



**5G**

**Building a Digital Society**

**A WPI Strategy report for Vodafone UK**

November 2023

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 [wpi-strategy.com](http://wpi-strategy.com)

 [nick@wpi-strategy.com](mailto:nick@wpi-strategy.com)

 [@wpi\\_strategy](https://twitter.com/wpi_strategy)

## About Vodafone

Vodafone UK connects people, businesses and devices to help our customers benefit from digital innovation. Our services span mobile, fixed line, broadband and the Internet of Things (IoT). We employ around 11,000 people across the UK, and operate more than 420 retail stores nationwide.

Having made the UK's first mobile phone call and sent the first text, Vodafone has a history as a tech pioneer. In 2018 we made the UK's first live holographic call using 5G, and were the first to start carrying live 5G traffic from a site in Salford, Greater Manchester. Today we serve over 18 million mobile and fixed line customers in the UK, with 4G network coverage at 99 per cent. Vodafone has launched 5G in 100 places across the UK so far. Our customers voted us the UK's Best Network Provider at the 2020 Trusted Reviews Awards. To help deliver Gigabit UK, we are rolling out full fibre broadband across 12 towns and cities in partnership with CityFibre, reaching one million homes and business by 2021.

Our ReConnect programme is supporting women and men back into work after a career break, our IoT technology is working to create a low-carbon society, and our free Digital Parenting magazine is helping families across the UK to navigate the online world safely. For two years running, we have been named one of the UK's 25 Best Big Companies to Work For by the Sunday Times, and a Top 100 Employer by Stonewall.

Vodafone is taking significant steps to reduce our impact on our planet by reducing our greenhouse gas emissions by 50% by 2025 and becoming net zero by 2040, purchasing 100% of our electricity from renewable sources by 2025, and reusing, reselling or recycling 100% of our redundant network equipment.

We are part of Vodafone Group, one of the world's largest telecommunications companies, with mobile operations in 21 countries, partnerships with mobile networks in 42 more, and fixed broadband operations in 17 markets. As of 30 June 2020, Vodafone Group had approximately 300+ million mobile customers, 27 million fixed broadband customers and 22 million TV customers, including all of the customers in Vodafone's joint ventures and associates.

For more information about Vodafone UK, please visit: [www.vodafone.co.uk](http://www.vodafone.co.uk)

# Foreword

The UK mobile network is undergoing a major transformation. Mobile operators are in the midst of shifting from 5G non-standalone, which uses 5G radios on top of 4G-era technology, to a fully-fledged 5G standalone (5GSA) network using new technology and infrastructure.

Vodafone is at the forefront of this shift. In 2023, we became the first UK mobile operator to launch 5GSA on our network with 5G Ultra in major British cities, and have innovated by enabling ITN's broadcast of the Coronation of King Charles III using a dedicated network slice. In addition to the increased speeds associated with 5G, 5GSA will deliver better reliability in busy areas, improved smartphone battery life, superior network coverage both indoors and outdoors, and better security through advanced end-to-end encryption.

The benefits of 5GSA will not just be felt by individuals: the 5GSA network will transform how businesses and public services are able to operate, increasing efficiency and boosting growth across the many sectors and services that we interact with daily - from healthcare, to rural connectivity, to energy efficiency.

But to achieve the £11bn of infrastructure investment that is required to transform society for the better and realise the benefits of 5GSA, the market needs to be restructured. Vodafone UK's proposed merger with Three UK will boost infrastructure investment and move the UK towards achieving the UK's 5GSA goals outlined in the government's Wireless Infrastructure Strategy. The combined business will bring connectivity to all areas of the country. Building upon 5G Ultra's transformative impact in major cities, together Vodafone and Three can bring groundbreaking benefits to all regions of the UK in cities, towns, villages and rural areas through investment in our digital infrastructure - achieving 5GSA coverage across 99% of the UK by 2030, worth £5bn in added growth to the UK economy every year.

This paper demonstrates just a few of the tangible ways in which 5G-enabled technology has the potential to improve people's lives every single day – but these opportunities will be lost unless 5GSA can be rolled out at pace. By combining with Three UK, we are ready to drive the investment to make these possibilities a reality.



**Ahmed Essam**  
Vodafone UK CEO

# Executive summary

5G Standalone (5GSA) has the potential to transform our society, boosting productivity and outcomes across both the public and private sectors. As our recent study 'Connecting the Countryside' showed, 838,000 people in the most deprived, rural parts of the country stand to benefit massively from the rollout of 5GSA. But the economic benefits of this connectivity will be felt across the the United Kingdom.

This report looks at three potential investment scenarios and shows the potential value of a speedy rollout of 5G Standalone to the country, to specific regions, and in specific sectors of our public services - health, rail and local government.

