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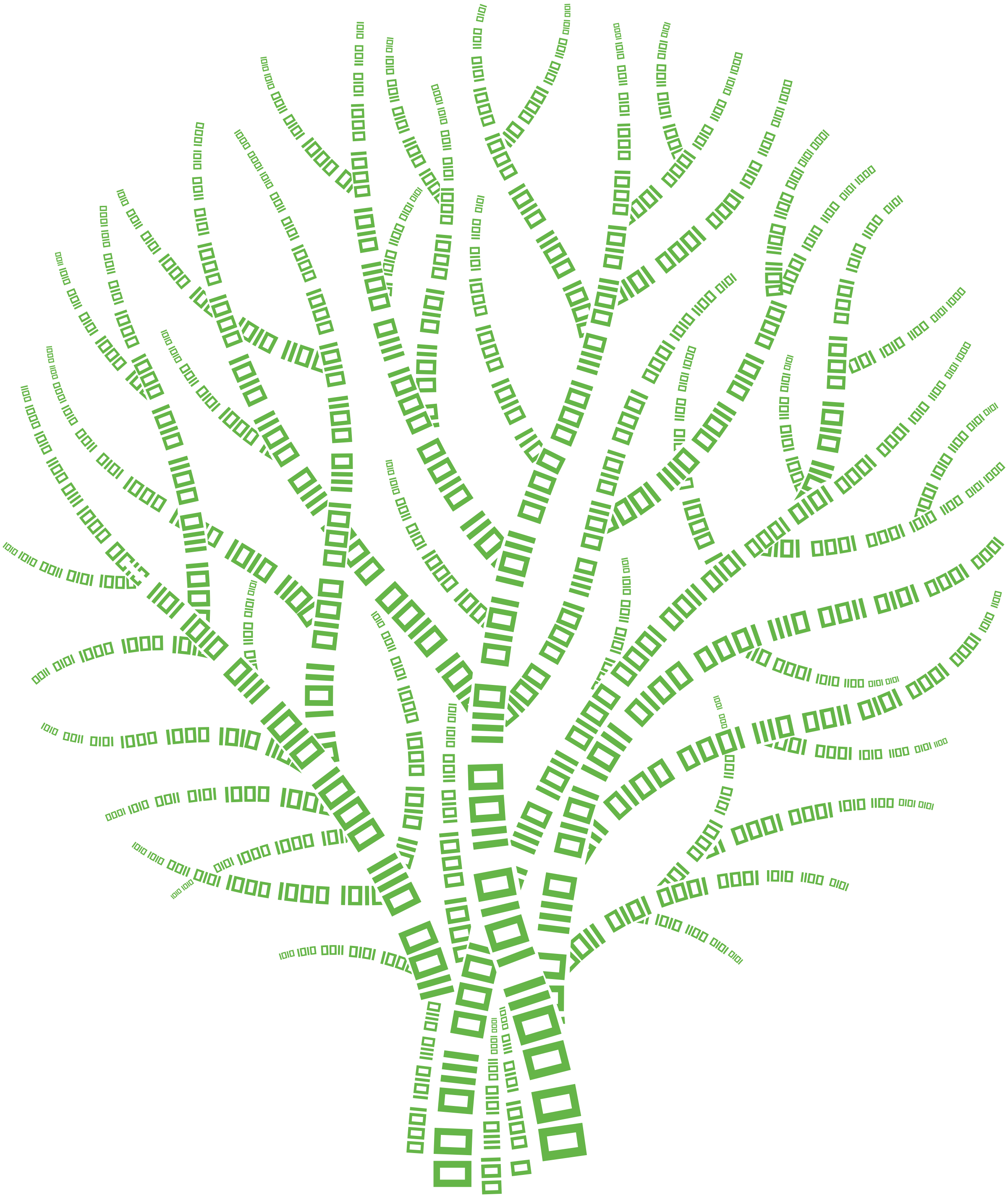

Tech for impact

The economic and environmental impact of digital technologies in the UK

September 2020

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Foreword

At Deloitte, our purpose is to make an impact that matters for our clients, our people and society. Under this banner, we make an enduring commitment to play a positive role in society, to help tackle the challenges of climate change and sustainable growth, of trust in business and of a skilled workforce fit for the future.

But our commitment to purpose doesn't just benefit the wider world. We believe that by focusing on impact we will build better relationships with our clients, develop greater engagement with our people and continue to be a trusted brand in the market. That's why we see a focus on impact as truly 'win-win'.

