Connectivity and Climate Change:

How 5G will help lay the path to net zero

OCTOBER 2021

Mobile UK

BUILDING MOBILE BRITAIN

About Mobile UK

Mobile UK is the trade association of the UK's mobile network operators - EE, O2, Three and Vodafone. Mobile UK's mission is to realise the power of mobile to improve the lives of our customers and the prosperity of the UK.

For further information on the work of Mobile UK visit: **http://www.mobileuk.org/**

About Building Mobile Britain

Mobile UK launched Building Mobile Britain to support the mobile industry's collaboration with national and local government, regulators, industry, consumers and citizens to overcome the challenges to expanding mobile networks.

For further information about Building Mobile Britain visit: **http://www.buildingmobilebritain.org.uk.**

About #5GCheckTheFacts

The #5GCheckTheFacts campaign provides factually accurate information about 5G and offers answers to common queries to help improve understanding about 5G.

For further information about #5GCheckTheFacts visit: **https://www.mobileuk.org/5g-and-health**

About this report

This report was produced by Policy Points, a research organisation that specialises in evidence-based policy making: **www.policypoints.co.uk**,

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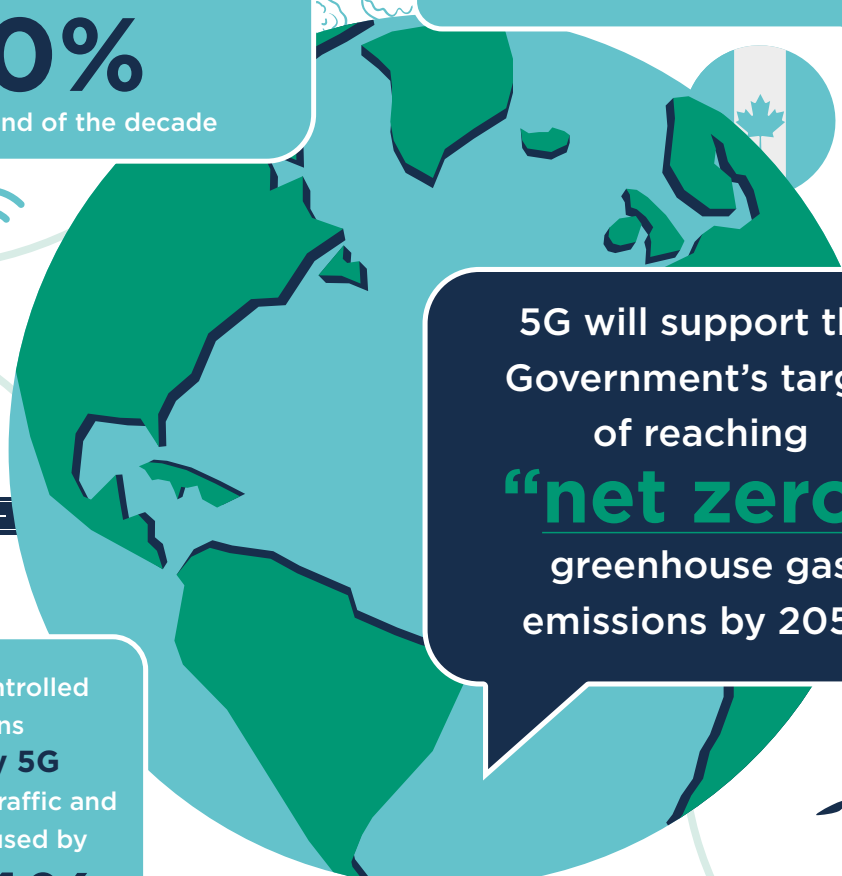
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G7

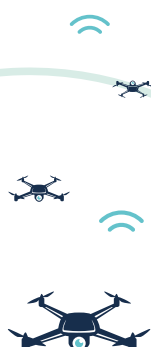Mobile technologies could help cut food wastage by as much as **50%** before the end of the decade

5G enabled technology could help the combined G7 manufacturing sectors **reduce their total carbon emissions by 1%**

5G will support the Government's target of reaching **"net zero"** greenhouse gas emissions by 2050

Dynamically controlled intersections **powered by 5G** could streamline traffic and reduce energy used by **13-44%**

5G enabled technologies in manufacturing could reduce annual carbon emissions by **2.6 $MtCO_2e$** by 2025
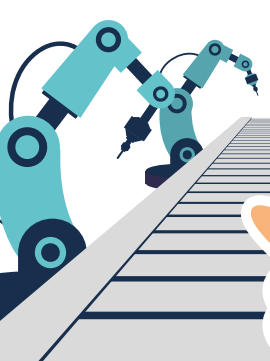
5G connected drones and sensors could improve process efficiency, cutting emissions in agriculture by **1 $MtCO_2e$**

GREENHOUSE GAS EMISSIONS

5G offers the potential to **reduce annual emissions** from transport by **6.6 – 9.3 $MtCO_2e$**

Foreword

It is widely accepted that climate change represents one of the greatest challenges of modern times. Addressing this global issue will require us all to think carefully and creatively about the ways in which we interact with our environment, and the steps that we can take to mitigate our impact.