5GSA isn't just about faster streaming - people will be able to see numerous benefits across society, from NHS savings in social care, to more reliable train journeys and smarter street lighting but crucially these benefits can only be fully delivered if 5GSA is rolled out nationwide:

- If 5GSA infrastructure is rolled out rapidly nationwide, the UK stands to gain **£7.4 billion** in economic benefit by 2030.
- 5G-enabled remote patient care could save the NHS up to **£1 billion** per year, equivalent to **15,400** full time nursing posts, while councils could reduce spending on social care by up to **5%**.
- Meanwhile, the use of 5G-enabled technology across the rail network could save passengers **25 million hours** in travel time over the next five years, worth **£325 million** to the UK economy.
- 5G-powered smart city lights could reduce energy usage, save money and reduce emissions: councils could save **£700 million** over the next 5 years, while emissions could be reduced by **one million tonnes of CO<sub>2</sub>** – equivalent to replacing **250,000** petrol or diesel cars with electric.

The proposed merger between Vodafone UK and Three UK will help drive this infrastructure investment required to roll out these savings nationwide, across public services as well as the businesses that drive the UK's economy.



# Chapter 1. The value of 5GSA across the UK

**The importance of 5G Standalone will only continue to increase over time, as new technologies become available, boosting productivity across a variety of industries and public services. The foundational role of 5GSA has also been recognised by the Government, which set an ambition of achieving 5GSA coverage in all populated areas in the UK by 2030 in its recent Wireless Infrastructure Strategy.<sup>1</sup>**

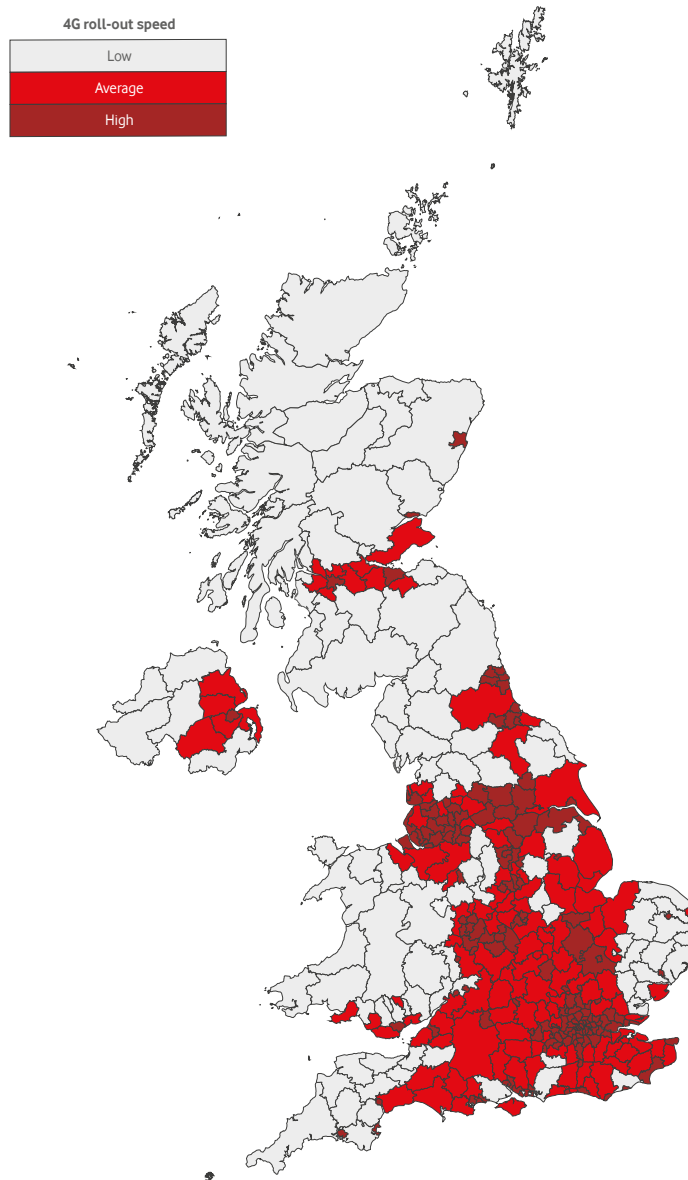
The ambition is useful in providing a goal that the Government and industry can work towards. However, the pace at which 5GSA is rolled out has a significant impact on its potential contribution to economic growth and productivity. The amount of investment that goes into 5GSA rollout will dictate when sectors can begin to make use of the network, which in turn has an impact on how soon the country can benefit from the economic potential of 5GSA.

