sector alone is currently facing a growing digital skills gap of nearly five million people.⁴⁶ More widely, only 54% of working age Europeans have sufficient digital skills for current workforce requirements, and 70% of European businesses already identify a lack of digital proficiency among their staff as an obstacle to investment.⁴⁷

The EU has only reached 47% out of the 20 million employed ICT specialists it is targeting. European industry is held back as a result,

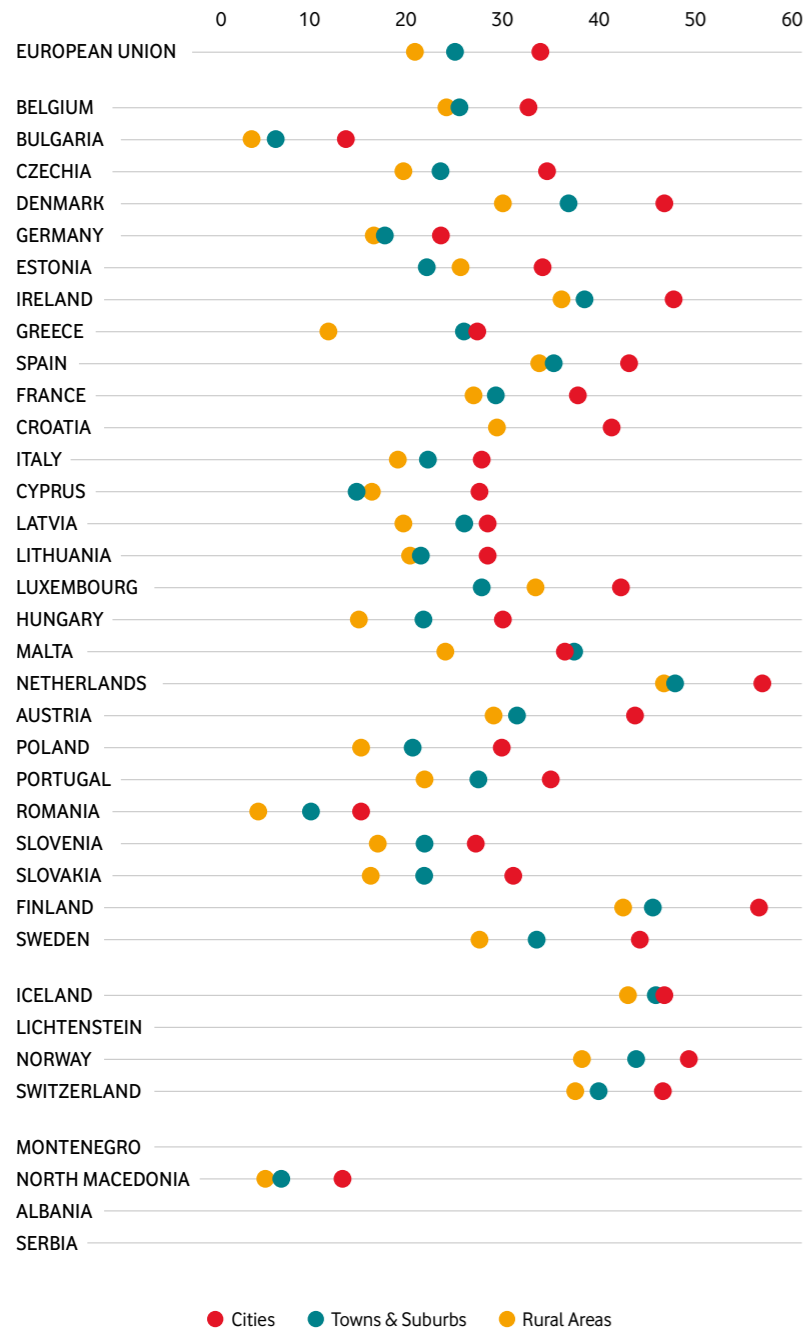
particularly as the take up of AI, big data and the cloud by big businesses is as low as 11%, 19% and 45%, respectively.