With COP26 in Glasgow, the eyes of the world are focussed on the UK, with the government announcing in April 2021 globally ambitious climate change targets to reduce emissions by 78% by 2035.

It is therefore imperative that as a nation we are utilising every tool at our disposal to support these ambitions, encouraging creative thinking to find solutions that will help us to drive down our carbon imprint.

According to the World Economic Forum, digital technologies could reduce global carbon emissions by 15% - almost one third of the 50% reduction required by 2030.

At our innovative 5PRING Application Accelerators – operated in partnership with leading organisations including O2, Wayra and Digital Catapult – we have already undertaken a Green Innovation Challenge.

Trials have demonstrated how 5G can optimise areas such as energy production by monitoring wind turbines in real-time to maximise productivity; optimising waste flows for more efficient recycling; or gather real time data to help residents in zero carbon buildings reduce their energy consumption.

5G also has broader applications with the potential to make systems cleaner and more reliable, leveraging intelligent transportation solutions to monitor vehicle and pedestrian flows.

The integrated Road Sensor Network trial that we are undertaking with Transport for West Midlands has shown that sensors placed at junctions can reduce road emissions by over 2.5%. The connectivity will

> *"This report from Mobile UK demonstrates the significant role that the widespread utilisation and adoption of 5G technology can play to help us to reach these targets to reduce our impact on the natural world."*

At West Midlands 5G (WM5G), we have had the privilege of operating the UK's largest 5G urban testbed, working with partners across the region to test, scale and deploy next-generation solutions. We have already begun to prove the potential of advanced connectivity, data, AI and Internet of Things (IoT) to reduce carbon emissions in key sectors including manufacturing and transport.

potentially even support the use of autonomous vehicles to enable more sustainable travel, deliveries, and infrastructure maintenance.

This report represents a vital step in developing a strong knowledge base of the potential that an interconnected web of 5G solutions deployed at scale will collectively contribute to reaching the goal of net zero carbon across the UK.

Foreword by Mark Stansfeld
Chairman of WM5G

Potential 5G and wider connectivity-enabled sectoral emissions reductions

Energy

5G connectivity could save over 250 million tonnes in CO_2 emissions globally by 2030 through accelerating the move to wind and solar energy. Other research has calculated that 5G-enabled use cases can reduce carbon emissions in the energy industry by almost 1% between 2020-2030. This is the equivalent of half of all of Canada's emissions in 2018.[1]
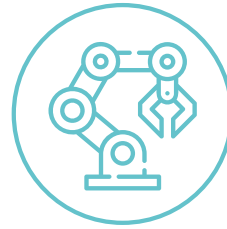
…reduce emissions from energy by

1.7 billion
tonnes of CO_2e between 2020-2030

Transport

Transportation is responsible for 24% of direct CO_2 emissions globally from fuel combustion.[2] 5G and wider connectivity, offers the potential to reduce annual emissions from transport by 6.6 – 9.3 $MtCO_2$e[*].

…reduce emissions from transport by

6.6 - 9.3 million
tonnes of CO_2e annually

Manufacturing

5G-enabled technology could help the combined G7 manufacturing sectors reduce their total carbon emissions by 1% during the period 2020-2035[3].
By way of comparison a reduction of 1% equates to around 182 $MtCO_2$e or roughly equivalent to 75% of the annual carbon emissions of France.

…reduce combined G7 manufacturing emissions by

182 million
tonnes of CO_2e by 2035

Agriculture

The agricultural industry could be transformed. Drones and sensors, connected to 5G and other networks, will support low carbon farming practices, helping to reduce UK emissions in agriculture by as much 1 $MtCO_2$e by the year 2035[4].

…reduce emissions from agriculture by

1 million
tonnes of CO_2e by 2035

MtCO2e = million tonnes carbon dioxide equivalent

Introduction:
Supporting the path to net zero

The UK has some of the most ambitious environmental policies in the world. These policies are designed to meet the Government's target of reaching "net zero" greenhouse gas emissions by 2050. It is the biggest challenge facing the world today, and will require concerted positive action from policy makers, industry and people to address, something that features centre stage for events such as the United Nations COP26 climate change conference, held in Glasgow in November 2021. The cost of not acting is enormous, with negative impacts on our health, to our natural world, and to our economic progress..

This report sets out the potential emissions reductions that are possible with the enhanced connectivity provided by 5G technologies, existing mobile networks and the Internet of Things. In particular, the focus is on how 5G can enable reductions in greenhouse gas emissions in the energy, transport, manufacturing and agricultural sectors. While 5G will have a transformative impact across the entire economy, it is these sectors that are expected to particularly benefit from the next generation of mobile connectivity. They are also crucial to efforts to reach net zero, collectively accounting for around half of all the UK's greenhouse gas emissions.[5]

Mobile connectivity already plays an important role in reducing emissions today.