Of course, this phenomenon is not limited to organisations like Deloitte. As societal and commercial value converge, all parts of the system can enjoy benefits of a commitment to impact.

In this report, our analysis explores the 'win-win' of clean technology in the UK. As this sector grows, not only will clean technology deliver a positive environmental impact, but it will deliver a positive economic impact too.

This report presents new economic analysis of the impact of clean tech across a set of five sectors of the UK economy. Our analysis has been conducted in support of techUK and their paper 'Making the UK a Clean Tech leader' and in doing so, built upon our previous work with GeSI on our research study 'Digital with Purpose: Delivering a SMARTer2030'.

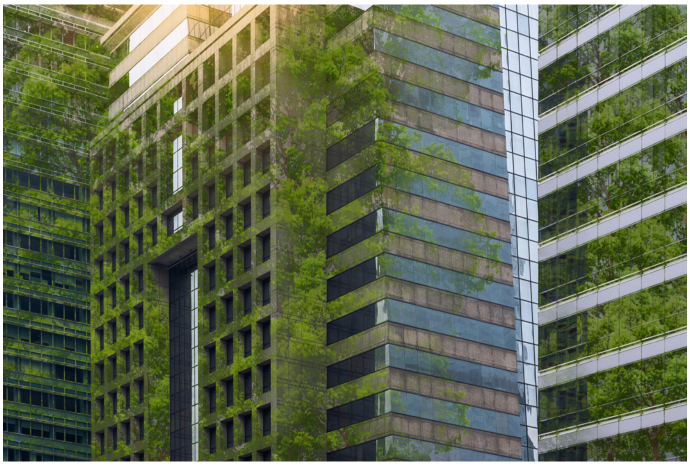
We are grateful to techUK and their members for supporting our analysis and providing case studies and additional insights reflected in this report.

We hope this report adds to the growing body of evidence in support of clean technology and will encourage policy makers, business leaders and consumers to continue to support and encourage its growth as we together strive to make an impact that matters.

David Halstead

David Halstead
TMT Industry Leader, Deloitte UK

Introduction



In June 2019, the UK became the first major economy to commit to a legally binding net zero emissions targets by 2050.

Achieving the target will require bold transformations across all industries and sectors of the economy. Whilst a fraction of the ambition will be delivered through high quality offsetting schemes that act as greenhouse gas removals, the majority of carbon reduction will be driven by operational changes to how we live and work – all of which will be in some way enabled by technology.

As the UK looks to a net zero future, policy makers and business leaders face a clear opportunity to embrace the advancements in clean technology that will both enable our climate ambitions and, in a 'win-win', support our economic growth.

This report, based on new research from Deloitte, explores the expected environmental and economic impact of the increased adoption of clean technology across five critical sectors in the UK economy: manufacturing, agriculture, energy and utilities, mobility, and buildings.

The findings of this report are featured in techUK's policy paper "Making the UK a digital clean tech leader."

Methodology

The analysis for this report substantially builds on analysis Deloitte previously conducted with GeSI, and which is featured in 'Digital with Purpose: Delivering a SMARTer2030' (GeSI and Deloitte, 2019). With input from techUK members, this report sets out a UK-centric view of the expected environmental and economic impact of clean technology according to one economic and one environmental indicator that could be delivered by 2030 for each of the following sectors: manufacturing, agriculture, energy and utilities, mobility and buildings.

The analysis focusses on key digital technologies in each sector for which it is possible to quantify their potential impact. In some sectors, such as manufacturing, the digital technologies being analysed are a broad collection of technologies. In other sectors, such as buildings, the digital technologies concerned are quite specific and so the analysis may not capture other potential applications of digital technologies that may generate impact in the sector.

With regard to the environmental impact, the main analysis presents figures without including the potential 'rebound effect.' This effect reflects the risk that improvements in efficiency might result in increased consumption which would undo such improvements, for example, an improvement in the efficiency of cars which made it cheaper to drive may result in people driving more. Some estimates put potential rebound effects at around 50%, however there is a large amount of uncertainty around these estimates both at a country and sector level driven by the economic and public policy context. However, it is generally expected that the rebound effect for developed countries will be lower than for developing countries (where demand is generally less sated, as incomes and consumption per capita are lower).[1]

The results in this report represent estimated values for 2030. This analysis does not incorporate the potential impact of COVID-19 on economic behaviours, which might persist to 2030 and alter the underlying BAU projections or the impacts of digital technologies.

