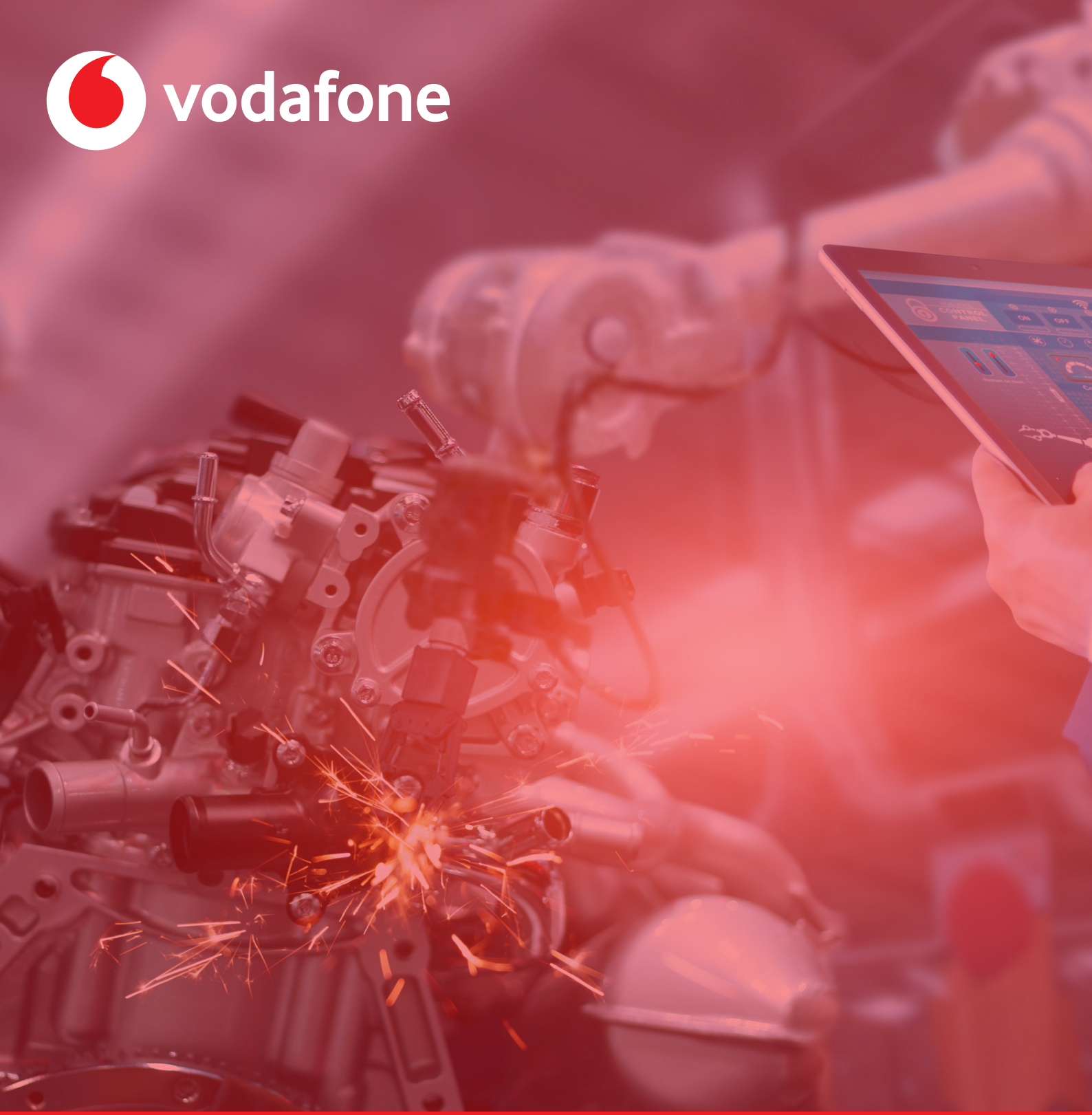


Powering Up Manufacturing, Levelling Up Britain

A WPI Strategy report for Vodafone UK

July 2021

Together we can

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About Vodafone

Vodafone is a technology communications company that connects people, businesses and devices to help our customers benefit from digital innovation. Our services span mobile, fixed line connections, home and office broadband, and the Internet of Things (IoT).

We have a strong track record as a tech pioneer, making the UK's first mobile phone call, sending the first text message, and making the UK's first live holographic call using 5G in 2018. We were also the first to start carrying live 5G traffic from a site in Salford, Greater Manchester. We have 5G in 100 locations in the UK and 240 across Germany, Spain, Italy and Ireland.

Our 4G network coverage currently reaches more than 99% of the UK population. And in October 2020, Vodafone was named Network Provider of the Year by readers of leading technology advice website, Trusted Reviews.

Today, Vodafone serves more than 18 million mobile and fixed-line customers in the UK. To help deliver Gigabit UK, our full-fibre broadband roll-out programme now covers 15 UK towns and cities through partnerships with CityFibre and Openreach.

For more information about Vodafone UK, please visit: **www.vodafone.co.uk**

Executive summary

Manufacturing is vital to the UK economy as a whole, but it is particularly important outside London and the South East of England: it is responsible for over 17% of Wales's total national output, and over 16% of the West Midlands', for example, compared to less than 2% of London's. That means improving manufacturing productivity across the board has a relatively higher impact in some regions and nations of the country than others – and in fact, those regions and nations correspond to those that are the main focus of the Government's "levelling up" agenda.

This report looks at the potential for digital technology, and in particular new applications of 5G delivered via mobile private networks (MPNs) and Internet of Things (IoT) technology, to improve the productivity of UK manufacturing. It describes some of those new applications, which are already being deployed in factories around the world – and includes a case study where Vodafone is working with industrial partners to transform their operations with 5G. And it calculates the boost to UK national and regional productivity if take-up of 5G in the UK manufacturing sector reaches the level by 2030 that evidence from the US suggests is possible.