This digital divide leads to lower productivity and hinders innovation. Reduced output also hinders wider economic growth, particularly along regional/rural-urban fault lines. As illustrated in Figure 16, for the 25% of the EU population who live in rural areas, there is already a "rural connectivity deficit" where residents in rural areas have both lower digital skills and slower internet access.⁴⁸



Only 54% of working age Europeans have sufficient digital skills for current workforce requirements and 70% of European businesses identify a lack of digital proficiency among their staff as an obstacle to investment.

Figure 16 Individuals with above basic overall digital skills, 2021



Today, as never before, we need educated specialists equipped with the right digital skills to power the innovative companies emerging in our country. Without them, it will be practically impossible to develop the economy. That's why we must emphasise the importance and role of digital competencies at every turn.

Michał Kanownik,
President of Digital Poland



Future jobs and businesses need a workforce equipped with the right digital skills to take advantage of new technologies and close the productivity gap – particularly if Europe is to keep up in areas such as AI and cybersecurity.

CONNECTIVITY AND DIGITALISATION ARE KEY TO MITIGATING THESE CHALLENGES

In her 2022 State of Union address, European Commission President Ursula von der Leyen declared 2023 the European Year of Skills. Promoting digital education and skills upgrade, especially in rural and marginalised communities as well as SMEs, is vital to the success of the European Commission’s ambitious digital targets and the prosperity of individual European citizens. Investing into digital skills is essential to deliver the productivity and innovation needed to regain Europe’s competitiveness, as well as more equitable societies.

While there are several programmes that target closing the digital skills gap, Europe needs to scale them. Countries which address this gap will benefit substantially in managing the digital transition by attracting the businesses of the future, enhancing their economies’ competitiveness and overcoming the digital divide.

Future jobs and businesses need a workforce equipped with the right digital skills to take advantage of new technologies and close the productivity gap – particularly if Europe is to keep up in areas such as AI and cybersecurity. **Advanced digital skills raise global GDP by an estimated \$6.3 trillion each year by boosting worker income and productivity. The same study demonstrated that 72% of organisations that employ advanced digital workers introduced a new product in the two years surveyed, compared to 47% of organisations that employ basic digital workers.**⁴⁹

The net economic benefit of significantly reducing the size of the digitally low-skilled adult population in the EU is estimated at as much as €200 billion per year over a decade, roughly 1% of the EU’s GDP. Besides the economic benefits, a more digitally literate society is key for a more secure, greener, healthier Europe.⁵⁰

It starts with how we educate the workers of tomorrow. Educational institutions and national curriculums should be modernised to embrace broad-based digital upskilling. Digital skills must be integrated throughout primary, secondary, and tertiary education, with teachers themselves upskilled and empowered to use digital technologies. Combined with better connectivity, this can also enable higher quality teaching through shared virtual learning, as classes can be live streamed and can improve access to educational content outside of school.

WORKFORCE DIGITAL SKILLS:

ANNUAL INCREASE IN GLOBAL GDP

\$6.3tn

ANNUAL INCREASE IN EU GDP

€200bn

Continuous upskilling for businesses is essential to bring back the competitiveness of the European economy, especially for SMEs.

In the classroom, enhanced connectivity can allow access to innovative educational tools such as remote field trips and specialist teaching resources which can improve the quality of education and enhance pupil engagement. A recent survey of European citizens found that digital education tools are already used by 36% of respondents, and a further 28% would like to use these in the future⁵¹

As always, targeted interventions in support of rural and other marginalised communities are essential. Better quality and longer education can also lead to increased levels of productivity and incomes, greatly reducing the chances of being in poverty.⁵² Connectivity for rural areas, combined with reskilling of rural businesses, also provide the foundations for the development of the rural economy in areas like

agriculture and tourism, and create opportunities for young and skilled people to stay in their home towns. Providing farmers with the skills they need helps the transition to smart farming, reducing climate change and increasing efficiency.