Economic impacts are presented in terms of 2030 Gross Value Added (GVA)[2], adjusted for inflation.[3] The exceptions are the impact for mobility, which is presented in terms of the value of time saved, and the impact for energy and utilities, which is presented in terms of savings in consumer energy bills. Environmental impacts are shown in tonnes of CO2e which refers to carbon emissions or equivalent.

For more detail on the methodology, please see the Appendix.

Summary findings

Economic impact

The total contribution of the manufacturing, agriculture, and buildings sectors[4] to the UK economy is estimated to increase by £114bn GVA in 2030, equivalent to 6% of total UK GVA in 2019.[5.] The economic impact that can be directly attributed to digital technologies in 2030 is estimated to be 12% of this increase, equivalent to around £13.7bn GVA. As an illustration, this increase is roughly equivalent to the current GVA of the pharmaceutical manufacturing industry in the UK.[6]

The breakdown of economic impact breakdown by sector in Figure 1 shows that an estimated 97% (£13.3bn) of this impact is expected to come from the application of 'Industry 4.0', i.e. digital technologies in the manufacturing sector. Smaller impacts are expected from the application of smart building technologies in the builsing sector, in the form of app-based temperature and lighting controls (a small part of the potential smart building technologies to be applied in the coming decade),[7] and precision farming techniques for the production of cereal crops in the agriculture sector.
These account for 2% (£289m) and 1% (£120m) of the total impact.

Beyond the measured GVA impact, it is estimated that application of smart grid and smart meters is estimated to reduce total consumer energy bills by £354m in 2030; and application of intelligent traffic systems is estimated to save drivers on UK roads time equivalent to around £1bn in 2030.

Environmental impact

The UK's total greenhouse gas emissions between 2019 and 2030 are estimated by BEIS to fall by 48 Mt CO2e,[8] equivalent to 11% of total UK CO2e emissions in 2018.[9] The environmental impact that can be attributed to digital technologies in 2030 is estimated to be equivalent to 15% of this decrease, reducing UK 2030 emissions by 7.2 Mt CO2e. As an illustration, this annual saving is greater than the total current annual emissions of a number of countries such as Jamaica, Cyprus, Latvia and Uruguay.[10] Taking into account a potential rebound effect of 50%, this impact may be lower, at 3.6 Mt CO2e, equivalent to 8% of the decrease projected by BEIS.

The breakdown by sector in Figure 2 shows that 52% (3.7 Mt CO2e) of the savings come from application of smart grids to energy networks, followed by 24% (1.7 Mt CO2e) from the use of Industry 4.0 in manufacturing. Of the remaining savings, 12% (0.9 Mt CO2e) come from the use of precision farming to reduce enteric fermentation-related emissions from livestock, 9% (0.7 Mt CO2e) comes from the use of intelligent traffic systems on urban emissions, and 3% (0.2 Mt CO2e) comes from the application of smart buildings technology.

Figure 1. Impact of digital technologies in manufacturing, agriculture and buildings
GVA 2030 (constant 2015 GBP, billions)

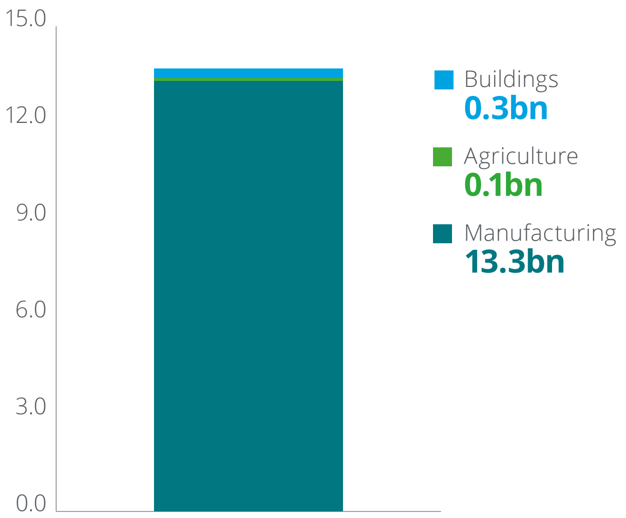
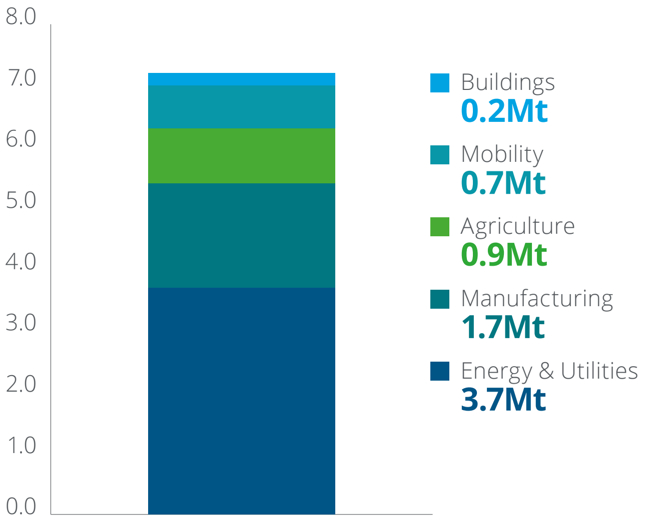