Our new analysis finds that the increase in manufacturing Gross Value Added (GVA) across the UK would be **£3.6 billion per year in 2025** and **£6.3 billion per year in 2030**, and that while all regions and nations would benefit from this in absolute terms, **the highest relative GVA impact would be felt in Wales, the West Midlands, East Midlands, North West and North East**. The lowest relative impact would be in London and the South East, reflecting the size of their manufacturing sectors compared to other sectors.

Improving manufacturing productivity through effective deployment of 5G and IoT would not just ensure that the UK does not fall behind other countries which are starting to adopt this new technology, but would disproportionately benefit so-called "left behind" regions and make a positive contribution to "levelling up". A growth in UK manufacturing would also support the Government's Global Britain ambitions, with manufacturing already making up a significant proportion of UK exports.

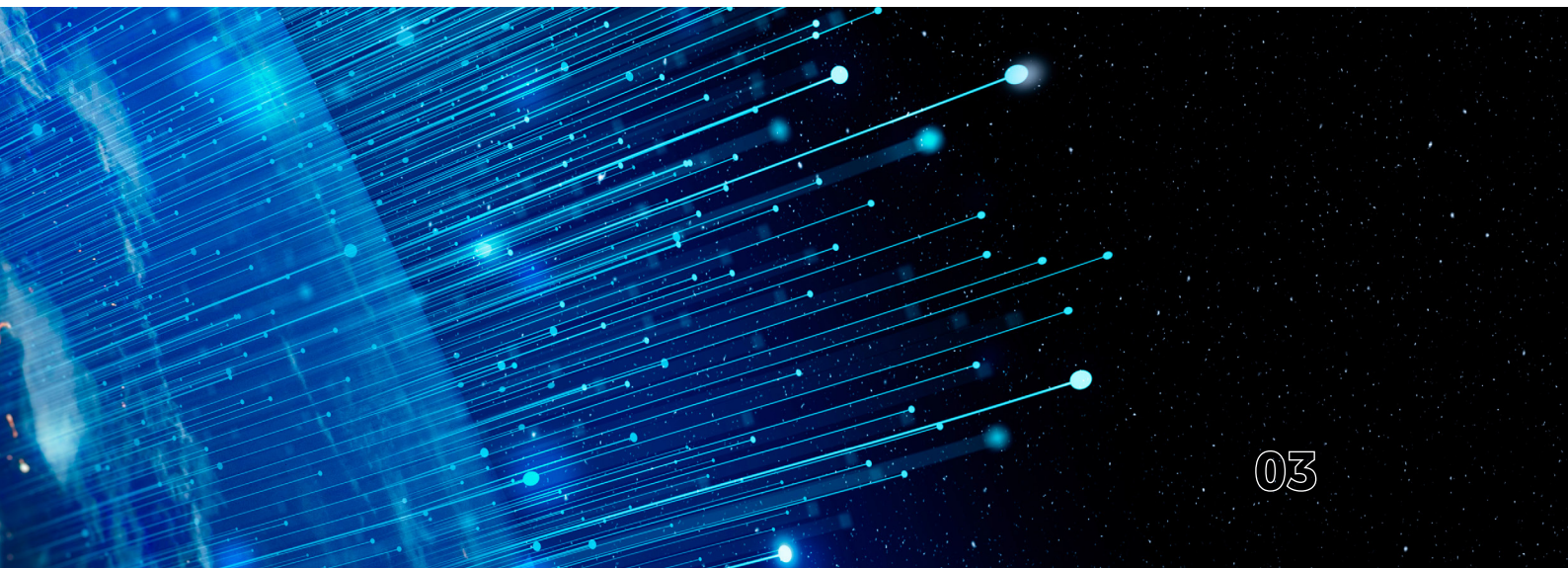
There is a strong case for the Government to adopt measures, in the forthcoming Levelling Up White Paper and elsewhere, which will encourage and support manufacturers to look seriously at how 5G could improve their operations, and to take it up where possible. If we get it right, manufacturing can play its part in ensuring that the whole of the UK can benefit from improvements to the economy.



Previous research commissioned by Vodafone found that 5G could add £150 billion to the UK economy by 2030.[1] But to achieve these wider economic and societal benefits, significant investment is required to roll-out and maintain 5G networks, build more mobile sites and develop new 5G applications and technologies. The uptake of 5G in the manufacturing sector would not only deliver productivity gains, but would also create a virtuous circle by opening up new and much needed revenues for mobile network operators. These new revenue streams can then be reinvested in the roll-out of 5G network infrastructure and development of new applications which will benefit smaller businesses which are less likely to have the economies of scale to invest in MPNs and consumers more generally – a win-win situation.

We recommend:

- **Aiming high**, with an ambitious and measurable government target that over the next decade the UK will become a global leader in the use of 5G technology in manufacturing.
- **Incentivising investment**, with policies to support manufacturers to upgrade their facilities with 5G MPNs and the expansion of the Made Smarter Adoption programme.
- **Supporting innovation**, by putting more focus and resources in the industrialisation of 5G with an extension of the Industrial 5G Testbeds and Trials programme by another five years and an increase in funding for manufacturing trials to at least £60 million; the introduction of regional 5G test and innovation centres, starting in those regions and nations which stand to gain most from take-up of 5G in manufacturing; and the creation of at least one new regional industry cluster focused on innovation in manufacturing, including through the application of 5G and IoT technology.