To assess the impact of rollout speed on the economic benefits of 5GSA, WPI Economics has modelled a baseline case in which the rollout of standalone 5G broadly matches the rollout profile of the 4G network in the UK. This is both in terms of overall coverage, and distribution of coverage across the country.

Each local authority has then been assigned to one of three categories of rollout: 'high', 'average' and 'low', corresponding to the group of local authorities that are statistically meaningfully higher or lower than the average 4G rollout coverage from 2017. This is depicted in Figure 1, which shows that rollout speed was fastest in and around major cities including Greater London, Greater Manchester, the West Midlands conurbation, West and South Yorkshire and the East Midlands. These also represent the most commercially attractive areas for investment, due to population density and the availability of high-skilled workers and infrastructure.



Figure 1: Map showing 4G rollout speed by local authority



WPI Economics then modelled three possible investment environments:

- **Poor investment environment**, in which rollout speed and coverage in the 'high' and 'low' areas remains the same as under the baseline (high in the most commercially attractive 'high' areas and low in the least commercially attractive 'low' areas, and with coverage assumed to be lower in 'average' areas than under 4G). In this investment environment, coverage in 'average' areas is the same as the average of the 'low' areas in the baseline 4G scenario – the equivalent of a 52% slower roll out in these areas.
- **Moderate investment environment**, in which rollout speed and coverage in each of the categories of local authorities is as it was in the baseline 4G case.
- **Good investment environment**, in which rollout speed and coverage in the 'high' and 'low' areas remains the same and rollout and coverage in the 'average' rollout areas increases compared to the 4G baseline. In this investment environment, coverage in "average" areas is the same as the average of the 'high' areas in the baseline 4G scenario – the equivalent of a 32% faster roll out in these areas.

When using the moderate investment environment as a benchmark, we find that the difference between the ‘poor’ and ‘good’ investment environments amounts to **£2.6 billion by 2025, and £7.4 billion by 2030**.

A poor investment environment delivers a loss of over £1.6 billion by 2025 and over £4.6 billion by 2030, compared to the moderate investment environment. By contrast, the good investment environment delivers almost an additional £1 billion by 2025 and over £2.8 billion by 2030, compared to the moderate investment environment. These substantial gains would be felt throughout the economy – delivering benefits to households, businesses, and public services.

Crucially, however, these benefits would not be evenly distributed throughout the country. As shown in Figure 2, the twelve regions of the UK all face vastly different fates under good and poor investment environments. By 2030 the South East stands to lose £1.4 billion of economic benefit under a poor investment environment, facing the most significant losses in the country. The East Midlands stands to lose £590 million, the North West £460 million, and the South West £496 million. These four regions also stand to gain the most from a good investment environment, underlining the importance of delivering a speedy rollout.

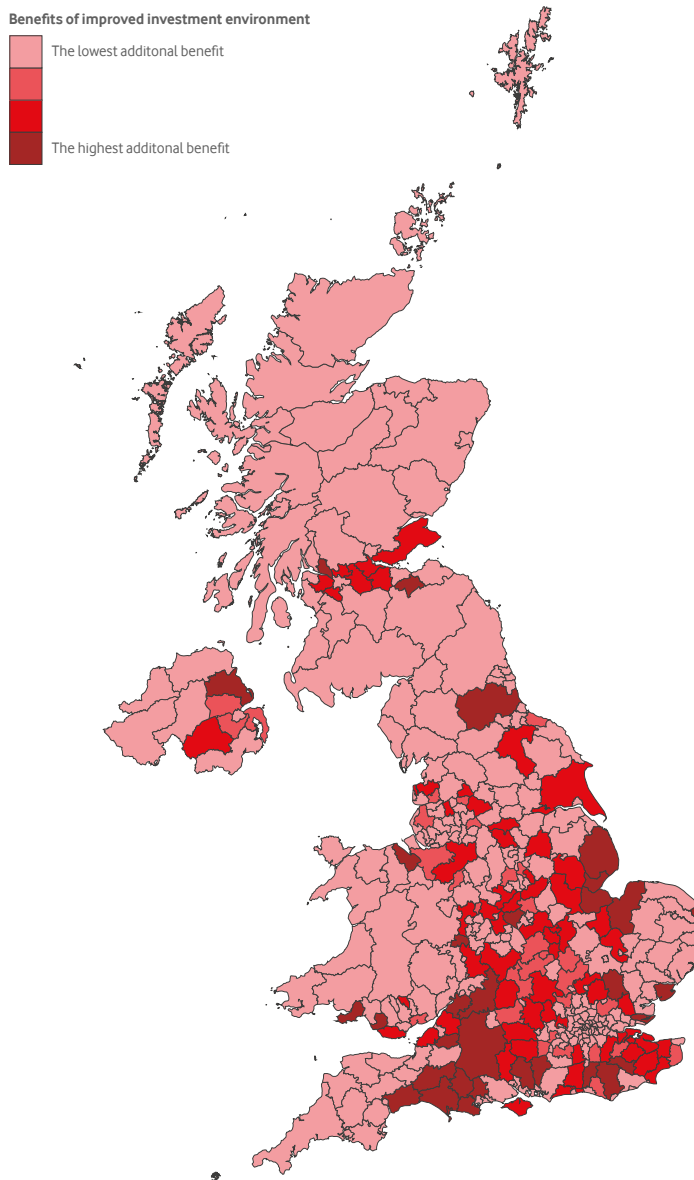
**Figure 2: Table showing bad and good investment environment for each region, and difference**