Second generation (2G) and third generation (3G) mobile networks are already an important component in our ability to reduce emissions. For example, the transmitting of information to and from energy-reducing smart meters in our homes and workplaces helps consumers to understand and reduce their energy use.[1] Long before the pandemic, mobile connectivity made home-working more commonplace, reducing the carbon-emitting consequences of commuting[6]. The pandemic has created a paradigm shift in remote working and mobile connectivity will continue to play a major part. And with newer and faster technologies it will enable even more opportunities.

Trials of 5G-connected technology are already highlighting the breadth of its potential to deliver better environmental outcomes.

5G combines extremely high-speeds and reliability to allow digital devices to communicate with each other instantaneously. Trials of 5G-connected technology in Finland are already delivering better environmental outcomes. The Finnish Environment Institute used 5G-connected drones to collect real-time data on global warming's effect on toxic algae blooms, which can damage ecosystems in our oceans and lakes.[7] The MegaSense project, using 5G-connected sensors, is providing policymakers and residents with real-time information on air quality across Finland's capital city of Helsinki.[8]

5G alongside existing mobile network technologies will facilitate and enable the transition to net zero.

The Climate Change Committee (CCC) – the independent, statutory organisation advising the UK Government on meeting emissions targets – has found a consensus across industry and academia on how digital technology will contribute to net zero.

> *"The consensus is that digital technology will be vital in managing the production and use of energy across interconnected sectors, will allow energy services, prices and tariffs to be increasingly flexible and dynamic, will reduce the demand for energy, materials, food and water, and will improve the forecasting, monitoring and modelling of emissions."*
>
> *(Climate Change Committee)*

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Smart agriculture

Lower impact on natural resources

—

Biodiversity restoration

—

Better animal welfare

—

Fewer emissions from fertilisers

—

Regenerative agriculture

—

Smaller land use

Smart logistics

Lower fuel consumption

—

Continuous incremental efficiency gains

—

Supply chain traceability

—

Fewer emissions

—

Less waste (including food)

Smart manufacturing

Greater resource efficiency

—

Lower energy consumption

—

Improved health and safety

—

Circular economy potential

—

Less pollution and waste

—

Greater precision fewer faults

IOT and digital technologies

5G connectivity will be an integral part of emissions-reducing digitalisation, including through the provision of connectivity to Internet of Things (IoT) technologies.

IoT is a catch-all term for the diverse digital devices – from streetlights to thermostats to safety equipment – that are interconnected and continuously receiving and / or sending data (often reacting to these data flows to improve performance).[9] There are numerous examples of how IoT will underpin efficiency gains – and therefore lower emissions – in industrial settings including smart agriculture, smart logistics and smart manufacturing (see above).[10]

The attributes of 5G mean that it can support IoT to reach its full potential. IoT technology is available and being adopted now to reduce emissions.

More established forms of connectivity – such as 4G and WiFi networks – can provide the connectivity to support some IoT activity, but the step-change in speed, capacity and reliability from 5G means that it can support more intense use of IoT devices, that will grow exponentially in numbers and require massive data transfers.[11]

Research undertaken by O2 found that the benefits of 5G (relative to other types of connectivity) will see its use grow to be present in 50% of smart industry IoT technologies by 2035.[12]

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As well as enabling better environmental outcomes, 5G will be more efficient in its own right.

Global standards for 5G mean that, in comparison to 4G, less power will be used to transmit more data.[13] An example is that one kilowatt-hour (kWh) of electricity is required to download 300 high-definition movies in 4G, but one kWh in 5G can download 5,000 ultra-high-definition movies.[14]
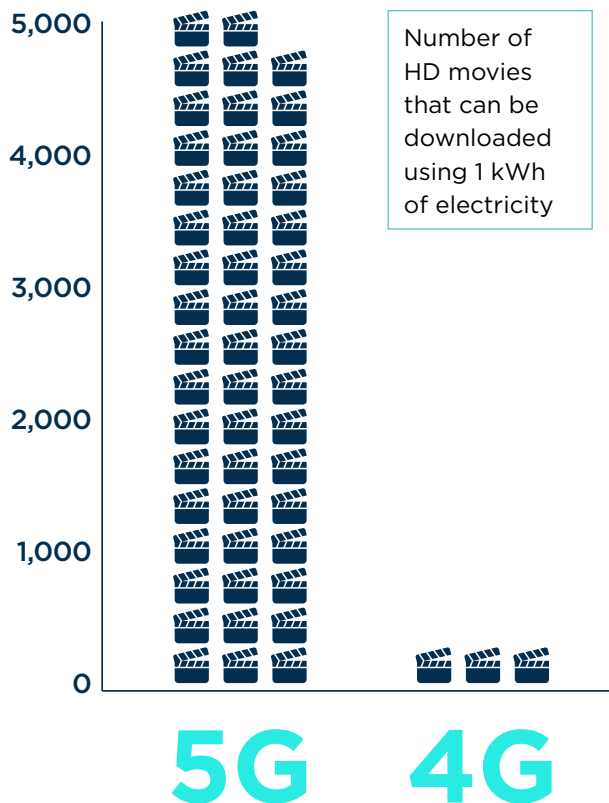
Number of HD movies that can be downloaded using 1 kWh of electricity