More broadly, continuous upskilling for businesses is essential to bring back the competitiveness of the European economy, especially for SMEs. As explored earlier in this section, digital technologies are essential for bolstering the strength of SMEs as they allow these businesses to innovate, streamline their processes and access wider markets. But even with the most user-friendly ‘plug and play’ models, the benefits of digital technologies for SMEs can only be realised by SME personnel who have the skills to identify the most appropriate technologies and then deploy them.

PICCOLE SCUOLE (SMALL SCHOOLS)

Piccole Scuole is a project in Italy that seeks to promote distance learning in geographically isolated small schools through shared teaching and expanded learning environments. Through shared teaching, two or more classes belonging to different schools are connected to each other through the daily use of videoconferencing. This fosters an exchange of experiences and ensures the teaching of all subjects for children in multi-age classrooms. An expanded learning environment can complement traditional teaching. One or more classes can work on a common project and organise periodic meetings between teachers, students and/or experts who can use videoconferencing as well as other digital tools according to the type of project.



V-HUB

CASE STUDY

VODAFONE'S V-HUB PLATFORMS

Vodafone's V-Hub platform is already supporting European SMEs with digital training courses to help their employees build their digital skills. Users have access to a variety of practical tutorials and courses, in addition to personalised one-to-one business support. This includes free guidance from V-Hub business experts, available online or over the phone, which can cover a range of digital topics such as setting up a business, finding new customers online, and protecting against cyber-threats. V-Hub has been used by over 5.2 million unique visitors across 14 markets. Since its launch, the service has achieved a strong return rate of 25% on average, increasing to almost 30% in Q3 and 35% in Q4 of FY23. We have set an ambition to reach 7 million visitors and help them digitalise their businesses through V-Hub by 2025. These types of collaborations are identified by EIT Digital, among others, as a key enabler for the European digital skills needed for improved competitiveness.



VODAFONE V-HUB PLATFORM:

NUMBER OF SUPPORTED SMEs

5m+ 

VODAFONE SKILLSUPLOAD:

NUMBER OF STUDENTS SUPPORTED

7.8m 

NUMBER OF SCHOOLS

4,000 

CASE STUDY

VODAFONE'S SKILLSUPLOAD INITIATIVE

In partnership with communities, educators, NGOs and governments, Vodafone Foundation runs a pan European initiative in 14 European countries called SkillsUpload to empower educators and students in the confident, creative and critical use of digital technologies. SkillsUpload Jr aims to transform the education sector by enhancing soft skills such as critical thinking as well as developing digital literacy. The programme aims to bridge the digital divide by focusing on

educating neglected groups such as girls and rural communities as well as targeting areas that the modern education system doesn't always cover, such as AI. Vodafone Foundation also provides HiDigital, a programme designed to increase digital competencies for people over 65, through face-to-face workshops, digital support and an online learning platform. To date, these programmes have benefited 7.8 million students and teachers in over 4,000 schools.

SKILLS UPLOAD



EUROPE IS BEHIND
AND MUST CLOSE
THE GAP

Though Europe faces a crisis resulting from its declining competitiveness, digital connectivity presents the continent with a €1 trillion opportunity to course-correct.

THE FUTURE OF CONNECTIVITY

THE NEXT FRONTIER IS A HUGE STEP-CHANGE FROM EVEN THE IMPRESSIVE DIGITAL WORLD OF TODAY

Digital connectivity presents Europe with an opportunity to change course and reverse its declining competitiveness - and stem the social and economic harms that flow from that decline. But Europe is far from the only economy on the

culsp of a fundamental change in the way society and economies rely on digitalisation, nor is it leading the way. This emphasises the need to take action, benefit from the next frontier of digital connectivity and assert Europe's open strategic autonomy by avoiding new dependencies on others.