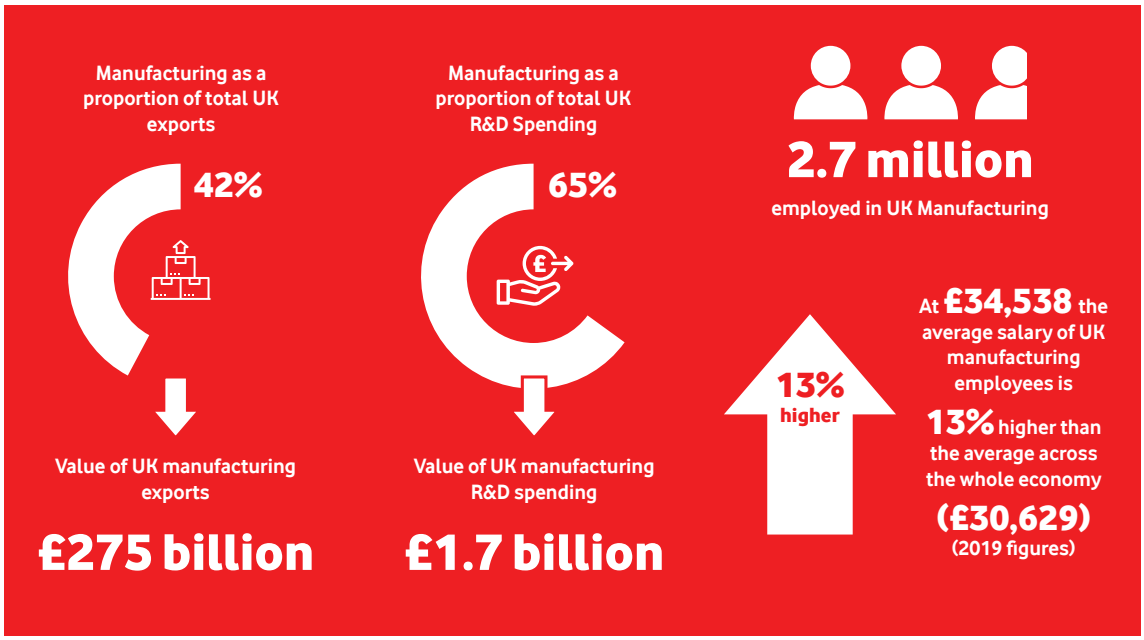


Chapter 1: Why manufacturing matters

Britain was once the world's leading manufacturing economy. The industrial revolution started here, and manufacturing played a big part in driving the country's global prominence from the late 18th to early 20th centuries. But since then, manufacturing in the UK has become less significant, both relative to other sectors of the UK economy – especially services – and relative to other countries' manufacturing sectors.

The story of Britain's industrial rise and fall is a familiar one, but the narrative of decline can be overstated. Manufacturing is still vital to the overall health of the British economy, and it is world-leading in some specialist areas including pharmaceuticals and aerospace. In 2019, it accounted for 9.7% of total economic output, and 8% of jobs.[2] The UK is no longer the world's leading manufacturing economy, but it is still the ninth biggest manufacturer in the world, not far behind Italy and France in seventh and eighth place respectively.[3] In some respects, UK manufacturing punches above its weight.

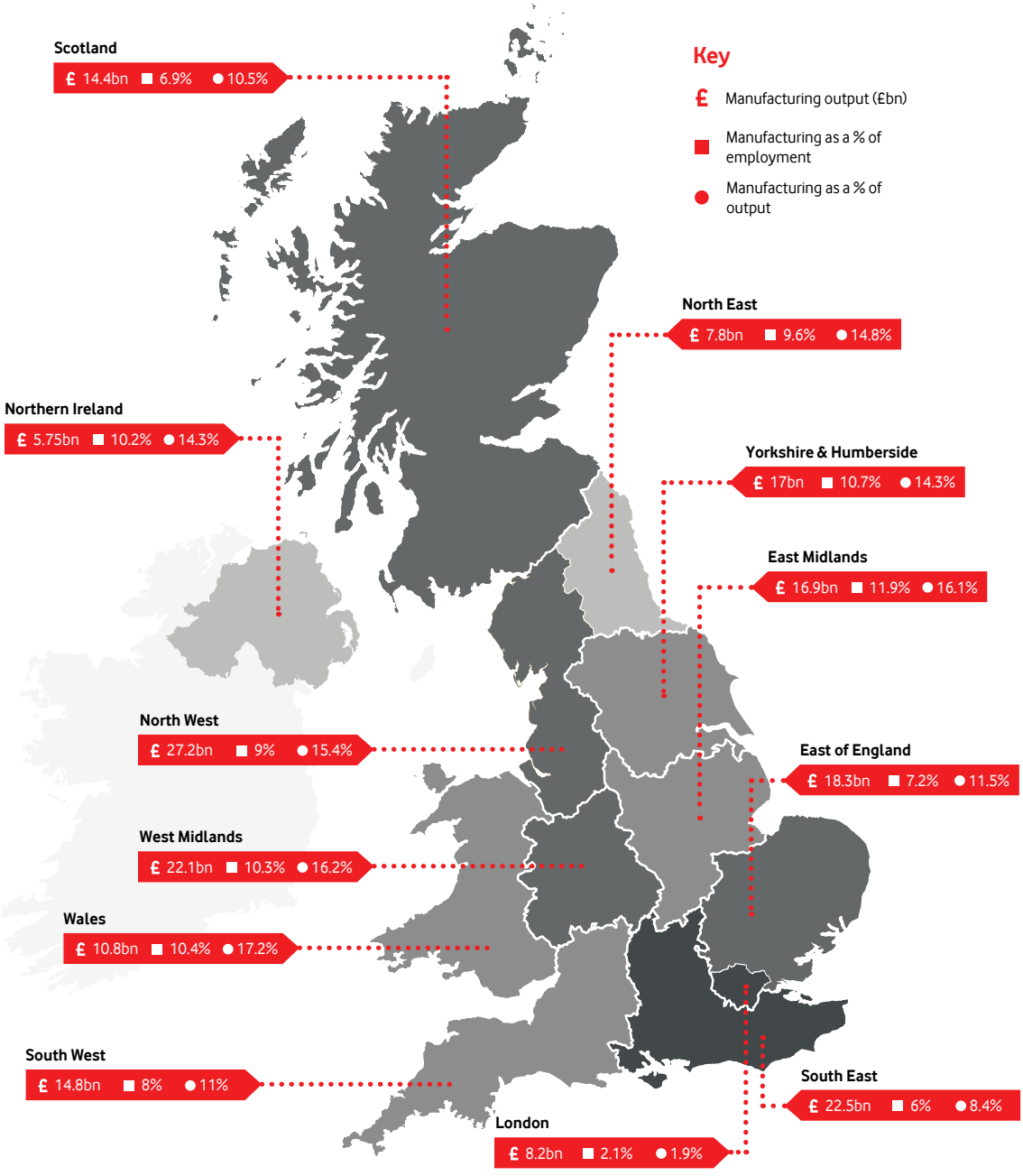
Figure 1: UK manufacturing in numbers[4]