Figure 2. Impact of digital technologies on sector-related emissions
CO2e emissions 2030 (Mt)



Focus sector: Manufacturing

The reduction of carbon emissions in manufacturing is primarily driven by the 'digitisation' of the sector through 'Industry 4.0'. This refers to a new Industrial Revolution, driving a digital transformation of manufacturing practices focusing on interconnectivity, automation, machine learning and real-time data.

Advanced digital technologies, such as Internet of Things (IoT), Artificial Intelligence (AI), Digital Reality and Blockchain, are applied to enable greater interoperability, flexible processes, and intelligent manufacturing.

Examples of digital transformations in the manufacturing sector include: automated workflow management, predictive maintenance, inventory optimisation and predictive modelling that estimates market demand.

Whilst about two thirds of manufacturing-related emissions can be eliminated with a switch to 100% renewable electricity, eliminating the remaining third of emissions is complex. Manufacturing creates carbon emissions at all points of the value chain, from raw material mining and material sourcing, to industrial processes and non-electrical energy consumption, all the way through to up – and downstream transportation and distribution.

Industry 4.0 is driving a digital revolution across all aspects of manufacturing processes. As there are a variety of processes involved across the manufacturing sector, the utilisation of transformative technologies has the potential to impact: energy efficiency, consumption and demand, inventory management, and operational controls such as lighting and cooling.

Most notably, there is great enablement potential across the sector to streamline efficiency and reduce energy demand within manufacturing processes.

In the era of Big Data, machine learning demonstrates considerable potential to drive the reduction in carbon-equivalent impact by streamlining the supply chain, improving production quality, predicting machine breakdowns, optimising heating and cooling systems, and prioritising the use of clean electricity over fossil fuel consumption. The utilisation of machine learning is dependent on the availability of high-quality data and transparency across the sector.

Supply chains across the manufacturing sector are notoriously complex, with production often utilising cheaper labour in less-developed markets, where the environmental impact of this additional transportation is a secondary concern. As more organisations recognise the often unmeasured carbon impact of manufacturing within their supply chain (i.e. Scope 3 emissions), scrutiny over environmentally friendly manufacturing practices has increased, particularly where hardware manufacturers have set science-based targets (including Dell, HP Inc, HPE, Sony, Xerox, Nokia, Ricoh, NEC, Logitech, Lenovo, Konica Minolta, Hitachi, Cisco and Brother).

Economic impact

Based on existing trends, it is estimated that the current GVA of manufacturing in the UK, accounting for approximately 11% of total GVA, is expected to rise from around £158bn to £166bn by 2030 (values are in 2015 prices). However, the digital transformation of manufacturing via the adoption of Industry 4.0 is expected to produce substantial productivity gains by 2030. Smart factories that enable automated workflows, predictive maintenance, and real-time monitoring of raw materials and work in progress could increase the value of manufacturing activities across the UK to around £179bn. Here, an increase in GVA of 8% is attributable to Industry 4.0 relative to a scenario without increased adoption of Industry 4.0 technologies by 2030.

Environmental impact

Manufacturing currently accounts for around 55 Mt CO2e in the UK, approximately 12% of total emissions.[11] Based on existing trends, manufacturing emissions are expected to decrease over the next decade to around 24 Mt CO2e. The increased deployment of Industry 4.0 technologies such as smart factories is expected to reduce this further through productivity and efficiency gains. For example, IoT in factories will ensure machines are used more efficiently, optimising their operations and energy consumption. Increased adoption of Industry 4.0 is expected to potentially decrease manufacturing emissions by a further 7% to 22 Mt CO2e in 2030, compared to a scenario without increased adoption.