»»

Telco infrastructures are at the core of the digital world and Europe cannot afford to lag in this front. Telcos are facing ever-increasing data traffic, x27 in the last decade and showing no relenting signs. On top of this, the new requirements in terms of speed, latency and personalisation, are some of the attributes of the new connectivity. Heavy investment is required to build the fiber and 5G infrastructures that will support the goals of the Digital Compass 2030. It is time to act.

José María Álvarez-Pallete López, CEO of Telefonica

»»

The opportunity

is now

There is now everything to play for:

our €1 trillion opportunity largely relies on the potential presented by the industrial internet, which refers to the integration of complex physical machinery with networked sensors and software.

EU AT THE CUSP OF THE NEXT NETWORK FRONTIER

During the last thirty years, successive generations of better, faster, and more reliable connectivity has driven waves of digital transformation. From dial-up internet on copper phone lines to fibre fixed services at home and at work, and through each iteration of 2G, 3G and 4G mobile services, communications and ICT innovation has changed society and transformed our lives.

5G mobile services are no different, delivering greater reliability, capacity, quality of service and security, with faster speeds, lower latency, and improved energy efficiency. But 5G remains largely a 'people to people' technology, allowing users to better browse and search, shop or collaborate, enjoy content, or connect with others through mobile devices and apps. Although the increased bandwidth of 5G has enabled telecoms operators to manage double-digital annual data traffic growth, it offers relatively few novel benefits for consumers that could not be delivered already by 4G.

But this is about to change. The next wave of digital transformation will see 5G evolve to become a communications network not only for people, but for devices and machines. Next generation 5G mobile networks are set to deliver profound improvements in industrial efficiency and create tangible new opportunities for businesses and manufacturing, catalysing the economy at large.

This step-change will be driven by new 5G technologies, including 5G Standalone (5GSA) and network slicing, among others. Just as 4G unleashed the consumer internet economy, 5GSA is on the cusp of unlocking the full power of the industrial internet.

5G Standalone is a true step change. Until recently, 5G networks and services were created by adding 5G radio antennas to an existing internet 'backbone' – the core – that was built for 4G services. This approach delivered the speed and capacity benefits of 5G for consumers, but without requiring a revamp of the core network.

5GSA requires a new, upgraded 5G core network architecture designed specifically to unleash the full power of 5G applications, delivering significantly better data speeds, ultralow latency, and much greater reliability. It also allows for greater 5G network coverage both outdoors and indoors and is capable of connecting vastly more devices simultaneously.

The introduction of 5GSA will also enable mobile network slicing, a new way of delivering customised connectivity that creates dedicated virtual, isolated 'traffic lanes' for customers. These networks are separate from each other, unaffected by general conditions on the internet, and can be optimised for specific use cases.

Modern, smart, connected devices and things – including the Internet of Things (IoT) – are already able to gather and process data and communicate with each other. Next-generation communications technologies like 5GSA and network slicing will become their underlying nervous system, connecting millions of machines and applications to cloud computing, AI and machine learning in real time. Together, they unlock business transformation.

The number of IoT devices worldwide is forecast to almost double from 15.1 billion in 2020 to more than 29 billion in 2030 – vastly exceeding the number of actively used mobile phones. 5GSA not only provides the latency and quality needed for this growth but is required for IoT to scale up.

5GSA can support **1 million devices** per square kilometre, compared to only 2,000 with 4G LTE. This ever-growing numbers of connected devices will, in turn, generate exponentially greater quantities of data within and across various sectors of the economy, from which cloud-based AI insights can be derived.

5GSA will be fundamental to the transformation of entire businesses or sectors, enabling them to create their own dedicated solutions and

applications, analyse data in the cloud and transmitting it securely, end-to-end, through virtual networks. This will pave the way for applications including robotics, augmented and virtual reality, connected vehicles, drones and smart factories. It will improve production processes for industry, public services, and society at large.

Although a small number of large enterprises remain likely to build their own mobile private networks

This ever-growing numbers of connected devices will, in turn, generate exponentially greater quantities of data within and across various sectors of the economy, from which cloud-based AI insights can be derived.