Manufacturing produces physical goods which, unlike much of the value that is created in the service sector, can be exported. It pays well and provides a significant proportion of the UK's better-paid jobs. And unlike other high-paying sectors like financial services, half of whose output is generated in London,[5] it is not concentrated in London and the South East of England. In fact, the North West is the region with the biggest manufacturing output, at £27.2 billion. While the South East has the second largest manufacturing output of any UK region in absolute terms, manufacturing's contribution to the South East's total output is the second smallest in the country at 8.4%. This is higher only than London's, whose local economy relies less on manufacturing than anywhere else in the UK. London is also the only region where manufacturing salaries are lower than the average regional salary.

Manufacturing is responsible for 17.2% of Wales's overall output, 16.2% of the West Midlands', 16.1% of the East Midlands' and 15.4% of the North West. All of these areas' manufacturing output is comfortably above the national average. And it provides more than one in ten of all jobs in Northern Ireland, Wales, Yorkshire and the Humber and the East and West Midlands – compared to just 2.1% of London's jobs. That means it is critical to the economic health and prosperity of UK regions and nations that are less prosperous. While several regions and nations of the UK have successful financial services hubs, the economic growth driven by the shift to services over the last half century or more has been felt unequally.

Figure 2: Manufacturing in the UK by region and nations[6]



One important implication of this is that if we can improve the productivity of the UK's manufacturing sector, the benefits will be felt disproportionately in areas outside London and the South East of England. But what will help manufacturing to grow faster?

One answer lies in technological improvement, which manufacturers have always sought to exploit. Clearly, the size and diversity of the UK's manufacturing sector – and the sheer range of things being made – means that there is no single technological solution that would improve productivity and increase growth across the board. However, cutting-edge digital innovations such as 5G and IoT technology offer a wide range of applications to improve operations and productivity, and are available for deployment now. The next chapter will show some of the exciting new possibilities 5G opens up for the manufacturing sector.

Chapter 2: The potential of 5G for manufacturing

5G is not just faster than 4G connectivity, it also offers much greater capacity, and the architecture flexibility to scale, enabling millions of devices to be connected simultaneously. In addition, lower latency means the delay between a device being instructed to perform an action and that action being carried out is reduced – it happens essentially in real time. This promises to transform many aspects of our lives, from healthcare to transport – and some of the most game-changing applications are in manufacturing.

Manufacturers have long recognised and taken advantage of the benefits of digital technology. With its speed, latency and capacity, 5G can deliver even more than existing 4G networks and unlock a range of additional use cases. For example, 5G can improve the interconnectedness and responsiveness of both machines and workers, and increase the amount of data available for analysis to optimise systems for high reliability, security, control and efficiency.

The use of 5G in industrial settings such as manufacturing could be facilitated by 5G MPNs. 5G MPNs are bespoke 5G networks built to deliver the specific connectivity needs of a business or organisation. This comes with a number of critical advantages, depending on the type of MPN deployed:

- **High quality of service:** the network speeds, latency, capacity and geographic coverage are built to meet an organisation's requirements.
- **High security:** no third party can use or access the network, with digital processes and data remaining private. Taking full advantage of the added security features that 5G introduced.
- **Flexibility:** the option to reconfigure and future-proof the network, for example to add more applications such as Artificial and Virtual Reality.
- **Mobility:** a company's SIMs can be used on its MPN as well as the consumer network, allowing users to take advantage of 5G while on the move.
- **High reliability and control:** by providing dedicated network components or resources (slices) on customer premises and dedicated monitoring capabilities from a self-service portal.
- **Worry-free:** mobile operators build and service 5G MPNs, making the maintenance of the network a worry-free experience for businesses and organisations.

Through the benefits of 5G MPNs, manufacturers are able – like never before – to ensure tools, parts and people are synchronised, and they have access to real-time data to make informed decisions. This enables a number of key manufacturing use cases, some of which are described below.

Vodafone has already built 5G MPNs for a number of industrial customers, both in the UK and around the world. This chapter gives some live examples of how 5G technology can be used in manufacturing, along with a case study showing how Vodafone is already working with partners to deploy 5G to transform their manufacturing operations.

Wirelessly networked machinery

5G enables networked factory machinery to be connected wirelessly and securely. This provides extra flexibility when production lines change, for example in small-batch production or during the process of iterating and refining new lines from prototype to final product, and enables faster reconfiguration of factory space.

5G also facilitates AI enabled video analytics that monitor production line outputs to identify faults. This improves efficiency and productivity across the production line and enables manufacturers to increase the speed of output.

Asset and environment monitoring

A factory is a highly complex place, with the state of machinery and other physical assets, as well as environmental factors such as air quality and temperature, potentially all having an impact on production and requiring monitoring. 5G's high capacity and speed means that it can be used to transfer large quantities of data from lots of devices simultaneously and with real time latency, enabling better and faster decision making, facilitating machine learning and allowing processes to be adapted to maximise productivity. And monitoring critical data such as heat, vibration, sound levels or gas also allows alarms to be triggered or machinery to be automatically shut down when necessary.