Figure 3. Impact of increased Industry 4.0 adoption on manufacturing productivity in 2030

Manufacturing productivity (manufacturing value added, constant £2015 billions)

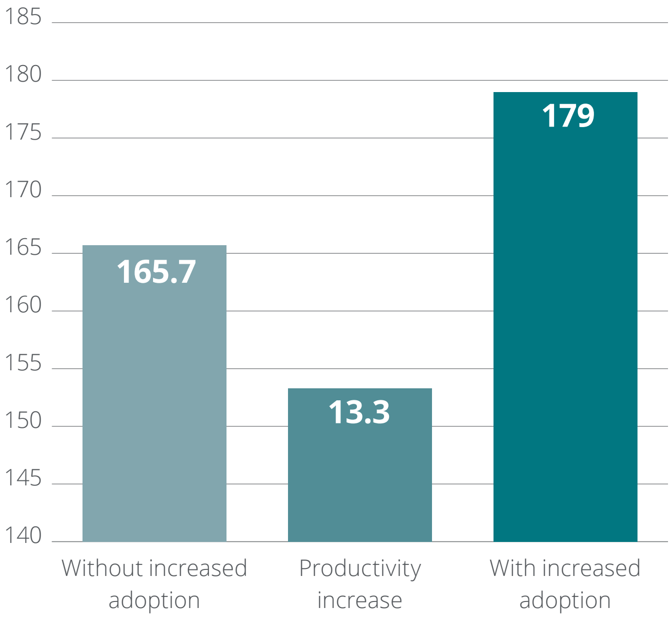
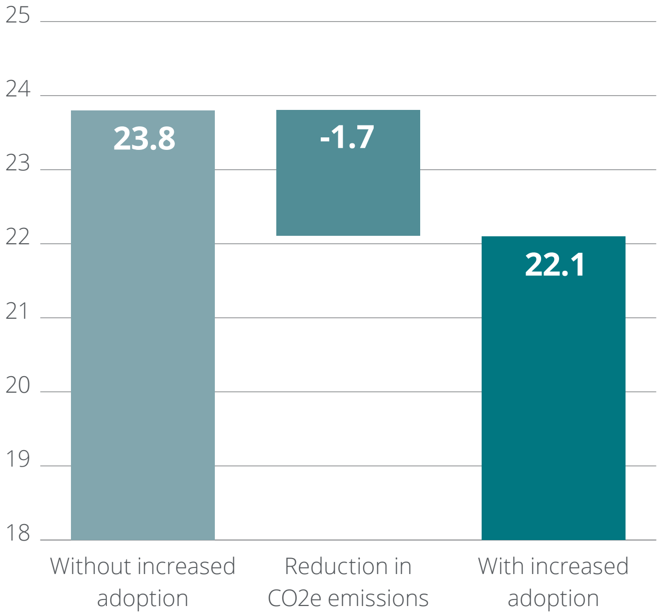


Figure 4. Impact of increased Industry 4.0 adoption on manufacturing emissions in 2030

Manufacturing emissions (Mt CO2e)



It is estimated based on existing trends that the current GVA of manufacturing in the UK, accounting for approximately 11% of total GVA, is expected to rise from around £158bn to £166bn by 2030 (values are in 2015 prices).

Case studies

Lineage, a global food warehousing and distribution company with operations in the UK, engaged ndustrial.io, a company specialising in detailed operational data for industry and IoT technology. Together with AT&T IoT connectivity, they used smart meters and sensors to better manage cooling operations. This information has enabled Lineage to develop cold storage management processes that have led to a $4 million reduction in cost and a reduction in emissions equivalent to 10.9 million litres of petrol.[12]

BMW harnessed the potential of digital technology in production by piloting human-robot cooperation. Ergonomic human-robot cooperation allowed robots to assume labour-intensive tasks, complimenting humans' flexibility, intelligence and sensitivity. The use of automation to move equipment and parts within a factory, as well as sensors and data analytics to monitor production through a digital twin, is forecast to halve production time and power required, as well as reduce water use per car by ~70% in comparison with their production average.[13]

AT&T harnessed IoT technology to connect durable pallets to the internet, allowing clients to maintain oversight of an inventory. This connectivity enabled widespread adoption of connected pallets, generating commercial and environmental benefits including: reduced fuel consumption from reduced load weight, reduced waste from broken pallets, and reduced raw material use as the more durable pallets can be used 162 times before the end of life, compared to ~18 times for wooden pallets. This translated into a potentially significant reduction in carbon. If 1 million wooden pallet trips were replaced with composite pallets, 640 tCO2e would be reduced per year. That is a 21% reduction in tCO2e emissions in comparison with their wooden alternative.[14]

Looking forward

Manufacturing is being transformed by innovation and automation, becoming increasingly simplified and efficient. As the cost of these technologies decreases and they become easier to implement, the technologies will have great potential to enable decarbonisation.