	Bad case impact (£, million)		Good case impact (£, million)		Difference (£, million)	
	2025	2030	2025	2030	2025	2030
<b>NORTH EAST</b>						
North East	-35	-100	30	85	65	185
Yorkshire and the Humber	-105	-300	75	210	180	510
North West	-160	-460	85	235	245	695
West Midlands	-75	-215	40	115	115	330
East Midlands	-210	-590	110	310	320	900
East of England	-170	-480	80	225	250	705
London	0	0	0	0	0	0
South East	-485	-1,375	280	790	765	2,165
South West	-175	-495	150	425	325	925
Scotland	-125	-350	70	195	195	545
Wales	-65	-185	60	170	125	355
Northern Ireland	-30	-90	15	35	45	125
<b>UK</b>	<b>-1,640</b>	<b>-4,645</b>	<b>990</b>	<b>2,800</b>	<b>2,630</b>	<b>7,440</b>

London, on the other hand, performs equally well under the poor, moderate and good investment environments. This is because London has seen and is likely to see a high level of investment regardless of the overall economic environment, due to its pre-existing attractiveness to investors. The same is also largely true for other major cities in the UK, which are already targets for significant investment. This is shown in Figure 3, which depicts which local authority areas would see the highest additional benefit as a result of the good investment environment we modelled. Our model assumes that the most commercially attractive areas will receive investment even with a poor investment environment, which is why these areas stand to gain little in relative terms.



**Figure 3: Map showing benefits of a good investment environment by local authority**



The benefits of moving to a better investment environment will therefore be felt outside of London and other major cities in the UK - where there is much more to gain. In other words, the areas that stand to lose the most from a poor investment environment, and gain the most from a good one, are also some of those most in need of levelling up.

To prevent a widening gap between areas of the country that are already attractive destinations for investment, and those which are not, it is essential that 5GSA is rolled out at pace throughout the country. This will allow businesses, industry and public services based outside of major cities to benefit from emerging use cases, and catalyse business investment in these areas. If this is done correctly, 5GSA rollout could be a significant contributor to levelling up the country as a whole, rather than just those areas that are already achieving significant investment.

## Chapter 2. 5G to improve daily life

**Most people associate 5G with mobile phones, the internet and faster speeds, and it is true that users of 5G-enabled smartphones will increasingly see improvements in their user experience. However, the far-reaching benefits of 5GSA beyond just the smartphones in our pockets are little understood.**

In the near term, the rollout of 5G Standalone has the potential to help cut NHS waiting lists, reduce energy consumption, and improve the efficiency of the railway network - as well as increase manufacturing output, help farmers increase their yields and improve our emergency services. However, when asked which sectors of society they thought 5G could improve the fastest, people were more likely to say that it could not improve any sector of society than to identify any of these benefits.<sup>2</sup>

### 5G-enabled rail

According to recent polling, nearly a quarter of people in the UK have been frustrated by train services over the past two years<sup>3</sup> The rollout of 5G promises real improvements for passengers of the UK's rail system because it has the power to increase both reliability and capacity on the network.