Predictive maintenance

When one machine unexpectedly fails, an entire production line can break down until it is fixed. One recent study found that machine downtime costs UK manufacturers as much as £180 billion per year.[7] Unplanned downtime is especially costly, because of the need to assess the fault, order parts and schedule repairs, all eating into a factory's capacity. 5G and IoT technology enables manufacturers to increase the number of sensors fitted to equipment, collect more data and measure more variables – vibration, temperature, pressure, humidity and more – so that it can be cross-referenced with previous information and used to model and forecast when repairs will be needed. This data collection and analysis can enable necessary maintenance to be carried out in a scheduled way, reducing downtime and minimising the impact of repairs on a factory's performance.

Digital twins

One way of facilitating predictive maintenance with the help of 5G technology is through the use of "digital twins", which use data collected via 5G-enabled sensors to create a digital representation of a physical machine or production line. This can be used to build a predictive model which can be run forwards and backwards at any speed, simulate how faults may develop over time, and test possible corrections or repair operations in a virtual environment without needing to shut down the physical factory. Digital twins can also be used to train workers in how to operate machinery, interacting with a digital model and exploring possible scenarios and processes virtually.

AR and VR simulation

Augmented Reality (AR) and Virtual Reality (VR) can present information, instructions, annotations in the form of digital overlays via tablets or smart glasses, or immersive 3D digital models and simulations via headsets. This information can be used to visualise and plan designs in detail prior to the construction of physical prototypes, to help workers through troubleshooting, maintenance and repair, and to train workers with less direct use of expensive physical machinery. 5G-supported AR and VR technology can also connect workers on a factory floor with engineers and designers located elsewhere, enabling them to access technical expertise without costly and time-consuming site visits. The high capacity and low latency of 5G allows real time simulations, without nausea-inducing lag.

Cobots

Collaborative robots, or "cobots", can work alongside human workers, interacting with them and reacting and adapting to them in real time to perform different parts of a complex task. They differ from standard industrial robots which simply complete and repeat a mechanical task away from humans – and which for safety reasons, sometimes have to be caged off or programmed to stop when a person comes too close. A cobot equipped with 5G connectivity can exhibit faster

reaction times and change its movements in response to the actions of its human collaborators, and adapt its behaviour through machine learning. And cobots can be smaller than most industrial robots, meaning they can be deployed in areas where there is limited space, as well as being connected wirelessly.

Autonomous vehicles

Within a 5G-networked factory, autonomous guided vehicles (AGVs) and autonomous forklifts can be used to move parts and finished products around the site with speed and precision without the need for a human operator, using sensors to enable several vehicles to operate in the same space and adjust their paths in response to data about what is in their way, without bumping into each other.

Asset tracking

IoT sensors can replace manual scanned barcode identification to enable parts, manufactured goods, machinery and tools to be located and tracked in real time within a 5G-equipped environment, increasing efficiency and productivity and preventing equipment loss.

Worker safety and efficiency

Case Study: ABB

Global technology automation company ABB, Vodafone, technical university Politecnico di Milano and robotics start-up SmartRobot formed a group to design and prototype an innovative assembly station using a collaborative robot, or cobot, called YuMi, working along with and adapting to an operator. Machine learning algorithms enabled by IoT and 5G technologies were used to increase automation and productivity.

YuMi is a two-armed cobot which works by an operator's side to complete tasks like assembling valves. The cobot adapts to human movements in real-time and instantaneously gathers and transfers data. A vision system built into the cobot, allows it to perceive the environment, watch the operator and adjust the cobot's actions and trajectories as necessary. AI software from Politecnico di Milano enables the cobot to recognize and predict human movement and actions so that the cobot safely coordinates with the operator, forming an augmented partnership between the two – enhancing productivity as well as the ergonomics to improve the operator's working conditions.

5G wireless communication enables a revolutionary, flexible design of the assembly cell. It facilitates communication and large throughput between the data-intensive intelligent vision system from SmartRobot and the ABB YuMi. In addition, the 5G network allows the system to remotely run powerful algorithms, i.e. machine learning, and to process the collected data in real time.

Wearable IoT devices can be used to track staff movements, helping manufacturers understand how space is being used and optimise efficiency, as well as improving safety by triggering warnings when people get too close to or interact unsafely with machinery.

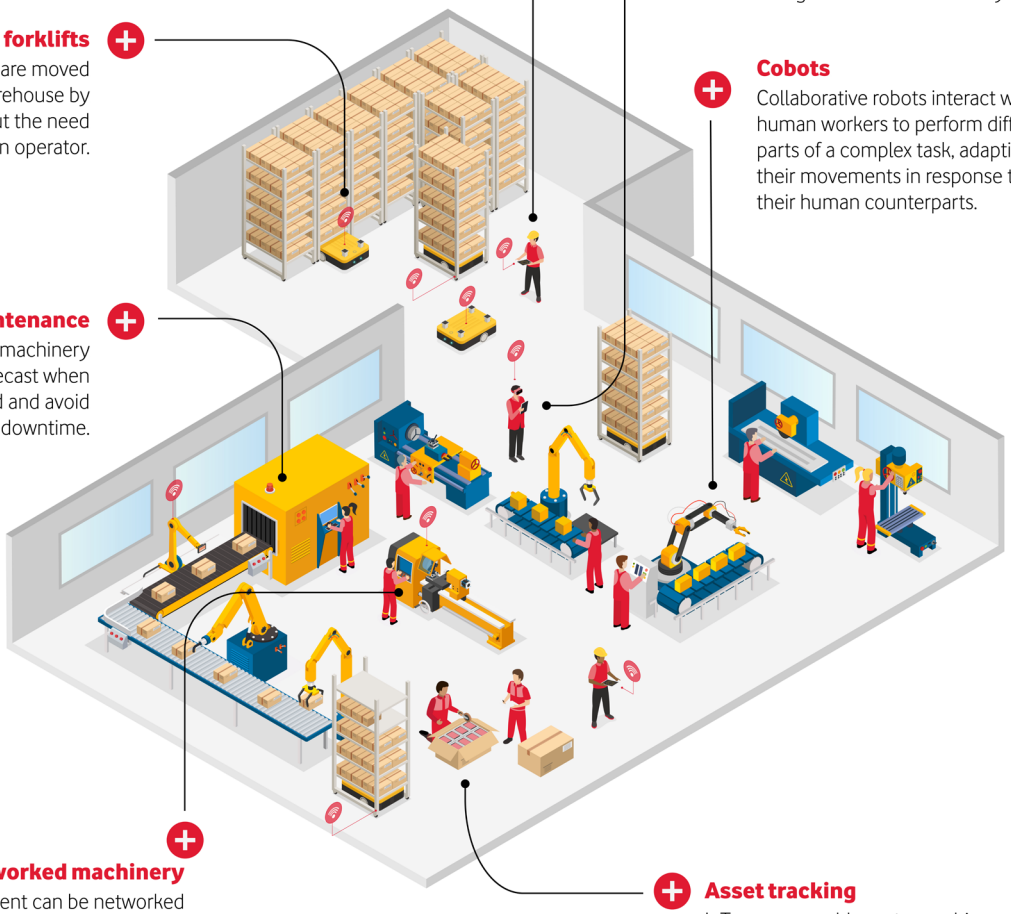
Figure 3: The 5G-enabled factory of the future