We might expect particular progress around excess stock – which, according to the Council of Supply Chain Management Professionals, amounts to $8 trillion worth of goods globally. The carbon emissions associated with the production, shipment and climate-controlling of storage facilities for over-produced stock are significant. There is, therefore, an opportunity for machine learning to help, both by improving demand forecasting and by reducing the carbon impacts of excess stock and the associated production, storage and transportation requirements.

Further, the Internet of Things offers the opportunity to manufacture products on-demand, especially if paired with localised 3D printing. On-demand manufacturing can radically reduce consumption of raw materials, provide a bespoke solution for the buyer, and reduce the commercial and environmental costs of waste and distribution.

Machine learning also has the potential ability to further minimise the emissions related to carbon-intensive materials and chemicals. For example, cement and steel production together account for over 10% of all global GHG emissions, with the cement industry alone emitting more greenhouse gases than every country bar the US and China. Machine learning, paired with additional digital technologies, such as generative design and 3D printing, has the potential to shorten supply chains and enable structural products that require less raw material and support the development of new climate-friendly materials with the same functional capabilities as cement or steel.

Focus sector: Agriculture

Agriculture is responsible for around 9% of UK emissions. Whilst around half of those emissions are driven by the methane produced by cows and sheep, clean technology has a critical role to play in reducing other sources of emissions, through 'precision farming'.

Through satellite tracking, radio-tags on livestock, airborne thermal imaging and ground-level sensors, precision farming brings IoT sensors and AI systems together to monitor farm data in real time. The systems can automatically react to changes in conditions and crop health to optimise yields and reduce the use of equipment and resources – such as water and fertiliser.

For example, the nitrous oxide from fertiliser use accounts for around a third of agricultural emissions. By precision farming using satellite imagery, farmers can focus their use of fertiliser on just the areas that need it – saving both money and emissions.

Precision farming can also be deployed to reduce the carbon dioxide emitted by tractors and vehicles through more efficient and effective routing, guided by a data driven understanding of where and when intervention is needed.

Beyond the deployment of clean technology to improve efficiency, the agriculture sector has a critical role to play in carbon sequestration.

Plants and vegetation absorb carbon dioxide from the atmosphere as they photosynthesise to generate energy. The absorbed carbon is broken down to fuel the regenerative carbon cycle or stored deep underground. When forested land mass is cleared for farming or livestock grazingit not only increases deforestation, but also replaces the carbon removal effect of vegetation with potent methane emissions from livestock. The World Wildlife Fund estimates that 27 football fields of forest are lost every minute globally.

Through the careful management of forests and vegetation, including planting cover crops between main cash crops and crop rotation, farmers can increase the organic matter in soil so that it holds more carbon. Other gains can be achieved from planting trees, hedges and other flora. Indeed, carbon sequestration shows signs of becoming an important income stream for farmers, as part of a burgeoning market for carbon offsets.

Economic impact

Agriculture is a vital part of the UK economy and meets a large proportion of the domestic food consumption needs. According to the Department for Environment, Food & Rural Affairs, the agriculture sector contributed around £10.4bn of GVA to the UK economy in 2019.[15] Based on historical trends, it is estimated that yield production (measured as cereal crop harvested per hectare) is around 11,239 kg/ha today and is expected to increase to 11,701 kg/ha in 2030. This is equivalent to a contribution of £1.9bn GVA today and £3.0bn in 2030 (values are in 2015 prices), and accounts for around 14% of agriculture GVA in the UK. The increased adoption of precision agriculture techniques, including IoT sensors and AI systems to monitor farm data in real time and to automatically react to changes in crop health, can further increase yield production by 4% to around £3.2bn. This would represent an additional contribution of £120m of GVA to the UK economy in 2030.

This analysis is limited to the impact of precision agriculture on cereal crop production, and does not take into account other crops, which may further increase agriculture productivity.