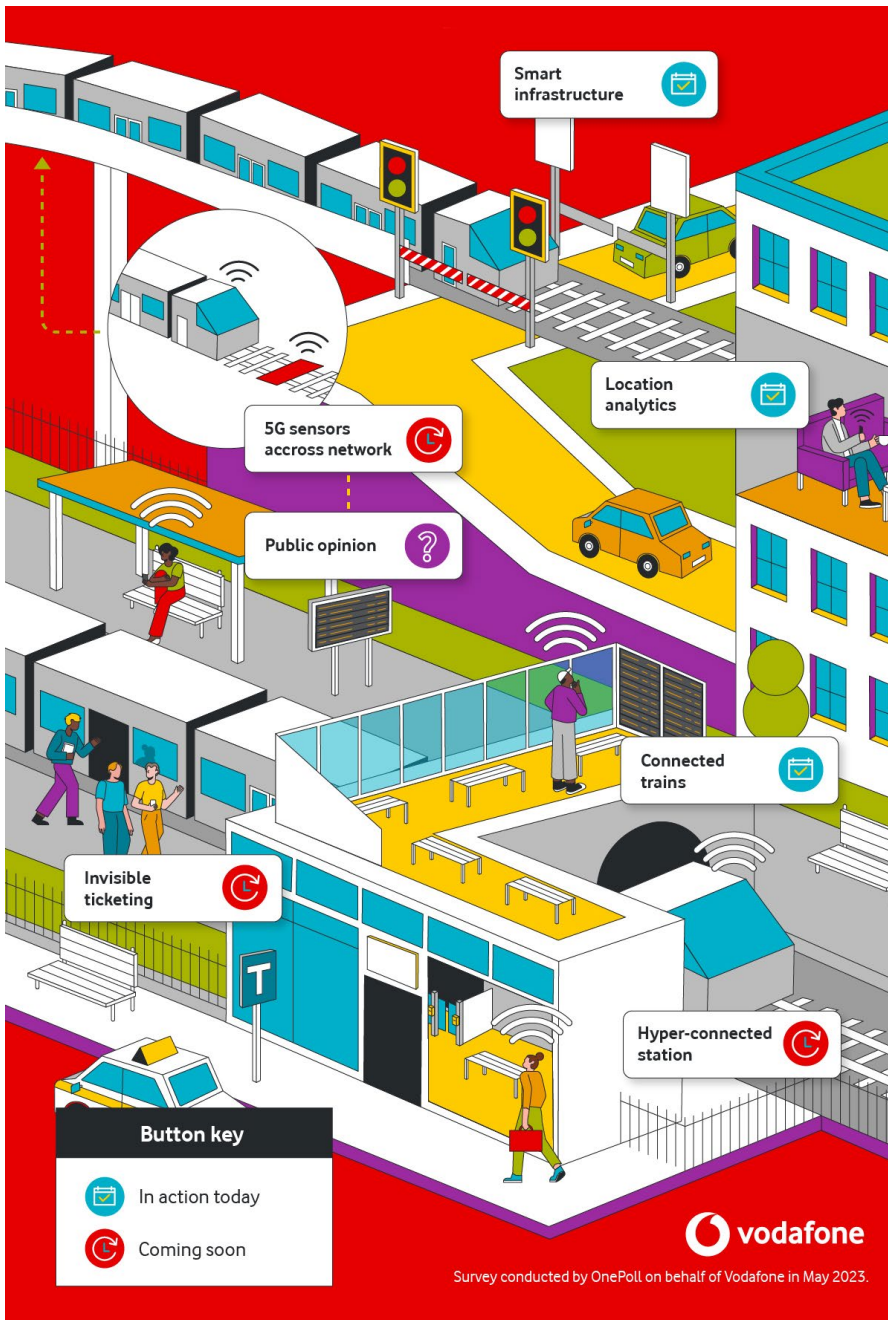
Reliability will be increased by the clearer, faster communication between drivers and network controllers, as well as between the trains themselves, facilitated by 5G. 5G-enabled sensors on the tracks will also bring greater reliability through improving track maintenance efficiency by up to 40% and the rate of fault incidence by 20%.<sup>4,5</sup>

Another source of passengers' frustration is the limited capacity of the rail network; more than a third of peak-hour trains to and from London were overcrowded in 2019.<sup>6</sup> The "virtual coupling" of trains, made possible by 5G, will allow them to share braking and acceleration data which, when modelled on the South West Main Line, showed train separation distance could be reduced by 43% compared to the current signalling system, allowing for more services to run without having to build additional railways.<sup>7</sup>

Limited capacity can also be mitigated by monitoring passenger flows with improved real-time data which 5G makes available. This will make train services more responsive to changes in demand and allow for trains to be redirected more easily in the event of accidents and delays.

WPI Economics' analysis also shows that over the next 5 years, a 10% reduction in minutes lost to train delays could save rail passengers 25 million hours - worth £325 million to the UK economy.<sup>8,9</sup> The greater reliability and capacity that 5G can bring to the rail network is desperately needed to boost productivity and would bring significant economic benefits, as well as easing passengers' everyday frustrations.