Digital twin
Engineers study a digital model of a machine or production line to predict how it will behave over time, simulate faults and test possible repairs without shutting down the factory.

AR/VR visualisation
Information is conveyed through 5G-enabled tablets or VR headsets to support design, troubleshooting, maintenance and training, and to connect with engineers located remotely.

Autonomous forklifts
Parts and finished products are moved to and from the factory warehouse by autonomous vehicles without the need for a human operator.

Cobots
Collaborative robots interact with human workers to perform different parts of a complex task, adapting their movements in response to their human counterparts.



Predictive maintenance
IoT sensors attached to machinery collect data to forecast when repairs will be needed and avoid unscheduled downtime.

Wirelessly networked machinery
5G means that equipment can be networked without the use of cables, reducing physical hazards and enabling the factory to be reconfigured quickly and flexibly without complex rewiring.

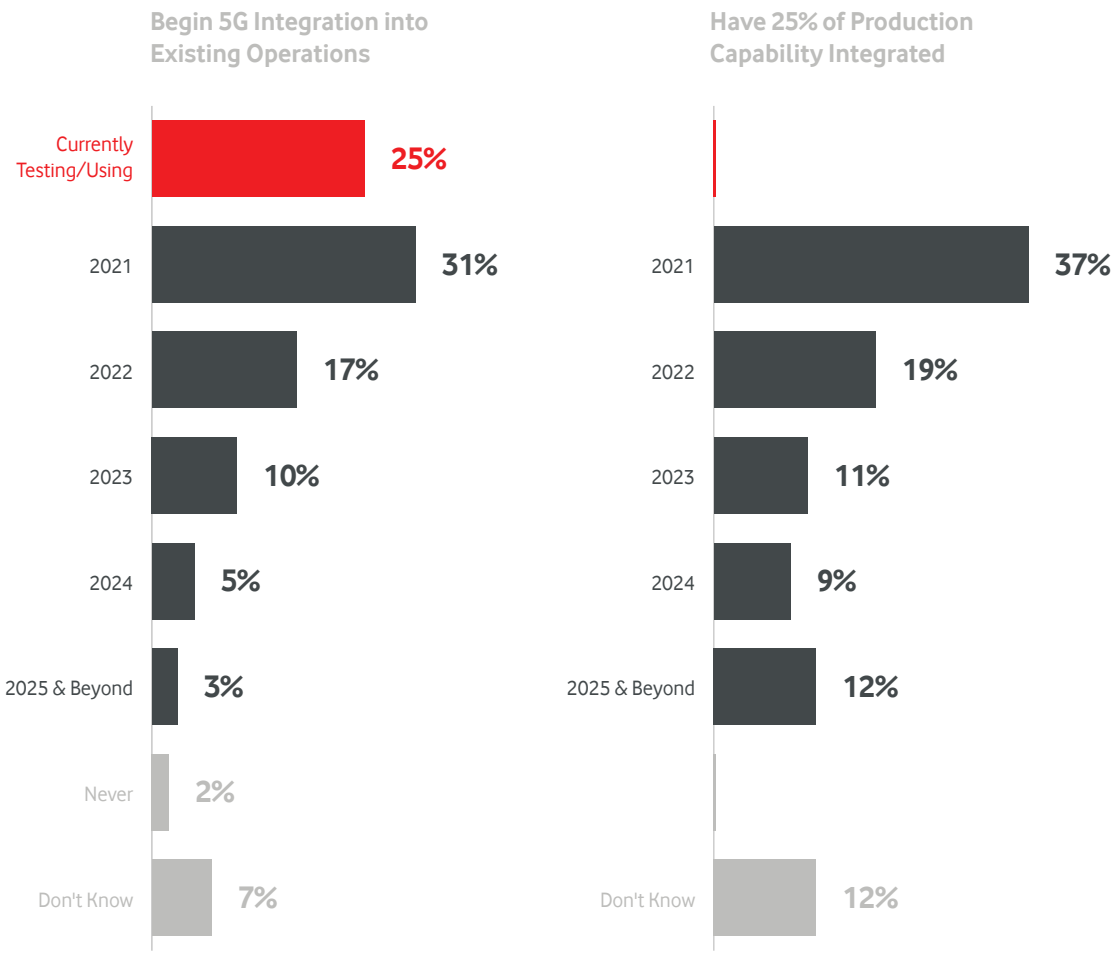
Asset tracking
IoT sensors enable parts, machines, finished products and tools to be tracked in real time.