(MPNs) and in-factory solutions, public 5GSA will democratise access to innovation and quality for those small and medium size businesses that are the foundations of European jobs, skills and growth. SMEs are often unable to rely on expensive and bespoke technology, but they stand to benefit the most from automated and virtual access to network slicing, data analytics and advanced APIs, customised to their needs and without requiring dedicated infrastructure.

AI will become a prime application for 5G and a major new source of productivity. For many AI applications to work in real time, networks must be able to handle large quantities of data from billions of sensors. 5GSA

is crucial for ensuring this data flows efficiently to the cloud to enable actionable AI insights.

5GSA and network slicing represent the beginning of a truly hyperconnected economy, where all people, places and most things are part of a ubiquitous 5GSA-powered network bringing together cloud, AI and IoT along with fibre, satellite, sensors, and indoor Wi-Fi. These next-generation connectivity technologies, and the digitalisation they underpin, will transform how businesses and the economy function, how public services perform, and how successfully the European way of life can be maintained and improved.

CASE STUDY

CHINA'S 5GSA LEAD

China is ahead of Europe on 5GSA and its 5G connectivity is already boosting productivity. For example, Unicom Guangdong is combining 5G with multi-access edge computing (MEC) to deliver low-latency and high-bandwidth connectivity for manufacturing applications difficult to support with traditional closed and siloed network architectures. This is supporting over 1,000 SMEs in the city of Foshan. As a result, Foshan's SMEs typically increased labour productivity by 40-60%, improved inventory usage by 20-40% and overall equipment effectiveness by 15-25%, while lowering direct manufacturing costs by 25-35%.

EUROPE IS RUNNING THE RISK OF FALLING FURTHER BEHIND

Europe must be at the forefront of the next wave of 5GSA connectivity technology. The digitalisation race cannot be won without these networks.

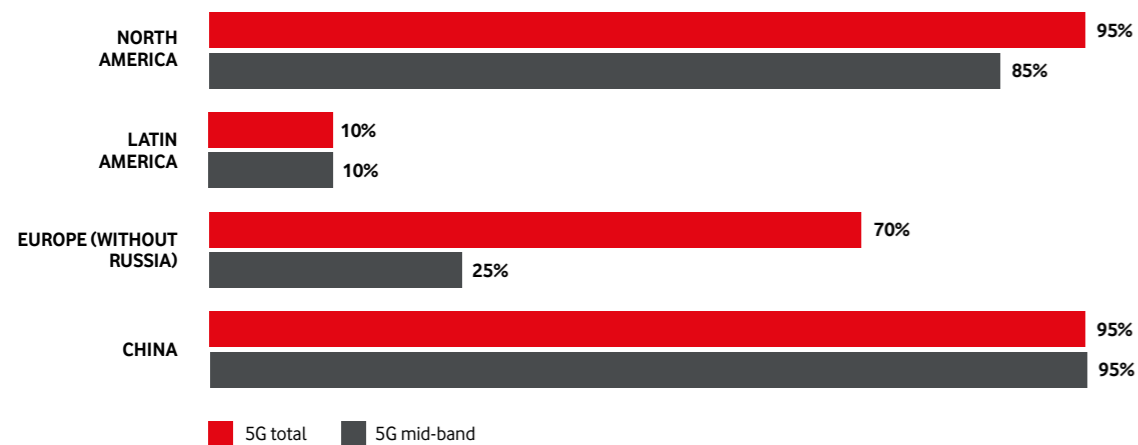
But Europe is already lagging in these technologies. The EU Commission's Digital Decade September 2023 progress report flags that "while 5G population coverage stands at 81%, the

deployment of 5G stand-alone networks is lagging behind. 5G is still falling short in quality with regards to end-users' expectations and industry needs, as well as in addressing the divide between rural and urban areas."⁴⁵

Ericsson's more recent report shows the stark gap between Europe's 5GSA and Advanced 5G coverage and that of the US, China and other global competitors (see Figure 17).