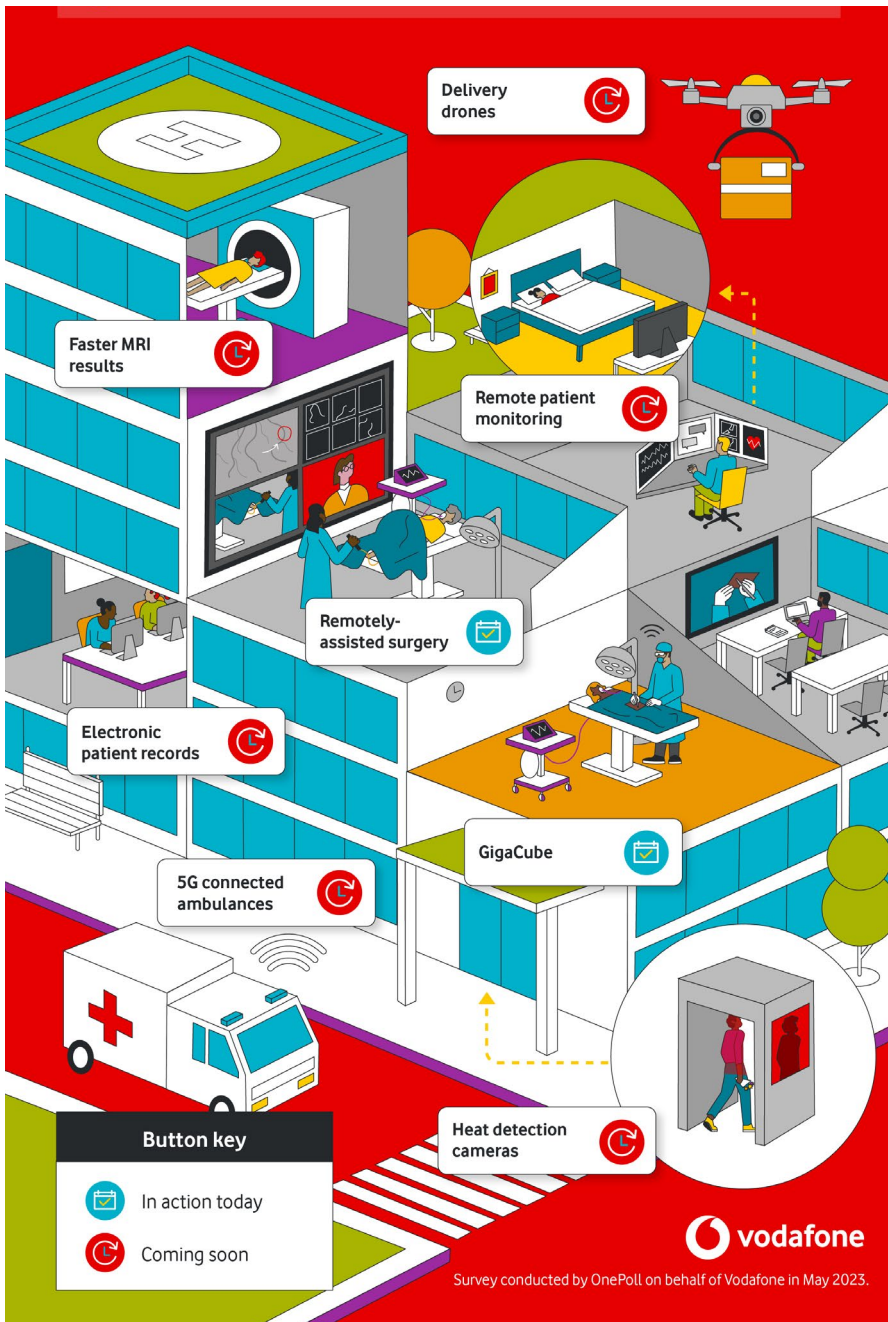
**5G social care**

Within health and social care, 5G has the potential to play a considerable role in increasing safety, reducing costs, and improving patients' quality of life.

Consultations are increasingly happening over video and phone calls, a transition accelerated by the COVID-19 pandemic. 5G will only serve to make this already commonplace practice more seamless, dependable and ultimately more efficient.

Beyond standard consultations, 5G will make it possible for patients to be monitored remotely, empowering them to live independently for longer. It will also enable residents of care homes to be monitored via sensors, alleviating strain on care home staff and resources. Monitoring can also be extended to patients taking medicine, to ensure that it is administered properly and minimise wastage.

The Liverpool 5G testbed showed that, if these measures were combined and implemented nationwide, cost savings for health and social care services could reach £269,000 for every 100 users (in 2023 pounds).<sup>10,11</sup> Given the number of recipients of public social care funding currently in the UK, this could equate to savings of almost £1 billion per year and reduce council spending on social care by as much as 5%.<sup>12</sup> The number of social care recipients is set to increase by an estimated 61% by 2038, increasing the potential savings year on year.<sup>13,14</sup>



The financial benefits arising from the use of 5G within social care are hugely significant, but beyond these savings 5G also promises tangible improvements to the quality of life of recipients of social care. A 5G-enabled medication consultation service has been shown to improve patient confidence by 73%, and the number of patients who indicated that they feel safe by 53%.<sup>15</sup> Similarly, ‘safehouse sensors’ in homes can monitor ambient temperatures and activity levels, which in turn allow experts to see who may require support or be suffering from fuel poverty. These sensors have brought a 0.7 point increase on the life satisfaction scale to users.<sup>16</sup>