Chapter 3: How 5G in manufacturing could boost the UK's productivity and support "levelling up"

What impact could 5G and IoT, and some of the applications described in the last chapter, have on the productivity of UK manufacturing, and what would be the regional effects of that? The potential use cases for 5G in manufacturing are only just starting to be explored, but even early studies focused on specific use cases have estimated increases in productive potential of 5G in manufacturing of between 1%-3%.[8] As the technology and the ways it is adopted develop, productivity increases could well be higher. To put this in context, even the mid part of this initial range would mean an increase in productivity as large as that seen for manufacturing over the whole of the last decade (2.1%).[9]

5G take-up across the manufacturing sector could be wide. A recent survey of US manufacturers by the Manufacturing Institute found that 91% believe that 5G connectivity will be important to the future of their business, with 61% saying it will be "very important". The same survey found that over half of US manufacturers (56%) report they will be testing or using 5G in some capacity within their facilities by the end of 2021. Only a very small percentage of US manufacturers (2%) believe they will never implement 5G solutions.[10]

Figure 4: US manufacturers' expectations of 5G integration into their operations[11]



In new analysis carried out for this paper, WPI Economics calculated the boost to UK manufacturing (GVA) under three scenarios for the impact of 5G on manufacturing productivity: a low scenario (1% increase in productivity), a medium scenario (3% increase in productivity) and a high scenario (5% increase in productivity). Our central estimate found that if take-up of 5G in the UK manufacturing sector reaches the level by 2030 that evidence from the US suggests, with 91% of manufacturers using 5G in their operations, then the increase in manufacturing GVA across the UK would be **£3.6 billion per year in 2025** and **£6.3 billion per year in 2030**, compared to a projection for manufacturing GVA to 2030.[12]

The regional impact of this productivity increase reflects the distribution of manufacturing across the UK's regions and nations, with the largest absolute increase being seen in the North West: a cumulative manufacturing GVA benefit from 5G of £5.25 billion over the period 2021-2030. Everywhere benefits, but London's benefit is among the smallest; because London relies least of all UK regions on manufacturing, improving manufacturing productivity across the UK would make less difference there than anywhere else.

We have given each region and nation a high, moderate or low score for the relative scale of the impact of 5G in manufacturing on total GVA per area. Our scores show the highest impact in Wales, followed in order by the West Midlands, East Midlands, North West and North East, all of which would see a high relative GVA impact on their overall economies from the productivity benefits of 5G in their manufacturing sectors. Northern Ireland and Yorkshire and the Humber would see a moderate impact and other areas would see only a low impact, with the smallest relative GVA impact in London – although all regions and nations benefit in absolute terms.

Figure 5: Manufacturing GVA increase following modelled 5G take-up

	Cumulative 2021-2025 (£ million)	Cumulative 2026-2030 (£ million)	Cumulative 2021-2030 (£ million)	Relative scale of GVA impact
Wales	500	1,500	2,000	High
West Midlands	1,000	3,250	4,250	High
East Midlands	750	2,500	3,250	High
North West	1,250	4,000	5,250	High
North East	250	1,250	1,500	High
Northern Ireland	250	750	1,000	Moderate
Yorkshire and the Humber	750	2,500	3,250	Moderate
East of England	750	2,750	3,500	Low
South West	750	2,250	2,750	Low
Scotland	750	2,000	2,750	Low
South East	1,000	3,250	4,250	Low
London	500	1,250	1,500	Low

Source: WPI Economics analysis; figures may not sum because of rounding

Figure 6: Relative scale of GVA impact



This demonstrates that, while the economic benefits of 5G in manufacturing are seen right across the UK, they are most significant, in terms of their contribution to overall regional and national economies, outside London and the South East. Many of the high impact areas have all been at the forefront of recent political discussions about "levelling up" and the need to support places that have been "left behind" by social and economic changes over recent decades. Speeding up take-up of 5G in manufacturing will benefit the whole country, and these benefits will be disproportionately felt in exactly those areas the Government is particularly keen to "level up". But it is also the case that slower uptake of 5G MPNs in the manufacturing sector will lead to slower productivity gains than those modelled here.

5G has the potential to unlock productivity and enable economic growth across the UK. Vodafone-commissioned research has found that 5G could add over £150bn to the UK economy by 2030. But to achieve these wider economic and societal benefits, significant investment is required to rollout and maintain 5G networks, build more mobile sites and develop new 5G applications and technologies. Mobile network operators are faced with these investment demands at a time when the industry is under serious cost pressures, for example through the requirement to swap equipment, increasing operating costs and high regulatory and spectrum costs.

To achieve its full potential, mobile operators need 5G to deliver an investment boost via the industrialisation of new 5G technologies, including 5G MPNs. This would lead to improvements to the current low return on capital employed in the UK for mobile infrastructure. This boost could be delivered by the uptake of 5G MPNs in manufacturing. Which would not only deliver productivity gains and support the Government's ambition to "level up" the country, but would also create a virtuous circle by opening up new revenues for mobile network operators. These new revenue streams can then be reinvested in the roll-out of 5G network infrastructure and the development of new applications, which will benefit smaller businesses which are less likely to have the economies of scale to invest in MPNs, and consumers more generally. Without these new revenue streams, mobile operators will not be able to fund the roll-out of 5G to consumers and smaller businesses across the UK. As a result, the technology and its benefits would only be accessible to those in large cities and metropolitan areas or organisations able to invest in MPNs to enhance their operations. In this circumstance, the Government target that the majority of the population will have access to a 5G signal in 2027 would not be met.

The next chapter will look at some ways in which the increased use of 5G in UK manufacturing can be encouraged and incentivised.



Chapter 4: Policy recommendations

As the Government shifts from its previous focus on an Industrial Strategy to a "Plan for Growth",[13] it needs to pay particular attention to manufacturing, a sector large enough and innovative enough to encompass both long-standing and new and emerging businesses and specialisms, and with a geographical distribution that makes its success especially important to less prosperous regions and nations of the country. With a Levelling Up White Paper due to be published later this year,[14] the Government has an opportunity to put manufacturing at the heart of its agenda for ensuring the whole of the UK can benefit from improvements to the economy. This chapter sets out some policies which would help it to do so.