5G   4G

Mobile technologies could help cut food wastage by as much as

50%

before the end of the decade.

It should be recognised, however, that the mass adoption of 5G and IoT across our society and our economy will increase energy demand.

While 5G and IoT use less energy on a like-for-like basis with predecessor technologies, the increase in their use will mean energy demand increases overall (and in addition, 3G and 4G networks will still be in use). Recent calculations of the mobile industry's carbon emissions estimate them to be around 220 million tonnes carbon dioxide equivalent (Mt CO_2 e) per year or approximately 0.4 per cent of total global carbon emissions.[15]

One way of mitigating this increased energy use is by increasing energy production from renewable sources.[16] Mobile operators have recognised this within their own operations, and are switching to renewable energy sources (see page 11). Indeed, the representative body for mobile operators worldwide has set an ambition on behalf of the industry to reach net zero emissions by 2050.

Policy makers need to act if the environmental benefits of 5G-enabled IoT are to be realised.

The CCC states that the roll-out of 5G and other digital infrastructure will be critical to our net zero ambitions.[17] Ultimately, both national and local politicians need to ensure that the best possible mobile connectivity is on offer to households and businesses as quickly as possible, particularly the revolutionary connectivity of 5G. The rest of this report looks at case studies of the energy, transport, manufacturing and agriculture sectors for how mobile connectivity – and 5G connectivity in particular – can help reduce their greenhouse gas emissions.

Five key messages

1 **5G is a technology that will help mitigate climate change, one of the biggest threats to our health, our natural environment and our economic prosperity.**

The Government's commitment to net zero by 2050 recognises this, and 5G connectivity will underpin UK and global efforts to achieve it.

The faster 5G networks get built, the faster they can assist the path to net zero.

2 **Policy makers must act now to enable quicker deployment of 5G to make it possible to meet climate action targets quicker.**

To realise our climate ambitions network operators must be able to build their 5G networks more quickly so that we can achieve them sooner – policy makers need to act - planning, tax, and regulatory reform are all necessary.

3 **5G mobile connectivity will facilitate emissions-reducing technologies.**

These technologies interconnect, continuously receiving and / or sending data. The speed, capacity and reliability of 5G connectivity makes it ideally suited for Internet of Things (IoT) devices that require massive data transfers. These devices will underpin efficiencies – and lower emissions – in many sectors.

5G-enabled use cases could reduce carbon emissions in the energy industry by almost

1% by 2030

This impact over the period 2020-30 is equivalent to almost

1.7 billion tonnes

of emissions, or half of all of Canada's emissions in 2018.

4 **IoT will support emissions reductions across the key sectors of energy (and other utilities), transport, manufacturing and agriculture. While IoT devices can function using many different types of connectivity, the speed and reliability of 5G means more can be done with IoT technology.**

Energy production and energy use will be better monitored and planned. Transport infrastructure will be smarter, meaning cleaner, shorter journeys. Manufacturing production processes will be less wasteful. Agricultural practices will minimise their negative environmental consequences.

5 **5G is also a more efficient technology in its own right.**

Global standards for 5G mean that, in comparison to 4G, it is more efficient and less power will be used to transmit more data. However, the roll-out of 5G will create an upwards pressure on the operator's energy usage. The UK and global mobile industry recognises this and is committed to greenhouse emissions reductions. More information on these commitments can be found on page 11.

How mobile network operators are contributing to net zero

Vodafone

Vodafone intends to cut its global carbon emissions to net zero by 2040. To meet this commitment, the company is aiming to eliminate carbon emissions from its own activities, as well as from the energy it purchases, by 2030. Vodafone also aims to halve its carbon emissions from joint ventures, supply chain purchases and business travel, as well as from the products it sells, by 2030. In the UK specifically, Vodafone will eliminate carbon emissions from its operations by 2027. As of July 2021, the company's European network is powered entirely by renewable electricity.

EE

EE is transitioning to a low carbon business model, having previously set a target in 2008 of an 80% reduction of carbon emissions by 2020. This target was met four years ahead of schedule. BT Group has since brought forward its net zero target for 2045 to 2030 for its own operational emissions and 2040 for supply chain and customer emissions. To meet this goal, the company will target innovative ways to further reduce dependency on fossil fuels, for example through the adoption of zero carbon vehicles in its fleet, reducing the carbon intensity of its buildings, press ahead with plans to retire legacy networks and will engage with suppliers and customers on steps to take to reduce their emissions.