5G is still falling short in quality with regards to end-users' expectations and industry needs, as well as in addressing the divide between rural and urban areas.

Figure 17 World Population and Mid-Band Coverage Split by Region (end of 2023)



FALLING SHORT

Given Europe's poor performance on the most advanced 5G technologies, it comes as no surprise that the continent also lags on other technologies that rely on cutting-edge connectivity.

73% of large AI models are being developed in the US and another 15% in China, while no EU country has yet to host its own general purpose AI system.⁴⁶ The US has close to 14,000 organisations active in AI, spanning companies, universities and research institutes, while China has 10,000 and the EU is just shy of 6,000.⁴⁷ Only 41% of EU enterprises use cloud computing, compared to 52% of American rivals.

These technologies represent the future of competitiveness and growth, but by failing to adopt and use them, Europe is losing ground every day. Europe was once the world leader in adopting 3G technology, and barely a decade ago was in a prime position to take advantage of digital transformation. But it has been outpaced on 4G, and on 5G is now dwarfed by China and the US on both coverage and uptake.

5G IN EU

POPULATION COVERAGE



ENTERPRISES USING CLOUD COMPUTING



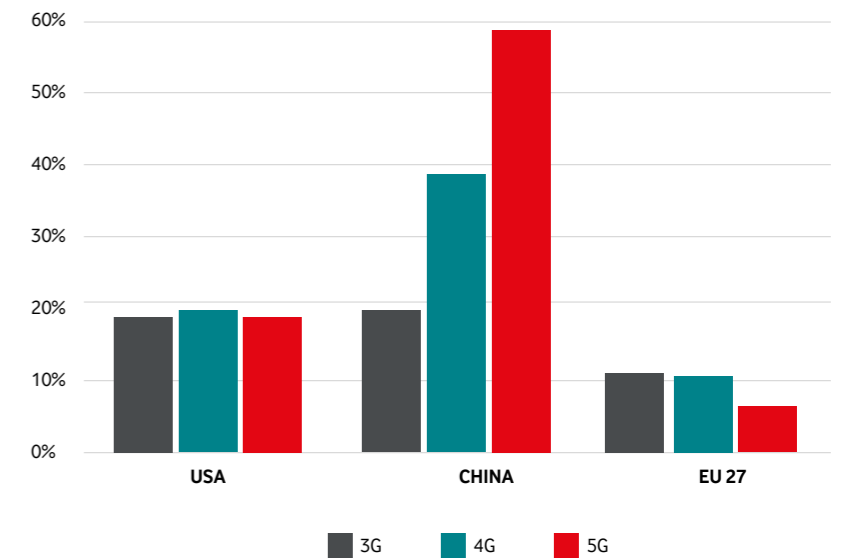
On the AI front, 73% of large models are being developed in the US with another 15% in China, while no EU country has yet to host its own general purpose AI system.

This is hampering the future of European industrial productivity, which mostly relies on 5G-enabled IoT solutions to power the fourth industrial revolution. It is estimated that IoT alone could deliver \$5.5 trillion to \$12.6 trillion in value globally by 2030, with factories accounting for the highest proportion of potential economic value. China has already become a dominant IoT force, expected to

take 26% of worldwide IoT value within seven years.⁴⁹ By contrast, the developed world's share of that value will decrease from 61% to 55% by the end of this decade. China's share of IoT economic value in the manufacturing sector is also forecast to be higher than either developed or emerging markets over the same period.⁵⁰