Environmental impact

In 2019, the total livestock population was around 37m in the UK, with cattle and calves accounting for around 26%.[16] Feed production and processing as well as enteric fermentation from ruminants such as cattle are amongst the main sources of agriculture emissions. It is estimated that CO2e emissions from enteric fermentation will account for around 20.8 Mt CO2e in the UK in 2030, approximately 5% of total emissions. Precision agriculture technologies use IoT sensors, cameras, microphones, and satellite systems as well as control and robotics, which enable automatic real-time monitoring of animal welfare, production and environmental impacts to increase efficiency.[17] Increased adoption of these technologies could reduce emissions from enteric fermentation by almost 4% to 19.9 Mt CO2e in 2030. This is equivalent to additional savings of 900 Kt CO2e, compared to a scenario without increased adoption of precision agriculture.

This analysis only considers the impact of precision agriculture on CO2e emissions from enteric fermentation. However, these technologies can also enable improved fertiliser use, and increase the efficiency of soil and water management, which may decrease emissions from agriculture further.

Figure 5. Impact of precision agriculture on yields in 2030

Cereal yield (kilograms per hectare)

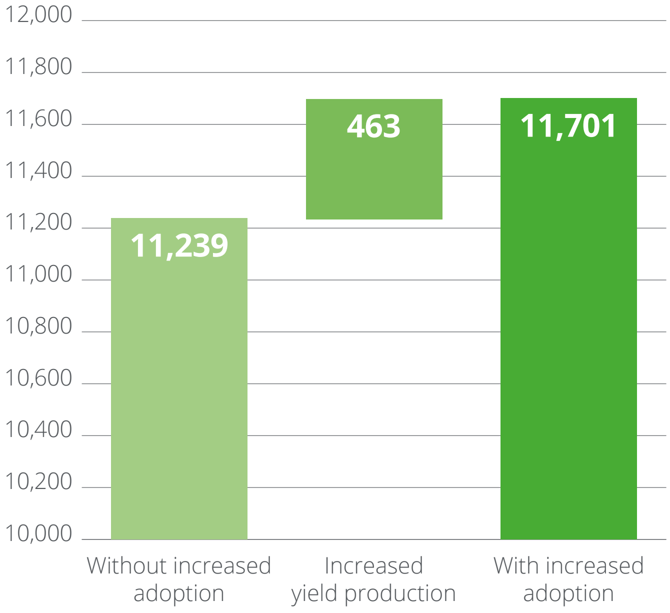
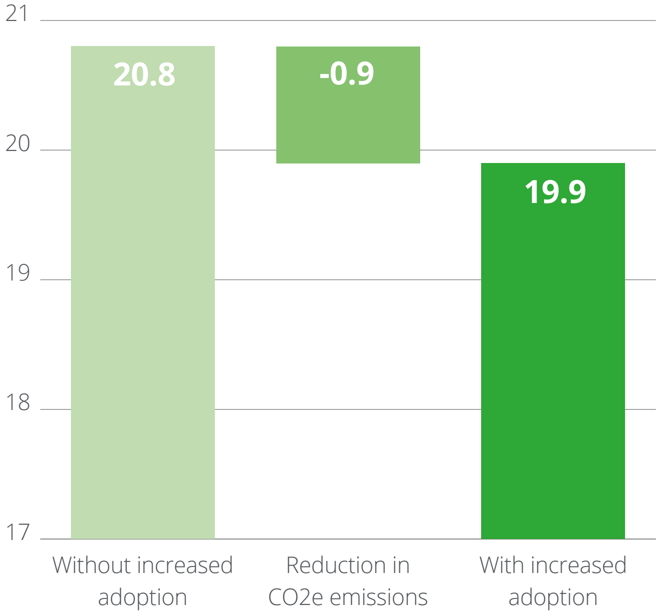


Figure 6. Impact of increased precision agriculture adoption on emissions from enteric fermentation in 2030

Mt CO2e from enteric fermentation (livestock)



Case studies

Dendra is an Oxford-based tech company that plans to plant 500 billion trees by 2060, utilising AI and drones. The drones survey and identify ideal environments, collect detailed terrain data, and generate high quality 3D maps of the areas, aiding reforestation. The typography of the soil is mapped, appropriate species selected, and planting patterns agreed on by the team. The drones then disperse biodegradable seedpods, using pressurised air, into the ground across large areas. The seedpods are filled with a germinated seed, nutrients, and other essentials, and when they penetrate the ground and reach moisture, they activate and grow. Dendra estimates its technology can enable governments to restore forests 150 times faster than planting by hand, and up to 10 times cheaper. The technology can be used to sow grasses and shrubs, and is expected to seed in micro-organisms and fungi in the future to encourage long-term ecosystem sustainability.[18]