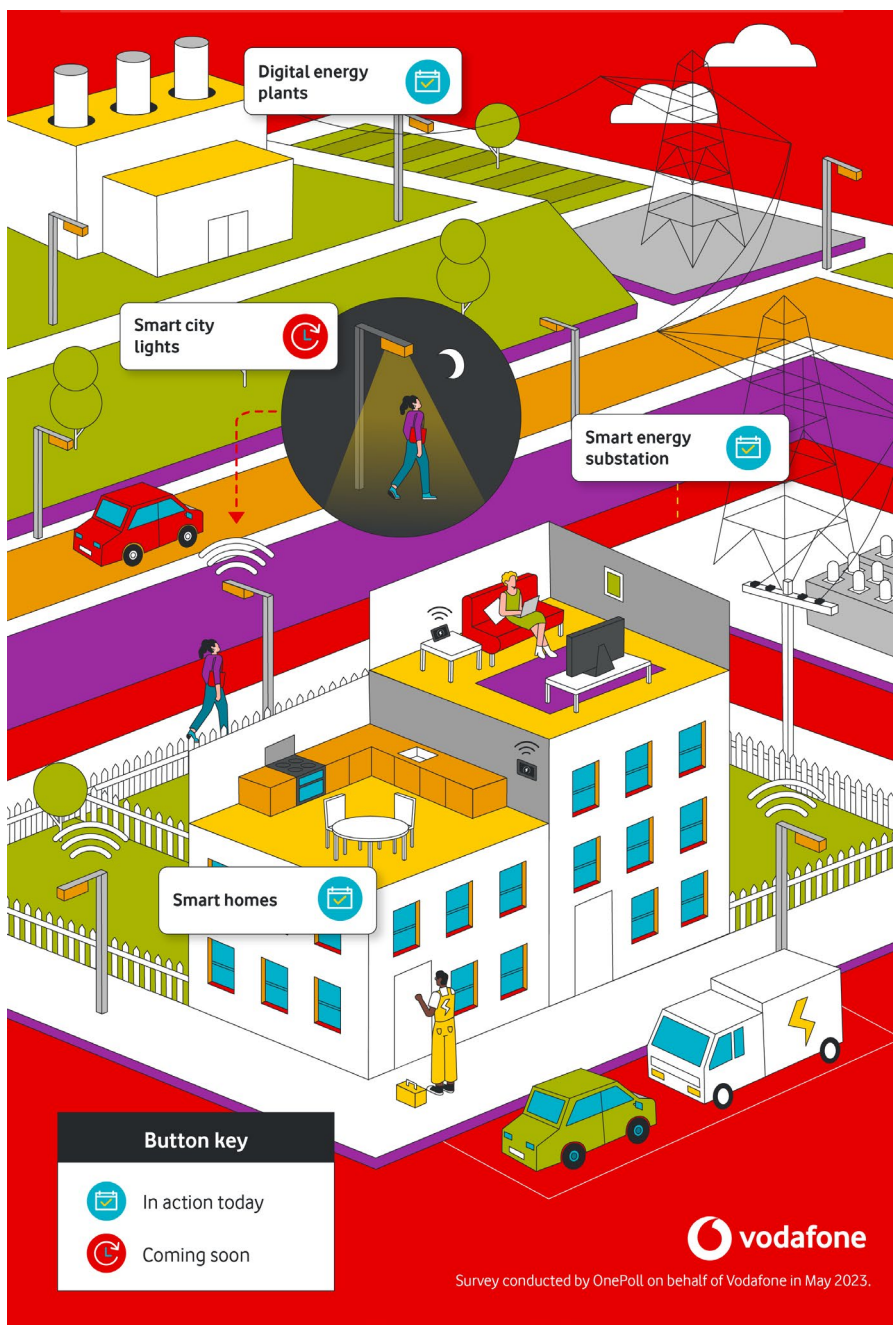


A partnership between Vodafone UK and Coventry University on a different testbed also enabled the deployment of the UK's first live 5GSA network in 2020 to enable healthcare students to take immersive AR and VR tours of the human body, assisting in the training of new doctors.

Quality of life improvements of the magnitude of the Liverpool study have been estimated to be worth £9,000 per user – which means the well-being benefits could be worth £1.4 billion.<sup>17,18</sup> Given the UK's ageing population this number has the potential to be even higher as more people come to rely on care services.

**5G connected streetlights**

5G doesn't just create financial savings across public services. It can also help enable the reduction of carbon emissions, for example by transforming our street lighting system.