Figure 18 Share of First 1bn Customers by Technology



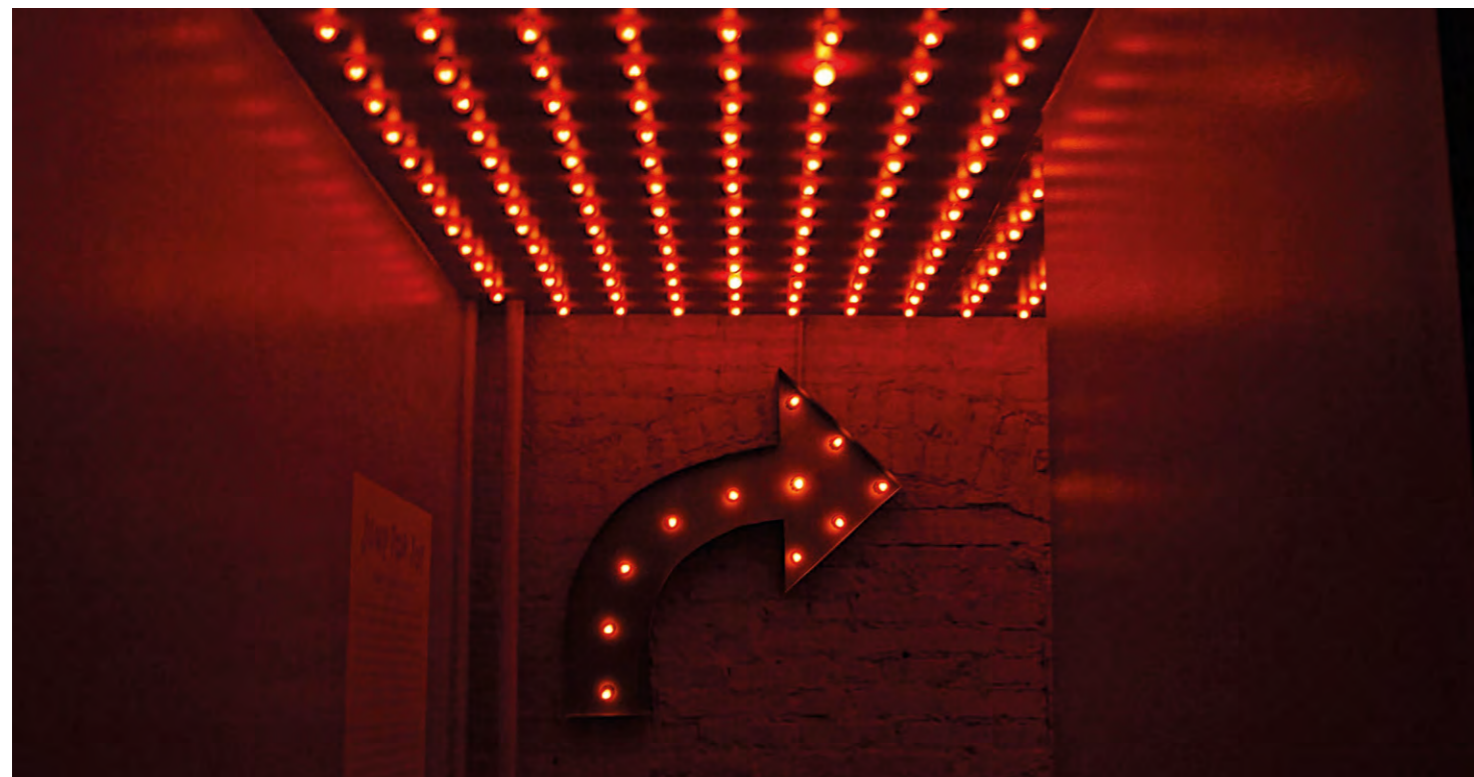
EUROPE'S FUTURE AT STAKE

With its world-class manufacturing, the EU should be well placed to regain its leadership in the era of industrial internet. Despite having largely lost out on becoming a key player in the consumer internet and the overall size of its market, Europe has a strong legacy of skills across all aspects of industrial digitalisation, including hardware, software, data science and connectivity.

This means that there is now everything to play for. Europe's €1 trillion opportunity largely relies on the potential of the industrial internet, integrating machines with networked sensors, software, AI and the Cloud, powered by 5GSA. The industrial internet truly represents the future of connectivity and digitalisation, and the speed of adoption will determine the future health and prosperity of economies and societies.