O2

O2 aims to reduce carbon emissions across its business by 2025, and plans to switch third-party landlords that support the O2 network over to renewable energy. O2 already uses 100% renewable energy where it controls the bill and has committed to reducing supply chain emissions by 30% by 2025. Since 2015, O2 has improved energy efficiency by 82%, thanks to innovations like its smart network that powers down when demand is low. They are the only network to receive the highest certification for carbon reduction in their supply chain from the Carbon Trust.

Following its merger in June 2021 and becoming Virgin Media O2, the new business announced it is working to achieve Net Zero carbon in its operations by 2025 and is now setting to work on reducing emissions across its value chain.

Three

Three is committed to limiting the effect it has on the environment and has been working with the Carbon Trust to understand its carbon footprint, along with assessing the pathway to becoming net zero. In 2020, around 94% of Three's buildings and network used renewable energy. A key focus for Three in 2021 is to have zero waste to landfill from their high street stores, with shopping centres and other locations following in 2022. Initiatives to reduce single use plastics through Three's supply chain are already being implemented along with Three's delivery partners, DPD, completing 15% of customer deliveries by electric vehicles during 2020.

GSMA

GSMA – the representative body for mobile operators worldwide – promotes the climate action of the industry. In February 2016, the industry was the first to commit fully to the 17 United Nations Sustainable Development Goals (SDG). Since then, it has had a particular focus on SDG13 – Climate Action. In February 2019 the GSMA Board set an ambition on behalf of the industry to reach net zero carbon emissions by 2050 at the latest.

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Connectivity to support the energy system to net zero

Data-driven production and use of energy

> *"...the complexity and scale of integrating the multiple technologies and solutions needed to meet net zero will not be possible without the digitalisation of the energy system."*
>
> ***(Energy Systems Catapult)***

Our future energy system needs to decarbonise, whilst at the same time support a wide variety of interconnected low carbon technologies. This is a complex challenge, requiring secure and affordable methods of energy production and the flexibility to adjust to different energy needs in different parts of the country.[18]

Connected digital technology – with 5G being a key feature underpinning this connectivity – will be at the heart of managing the future energy system efficiently and effectively.

This connectivity will allow the collection and analysis of vast amounts of data on energy demand, network capability and storage capacity. Combining this with data from connected transport, homes and buildings, will allow for a fully optimised and strategically planned energy system.[19]

One feature of this data-driven digitalisation is that it will support people to both produce and consume energy (which has led to them sometimes being described as "prosumers"). Connected solar panels, wind turbines and electric vehicle batteries of households up and down the country will be able to store surplus energy and discharge it back to the energy network for use elsewhere.[20]

Additional research has found that 5G connectivity could facilitate the saving of over 250 million tonnes in CO_2 emissions in 2030 through accelerating the move to wind and solar energy. Based on extensive industry interviews and detailed modelling, this research estimates that 5G-enabled use cases could reduce carbon emissions in the energy industry by almost 1% by 2030. This impact over the period 2020-30 is equivalent to almost 1.7 billion tonnes of emissions, or half of all of Canada's emissions in 2018.

Source: STL partners

The full benefits from this digitalisation will only be realised with the fastest connectivity. The Energy Systems Catapult – a Government innovation body – argues that 5G's very high data speeds and low latency can enable energy-saving IoT that is currently not feasible with slower 4G connectivity.[21]

In short, data-driven digitalisation is crucial to making the energy systems needed for net zero a success, and 5G is a key component to making data-driven digitalisation a success.

It is also worth highlighting that other utilities will also benefit from IoT technology. For instance, Vodafone has announced a 10-year deal with SES Water to provide IoT solutions to revolutionise how water leaks are prevented and detected.

This technology aims to cut leakage by 15% over next five years, and pave the way for a more than 50% reduction by 2045.[22]

BT is also working with Yorkshire Water on a NB-IoT (Narrow Band Internet of Things) solution which has the potential to deliver significant improvements in data quality and battery life, enabling Yorkshire Water to identify and prevent leaks and network incidents more accurately than ever before.

KEY STATISTICS

+ **Greenhouse gas emissions from the power sector were 65 $MtCO_2$ in 2018, 15% of the UK total.**

+ **The Energy Systems Catapult has run trials using connected homes on the effectiveness of smart energy services enabled by digital connectivity, and how they can transform mainstream consumers' experience and control of heating at home. 78% of households involved in the trial confirmed that smart heating controls improved or maintained comfort levels and 85% of households were open to switching to low carbon heating when it came time to replace their boiler (compared to around a third of the wider population).[23]**

78%
of households involved in the trial confirmed that smart heating controls improved or maintained comfort levels

Connectivity to support transport to net zero

Cleaner vehicles and cleaner journeys

KEY STATISTICS

+ Total UK emissions from surface transport in 2019 were 113 $MtCO_2e$.