There are approximately 7.2 million street lights in the UK, costing councils £882 million per year of which £300 million goes towards electricity alone.<sup>19,20,21</sup> This figure could be significantly reduced through installing 5G-enabled smart features such as night dimming and traffic sensors, which also have environmental advantages.

5G-enabled sensors allow streetlights to be grouped in networks of connected lighting systems. The high transfer speed of 5G enables data to be sent almost instantly, creating a more responsive system which can transform local communities by protecting the environment and boosting wellbeing, as well as bringing significant savings to local councils and streamlining the planning process.

Smart streetlights could also respond to traffic, switching on only when moving vehicles are approaching. They could also be easily pre-programmed to shine more brightly for a particular event, or be overridden by a centrally-managed control in the event of an emergency.

Multiple pilots have shown the economic and environmental value of smart street lighting; a test in Oslo showed energy savings could be 45%, whilst a trial in the City of London showed that in dense, urban areas the savings could be as high as 60%.<sup>22,23</sup>

If this were extended across the UK, emissions over a 5-year period could be cut by 1,075,000 tonnes of CO<sub>2</sub>, which is the equivalent of replacing 250,000 petrol or diesel cars with electric vehicles. These energy savings would translate to £700 million back in the pocket of UK taxpayers, with London alone projected to save £75 million over the same timeframe.<sup>24</sup>

The benefits of reduced lighting extend beyond saving money and improving the environment: these 5G-enabled measures would reduce light pollution, potentially improving mental health, improving sleep, and allowing for British nocturnal wildlife to thrive.

Communities also stand to benefit from the improvements to planning of local service delivery which the rollout of standalone 5G would enable. Smart street lights can be fitted with sensors which detect changes in temperature, noise, air quality, and footfall. This wealth of information could transform planning as councils are able to make more informed decisions, leading to better outcomes for citizens and businesses. For example, hyper-local traffic data provided by 5G-enabled sensors could help councils to target interventions in order to reduce pollution.





## Chapter 3. Making it happen

**This report shows the significant potential that 5G Standalone can bring to communities right across the UK. However, these opportunities will only become a reality with a strong investment environment and a consolidation of the mobile market. To meet the ambitions set out in the Government's Wireless Infrastructure Strategy, including providing standalone 5G coverage to all populated areas by 2030, market change is required.<sup>25</sup> To improve both sustainability and competition, a more consolidated market is required to enable investment in infrastructure at scale - this will drive financial contributions in our mobile networks, countering the stagnant market created by the current emerging duopoly.**

This 2030 ambition is vital, not just to individuals and households operating in an increasingly digital world who deserve to feel the benefits that a fast and reliable internet connection can provide, but vital to fulfilling the Government's ambition to position the UK as a leader in the industries of the future, and become a science and technology superpower. Indeed, 5GSA has the potential to unlock innovations utilising IoT and AI, creating 600,000 new highly skilled jobs - whilst providing a route to growth through productivity efficiencies.<sup>26</sup>

Together, Vodafone UK and Three UK will be able to meet the challenge of delivering on the goals of the Wireless Infrastructure Strategy. By combining the two networks, capacity will increase by over two and a half times by 2034 compared to today, with up to 75% greater capacity delivered by 2028 alone compared to both companies operating on their own over the same period.<sup>27</sup> In addition, the ability to deliver these services cost-effectively, and at scale, means that the new, combined entity will be able to commit to investing over £11 billion by 2034.

The proposed merger will result in a combined network that will reach over 95% of the population, including every school and hospital, with a standalone 5G network by 2030, and achieve over 99% population coverage by 2034. From day one, at least 7 million customers will immediately see improved network speeds and will benefit from reduced network congestion and less buffering. UK 4G geographic coverage will improve from 88% to 91%, exceeding the Government's 2027 targets and covering 25% of uncovered areas for current Vodafone and Three customers.

All of this will mean that the benefits of a digital society can be rolled out across the UK, generating economic benefits, saving people time, and boosting energy efficiency. In the public sector, it will support the digital transformation of local government services, healthcare, transport, and other public services, in addition to smart urban solutions. There will also be major benefits in the professional services, manufacturing and agricultural sectors, as well as gaming and broadcasting.

The UK cannot stand to lose out on the multitude of opportunities that could be realised through the speedy rollout of 5GSA across the country. From healthcare to manufacturing, transport to agriculture, it is imperative that the government unlocks the economic potential that the 5GSA network can generate. Market consolidation to drive infrastructure investment is the first step.

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WPI Strategy Limited

1st Floor,  
5-6 St Matthew Street,  
London,  
SW1P 2JT

@WPI\_Strategy

**wpi-strategy.com**

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