If in a rapidly-digitalising world, Europe cannot close the gap on high-quality 5G adoption and deployment, or components of digital transformation, then Europe's competitiveness and the sustainability of the European way of life will decline further.

The future of Europe's societies and its economies are at stake. On a global scale, the winners could secure a competitive advantage in



technologies that will drive growth and prosperity for years to come. The losers risk slipping further behind. This is a leapfrog moment – an opportunity that Europe cannot afford to miss.

Europe's mobile operators are investing and innovating to transform the capabilities of telecoms networks, alongside their existing outlays in capacity and coverage. They remain the primary connectivity investors. They can build at the pan-European scale needed to meet the opportunities offered by the digital transformation.

But for such a critical sector, investment in telecoms currently falls well short of what Europe needs.

Europe's poor investment climate is the main reason. While the recent macroeconomic downturn has strained access to capital, investment naturally follow when there are healthy returns to be made. This is missing in many parts of Europe as a direct consequence of poor market and regulatory conditions.

To drive competitiveness, Europe needs to revamp its connectivity investment climate. We will show in a later paper how this is a long way from happening. Europe has fallen behind in the race to exploit crucial technologies and the digital

ecosystem has evolved in a manner not yet fully understood by EU policymakers. As a result, the EU's digital networks are held back by regulation not fit for its purpose. Our next report will showcase how Europe can lead on digital by creating the right market and regulatory framework to drive investment whilst making the best use of the Single Market to reap maximum benefits.

The five-year mandate of the next European Parliament and Commission will be decisive for creating the regulatory framework and optimising the Single Market to achieve this objective. We need to seize this opportunity to restore Europe's competitiveness.

GLOSSARY

Term	Definition
Application Programming Interface (API)	A software solution that allows access to the data or functions of one application from another application, acting as an interface intermediary.
Bandwidth	A capacity at which a network can transmit data.
Connectivity deficit	The lack or inadequacy of access to modern communication networks and technologies.
Data lake	A system or repository of data stored in its natural/raw format.
Digital intensity	A degree to which different industry sectors have adopted digital technologies.
Fiber To The Premises (FTTP)	A fibre optic cable delivery medium that provides Internet access directly to a user or groups of users from an Internet service provider.
Industrial internet	Integration of industrial processes with advanced computing, data analytics, and the Internet of Things (IoT) to enhance efficiency, productivity, and decision-making in industrial settings.
Information and Communication Technologies (ICT)	Technologies used for the acquisition, storage, processing, transmission, and dissemination of information.
Internet of things (IoT)	A network of interconnected devices, objects, or “things” embedded with sensors, software, and other technologies to collect and exchange data over the internet.
Long Term Evolution (LTE)	A standard for wireless broadband communication that delivers high-speed data transmission for mobile devices.

Term	Definition
Multi-access Edge Computing (MEC)	A type of network architecture that provides cloud computing capabilities and an IT service environment at the edge of the network.
Network orchestration	Actions a network controller performs in setting up devices, applications, and services in the network to achieve objectives.
Network slicing	A telecommunications configuration that allows multiple networks (virtualised and independent) to be created on top of a common physical infrastructure.
Total Factor Productivity (TFP)	A measure of productive efficiency in that it measures how much output can be produced from a certain amount of inputs.
Very High-Capacity Networks (VHCNs)	A network designed to provide extremely high data transmission speeds and capacity, typically associated with advanced technologies like 5G and fibre-optic networks. A term introduced by the European Electronic Communications Code (EU) 2018/1972 (EECC).
Virtual wheeling	Virtual wheeling connects multiple buyers with the sellers through a technology platform that aggregates supply and consumption data to produce a single bill for consumers.
Zero latency	Having no delay between the time a request is initiated and the response is given.
5G	5th generation mobile network, a new global wireless standard after 1G, 2G, 3G, and 4G networks.
5G Standalone (5GSA)	An implementation of 5G that solely uses a 5G core network operating independently, without relying on existing 4G infrastructure.

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