+ These emissions made up 22% of total UK greenhouse gas emissions. The biggest contributing factor to these emissions were fossil-fuelled road vehicles, with cars, vans and HGVs primarily responsible.

5G connectivity will **decrease total UK emissions** from surface transport by

7%

The calculation is based upon what IoT and 5G could achieve if it were applied to today's CO_2e emissions from transport

+ The ability to synchronise speeds and shift to truck platooning via 5G-connected lorries will reduce air resistance, potentially reducing fuel use by 7 – 16%.[24]

+ 5G connected infrastructure has the potential to improve the operation of dynamically controlled intersections, thus streamlining the flow of traffic and reducing delays— potentially reducing the energy demand by 13 – 44%.[25]

+ 5G connectivity will increase vehicle efficiency. While it is difficult to say what this efficiency would translate to, there are some examples that can be used as comparators. Cars fitted with Gear Shift Indicators and Fuel Consumption Meters reduce fuel consumption by 1.5% and 0.3 - 1%, respectively.[26]

+ Research undertaken by Vodafone has suggested that digital technologies, including 5G, IoT and telematics will reduce annual emissions from transport by 6.6 – 9.3 $MtCO_2e$.[27]
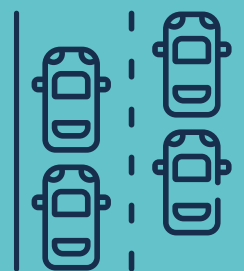
> *"The transport industry has entered a period of rapid advancement, and the pace of change is only increasing… The development and rollout of 5G mobile broadband has the potential to not only support, but accelerate these revolutionary changes as today's digital transport solutions evolve and entirely new opportunities become viable."*
>
> *(The World Bank)*

Digital connectivity – including 5G – will support reduced greenhouse gas emissions from transport in three ways.

1 By making road journeys more efficient, minimising emissions. So-called "Connected Vehicle-to-Everything" (C-V2X) technology is how this will happen. Vehicles will digitally connect to infrastructure such as predictive traffic lights, automatic toll points and hazard warning systems. Vehicles will be sat idle less frequently, meaning less energy will be consumed. Moreover, 5G-monitored parking can present information that helps road users more easily find spaces to park. In the West Midlands, one in three cars circling around city centres are looking for an available spot.[28]

The World Bank estimates that eliminating the need to search for parking spaces could drop energy use by 5%. This will support cleaner business and leisure journeys, but also means that goods transit on our roads will become less carbon-intensive.[29]

5G offers the potential to reduce annual emissions from transport by

6.6 – 9.3 MtCO$_2$e

2 By enabling people to use lower-carbon forms of transport;

Digitally-collected information makes journeys on alternative forms of transport more certain, easier and therefore more appealing – an example is the location data for bus, tram and rail that is delivered to journey planning applications and websites.[30]

But the digital nudge to low-carbon travel is about more than just information. Authorities in the West Midlands are trialling the use of 5G to capture HD CCTV images in real-time on local trams, making them safer to use.[31]

3 By making journeys less frequent. Good quality digital connectivity means that more people will be able to work from home, cutting down the carbon-emissions produced by commuting. And it is not just travelling to and from the workplace – digital connectivity, as has been seen throughout the pandemic, means less travel is needed to go to meetings when networking and collaboration can be done through a digital connection.

While 5G is only one type of digital connectivity that will drive the revolution, the World Bank believes that 5G technology widens the scope of how transport will change.

Connected and autonomous vehicles, smart and efficient logistics and improved urban mobility and public transport are expected to be key components of how transport will benefit from 5G connectivity.[32]

Connectivity to support manufacturing to net zero

+ Greenhouse gas emissions from manufacturing in the UK were 60 MtCO$_2$e in 2018. This represents 11% of all emissions in 2018.[33]

+ Our analysis suggests that 5G-enabled technology can help the combined G7 manufacturing sectors reduce their total carbon emissions by 1% during the period 2020-2035. A reduction of 1% equates to around 182 MtCO$_2$e - roughly equivalent to 75% of the annual carbon emissions of France.

+ The Climate Change Committee's Balanced Net Zero Pathway involves emissions cuts from manufacturing and construction of 70% by 2035 and 90% by 2040 from 2018 levels.

+ It is estimated that 5G-enabled technologies in manufacturing will bring efficiency improvements that could reduce the industry's annual carbon emissions by 2.6 MtCO$_2$e annually by 2035.[34]

Greater efficiency, fewer emissions

The Fourth Industrial Revolution, or "Industry 4.0", is the deployment of modern smart technologies to bring large-scale automation to traditional manufacturing processes. 5G will play an integral role in the revolution.