As this report has set out, manufacturing is on the brink of a technological step-change. The new applications for 5G and 5G MPNs described above are already possible, but are only just beginning to be rolled out in factories around the world. The sooner UK manufacturers upgrade their facilities, the sooner they – and the UK economy as a whole – will see the productivity gains described in the previous chapter come to fruition. The alternative is to see the UK falling behind other countries that take better advantage of these advances in technology and innovation. And as our analysis shows, maximising the benefits of 5G in manufacturing will particularly help those parts of the country where manufacturing makes an above-average contribution.

Aiming high

- Government has a role to play in encouraging take-up of new technology. That is especially the case when it helps the Government achieve its own stated priorities. As this report has shown, increased uptake of 5G and IoT in manufacturing stands to support the "levelling up" of so-called "left behind" areas of the country, which have seen slower growth rates over recent decades than London and the South East but which rely on manufacturing more.

- If the Government wants to encourage business growth and the creation of skilled, well-paid jobs in less prosperous parts of the UK, then encouraging manufacturers to invest in 5G MPNs and 5G applications should be an explicit policy goal. And of course, making the UK a global leader in 5G manufacturing and innovation would attract investment and encourage more people to set up or expand manufacturing businesses here. This requires publicly making it a priority, with ministers highlighting the potential of 5G.

- **RECOMMENDATION 1: The Government should set an ambitious target, with measurable benchmarks, that over the next decade the UK will become a global leader in the use of 5G technology in manufacturing.**

Incentivising investment

- The national roll-out of 5G is ongoing, with the Government committed to ensuring that a majority of the population have access to a 5G signal by 2027. But industrial applications of 5G will require private networks, commissioned and built on a bespoke basis according to the specific needs of individual businesses. The Government should work with mobile operators to encourage the take-up of 5G MPNs in the manufacturing sector and in other sectors that can benefit from them. This should include incentives for manufacturing businesses choosing to invest in 5G private networks, which may be capital intensive in the short term but will lead to long-term productivity gains. In South Korea, the Korean Government's 5G Plus Strategy includes £20 billion in tax breaks and government investments by 2022, with a focus on fostering 15 5G-based "strategic industries" including five "key services", one of which is smart factories.[15]

- Incentivising investment in the deployment of 5G will also create a virtuous circle by opening up new revenues for mobile network operators. These new revenue streams can then be reinvested in the roll-out of 5G network infrastructure and development of new applications which will benefit smaller businesses and consumers– a win-win situation. Without new revenue streams, investment in 5G in the UK will stall, and 5G will not deliver its full potential for businesses and consumers across the UK.

- **RECOMMENDATION 2: The Government should consider what incentives can be put in place to make it easier for manufacturers of different sizes to upgrade their factories with 5G MPNs, including policies along the lines of the existing time-limited super-deduction capital allowance, focused on tech upgrades in manufacturing in particular.**

- The Made Smarter partnership between the UK Government and manufacturing is supporting the adoption of industrial digital technologies, including with a £147 million investment from the UKRI Industrial Strategy Challenge Fund (ICSF).[16] Its pilot programme in the North West offers up to 50% match funding for technology implementation to SME manufacturers and has been rolled out to more regions in England with an additional £8 million in funding.[17]

- **RECOMMENDATION 3: The Made Smarter Adoption programme should be expanded further, with significant additional resources and a particular focus on supporting manufacturers to realise the benefits of 5G.**

Ensuring security

- It is vital that the Government ensures MPNs operate with a high level of security, similar to that required for public communications networks and services.

- **RECOMMENDATION 4: MPNs should therefore be covered by future legislation on supply chain cyber security and Managed Service Providers, and this legislation must complement the Government's existing plans for legal security requirements on consumer IoT devices.**

- Once the new Telecoms Security Requirements (TSRs) are in force, the Government should review their applicability to MPNs. It may be necessary to expand the scope of the TSRs to include MPNs if separate legislation cannot guarantee that MPNs operate to the highest levels of security.

Supporting innovation

- The Government's 5G Testbeds and Trials Programme is already investing £200 million across a range of sectors between 2017 and 2022. This includes £15.7 million to stimulate trials and adoption in the manufacturing sector through the Worcestershire 5G,[18] 5G Factory of the Future,[19] 5G Encode,[20] and 5GEM testbeds.[21]

- While any such investment is welcome, the £15.7 million manufacturing component of this programme is a very small sum. More focus and resources should be put into the industrialisation of 5G. More investment in 5G in manufacturing would not only have a positive impact on the businesses directly involved but could provide new use cases for 5G applications. In addition, it would show the Government's commitment to encouraging take-up of 5G by British manufacturers.

- **RECOMMENDATION 5: The Government should extend the Industrial 5G Testbeds and Trials Programme by another five years from 2022-27 and increase its funding for manufacturing trials to at least £60 million.** Taking into account the lessons learnt to date, Government should consider reshaping the programme to make it even more effective and drive innovation. This should include longer timeframes, support with local 5G deployment, seed funding, OpenRAN and support for 5G MPNs in industrial sectors.

- As part of this important focus on developing new industrial applications for 5G, the whole ecosystem will need to work together.

- **RECOMMENDATION 6: The Government should introduce regional 5G test and innovation centres, starting in those regions and nations which stand to gain most from take-up of 5G in manufacturing.** This will allow the whole ecosystem, including telecoms providers and manufacturers, to come together to test and develop 5G and IoT applications for manufacturing processes.

- Vodafone recently took part in the Covid Recovery Commission, a cross-sector group of businesses formed in 2020 to examine the impact of the Covid-19 pandemic on the "levelling up" agenda, and to produce bold and innovative policy solutions to help reform the UK's post-Covid economy. The Commission recommended creating at least one new globally competitive industry cluster in every region and nation of the UK by 2030. It also recommends the introduction of Catapult Quarters, using incentives and regulatory relaxations to bring together research and innovation expertise, highly skilled workers, digital technology, fast-growing businesses and domestic and foreign investment.[22]

- **RECOMMENDATION 7: At least one new regional industry cluster should be focused on innovation in manufacturing, including through the application of 5G and IoT technology.**

Endnotes

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