Central to the progress and success of this revolution is the integration of digital connectivity that will underpin the new technology.

Factories of the future will use a variety of technologies and advanced networks to improve automation, precision, quality and productivity. Some degree of automation has existed in manufacturing for decades, but smart factories will go far beyond the current practices.

Smart manufacturing advancements will bring huge efficiency savings to the industry, and with that an opportunity for substantial greenhouse gas emission reductions.

Traditional manufacturing processes have been essentially linear, with the supply chain moving through a static series of sequential steps. However, with digital interconnection – including 5G – of separate processes throughout the supply chain, and the use of AI, manufacturing will become more dynamic, adaptable and flexible, enabling real-time decisions to be made that will autonomously optimise and run the entire production process.[35]

Smart manufacturing advancements will bring huge efficiency savings to the industry, and with that an opportunity for substantial greenhouse gas emission reductions. For instance, a leading smartphone manufacturer in China installed 5G-connected AI cameras to perform quality assurance checks on its assembly line.

As a result, they witnessed an 18-fold increase in the inspection speed compared with the previous manual methods and a 6% reduction in per-unit smartphone energy consumption.[36]

A survey of 600 manufacturers by ABI Research and Nokia found that 92% are considering 4G/5G private wireless technologies to improve the flexibility and agility of their operations.[37]

The appetite for transformation within the industry is clear. Around 94% of manufacturers are currently adjusting their businesses in new ways to drive growth, and 84% see climate change and a carbon-neutral future as an opportunity to transform.[38]

Industry 4.0 promises huge benefits to productivity, efficiency, cost and greenhouse gas emissions within the industry. But the requirements for cutting edge digital infrastructure to power the revolution are equally considerable. The complex interconnected supply chains envisioned will require vast amounts of data to be transferred across networks rapidly.

5G – which can transfer more data more reliably and rapidly and ensure the quality of connections – will be a key component of the digital plumbing in the vast networks operating in smart factories. With 5G technology, up to 50,000 devices such as sensors and actuators can be connected to a network per cell.[39] This capability will be critical to achieving the ambitions of revolutionising manufacturing. Therefore, the connectivity needs to be in place for the emissions-reducing potential of manufacturing to be fulfilled.

5G enabled technology could help the combined G7 manufacturing sectors **reduce their total carbon emissions by 1%**

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Connectivity to support agriculture to net zero

KEY STATISTICS

+ Greenhouse gas emissions from agriculture were 54.6 $MtCO_2e$ in 2018. These emissions accounted for 10% of all UK greenhouse gas in 2018, an increase from 7% in 1990.

+ The CCC has estimated that annual agriculture Greenhouse gases will have to fall by 36% under its central scenario for the UK to reach Net Zero.

+ Our analysis suggests that 5G-enabled technology such as drones and sensors will be part of these low carbon farming practices, helping to reduce emissions in agriculture by as much as 1 $MtCO_2e$ by the year 2035. This includes a reduction in emissions by 0.5 $MtCO_2e$ in the year 2035.[40]

A digital revolution in farming

The terms "precision farming", "digital farming" and "smart farming" are used interchangeably to describe the technology that is set to revolutionise agriculture in the coming years.

Digital connectivity – including mobile connectivity – underpins the technology that is driving the revolution.

Examples of what this means in practice are many and varied. Sensors will collect information on key agricultural variables such as temperature, moisture, light, humidity and grassland yields. Farm machinery – such as autonomous tractors that can plough fields and drones that can spray crops – will be deployed and controlled remotely, without the need for humans to manage the machinery in-person.[41] Digital tags on livestock can monitor the health of animals that are spread over large areas of land, allowing sick animals to be targeted early and effectively, and preventing the spread of infections in herds.[42] New wearable, mobile-connected technology for cows that reduces methane emissions from the animals' nostrils is currently being trialled.[43]

"Mobile connectivity is very important for digital farming. Many devices need a mobile connection in order to work… the idea is very much that the smart phone or the tablet, with the farm management software, will be an integral part of managing your farm operations and for that you need a seamless mobile connectivity."

(Ulrich Adam, former Secretary General of the European Agricultural Machinery Association[44])

All of this enables greater efficiency in agriculture. Where there are greater efficiencies, there will be reductions in the emissions that harm our environment.[45]

For instance, an initiative in Ireland in 2020 trialled smart farming practices, finding that costs fell by an average €5,600 and greenhouse gas emissions fell by 9% at participating farms.[46]

The technology described is not just enabling farmers to reduce their emissions. The entire process that begins with a farmer growing crops and that ends with food on our plates is set to be transformed by IoT technology.

It has been predicted that food wastage could be reduced by 20% by 2025, and by as much as 50% before the end of the next decade. The CCC states that reducing food waste would reduce agricultural emissions by avoiding unnecessary food production and allowing a more efficient use of land.[47] This is extremely important when considering food production will need to increase by 70% by 2050 in order to meet the demands of population growth.

Drones and sensors, **connected to 5G networks,** could help reduce emissions in agriculture by

1 MtCO$_2$e
by 2035

The promise of IoT technology is huge, but it needs the digital plumbing of extremely high-speed connectivity to collect data, allow Artificial Intelligence to spot patterns, and then use the information to influence a course of action.

Therefore, a variety of connectivity options, including 5G connectivity needs to be in place for the emissions-reducing potential of agriculture to be fulfilled. For instance, currently only around a quarter of UK farms use precision farming techniques to guide the application of fertiliser.

The more and better mobile connectivity there is, the more likely that greenhouse gas reductions from agriculture can be achieved.

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Recommendations

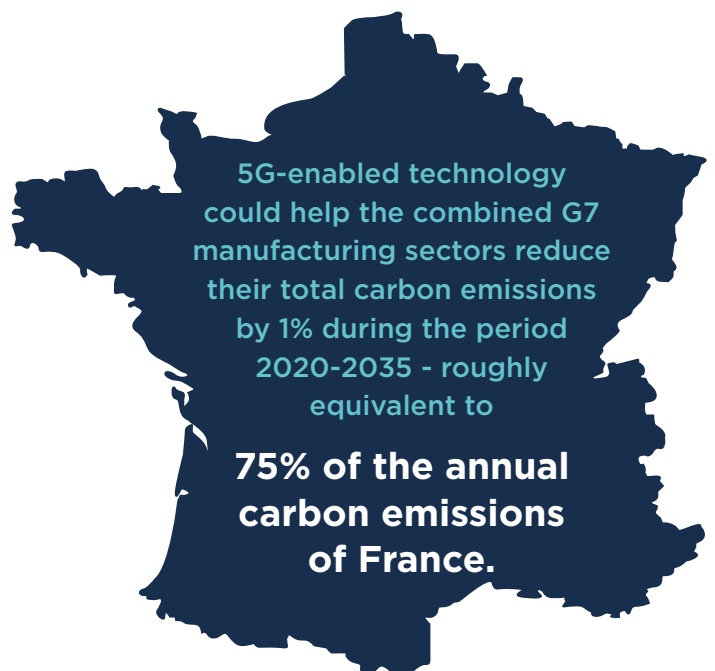## Ensuring mobile connectivity

The previous chapters have demonstrated how mobile connectivity – and particularly 5G – is crucial to net zero.

However, to realise the potential of 5G, IoT, and related mobile technologies to help facilitate climate action, Governments and policy makers need to act now. More rapid deployment of these networks will help realise our climate targets more quickly.

Therefore, building mobile networks quicker will enable national and local government to realise their environmental goals sooner. In order to do this, policy and regulatory frameworks need to be right. To get these policy and regulatory frameworks right requires:

- Reform the Permitted Development Rights regime to enable fast and effective deployment of mobile infrastructure.

- Provide Government support for wider and more effective adoption of the reformed Electronic Communications Code.

- Appoint of local authority digital champions to facilitate and assist mobile infrastructure rollout.

- Ensure that all Local Development Plans reference the importance of mobile infrastructure to economic development and social inclusion.

- Require all public bodies to make their assets available for siting mobile apparatus on Electronic Communication Code Terms.

- Introduce business rates relief for new mobile infrastructure development, especially in harder to reach areas.

- Continue to promote of full-fibre deployment to facilitate mobile and 5G rollout

- Action to be taken by the Government to incentivise take-up of technologies in key sectors that will benefit from 5G. This will enable the opportunities and technologies that 5G connectivity can facilitate to be realised more quickly and ensure that the role of mobile technology is better understood in the path to net zero.

5G-enabled technology could help the combined G7 manufacturing sectors reduce their total carbon emissions by 1% during the period 2020-2035 - roughly equivalent to

75% of the annual carbon emissions of France.

Methodological notes and sources

For the statistic on manufacturing emissions reductions created from 5G, the process and sources used were:

- Understand the baseline for future profile of manufacturing emissions in the G7, based on previous performance (source: CAIT Climate Explorer).

- Understand the how various factors will contribute to reduced emissions against this baseline, i.e. improved resource efficiency and materials substation. (source: Climate Change Committee Sixth Carbon Budget sector focus on manufacturing).

- Apply assumption of how 5G will contribute to reduced emissions against the baseline (source: O2 – A Greener, Connected Future).

For the statistic on agricultural emissions reductions created from 5G, the process and sources used were:

- Understand the impact of productivity improvements on agricultural emissions (source: Climate Change Committee Sixth Carbon Budget sector focus on agriculture).

- Apply assumption of how 5G will contribute to reduced emissions against the baseline (source: O2 – A Greener, Connected Future).

More generally, the Climate Change Committee's Sixth Carbon Budget analysis and methodology was used to inform thinking around the statistical sources.

Endnotes

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Notes

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