IBM and **Yara** launched YaraIrix, a smartphone tool for precision farming. YaraIrix measures chlorophyll levels, using hardware paired with a smartphone camera. This enabled precise measurements of the nitrogen needs of crops and made it easier for farmers to apply the correct amount of fertiliser, reducing the overall amount of fertiliser applied, and saving emissions of nitrous oxide.[19]

AT&T developed PrecisionKing, an IoT solution that connects water-level sensors to water pumps, to enable automated irrigation. The sensors were placed across farmers' fields where they monitored water levels every hour, 24 hours a day. The sensor data was transmitted to a management system that can be programmed with customised parameters to automatically signal the pumps to turn on or off. This technology has the potential to save 80,000 US gallons of water and 0.28 Mt CO2e per acre of farmland.[20]

Looking forward

The majority of agricultural practices in the UK are small or medium sized enterprises that vary in their level of technology adoption due to a host of reasons, including weakened rural connectivity. The continued roll out of connectivity and innovative 5G solutions has the potential to enable farmers to utilise the benefits associated with the digitalisation of agriculture, driving both cost reductions and carbon savings.

Looking to the future, we might expect increased use of drones with sensors and cameras to provide farmers with an enhanced insight into their land use. This would aid decisions such as where best to lay crops and efficiently deploy resources.

Remote sensing of emissions through drone utilisation and machine learning makes it possible to estimate the amount of carbon sequestered in a given area of land, as well as track GHG emissions from it. Machine learning and big data modelling allow management to closely monitor risks to the health of forests and peatlands. Modelling can identify and flag physical risks, such as fires, droughts, other adverse weather events and pest outbreaks.

Hydroponics and vertical farms located in urban environments are also expected to continue to proliferate. These farming methods combine a reliance on digital technology with a reduced carbon footprint, and are expected to sit alongside traditional agriculture in the UK in the years to come.

In 2019, the total livestock population was around 37m in the UK, with cattle and calves accounting for around 26%.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Focus sector: Energy and utilities

The transition to renewable energy is central to achieving the UK's net zero ambitions. It is estimated that global electricity demand will double to 2050, so a move towards a net zero position requires not only an increase in renewable energy, but also greater efficiency of electricity distribution.

Technology-enabled energy management is, therefore a critical component of realising the transition to net zero. Across both demand and supply, smart grid technology combines digital communications with machine learning to enable more efficient energy transmission and access to renewables.

Efficiencies on the supply side are enabled by more intelligent distribution of energy based on a real-time understanding of consumption. This allows networks to reduce transmission wastage, operate at higher capacities, and quickly deliver electricity based on demand. Smart grids allow consumers to become 'prosumers', supplying the grid with surplus energy produced by their own renewable sources (e.g. solar panels on the roof).

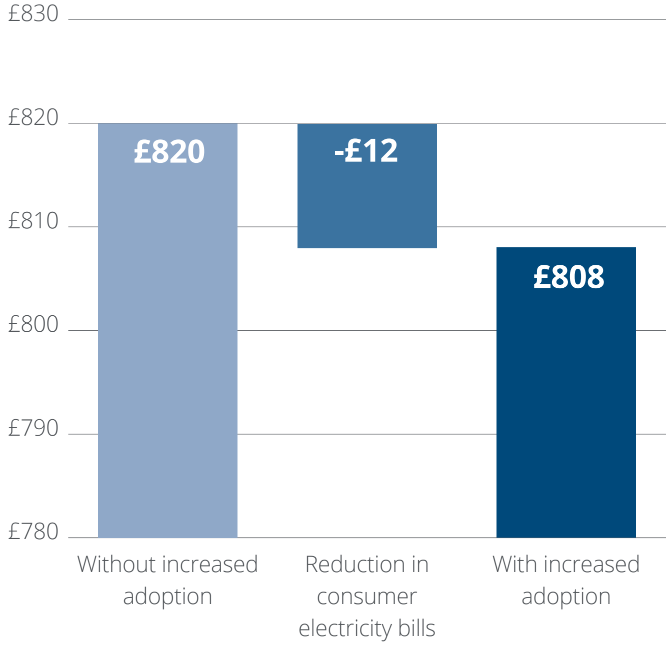
Efficiencies on the demand side are enabled by automated smart meters, which providing a means of automatically monitoring and managing the use of electricity. One focus area of high energy demand – particularly in the UK – is data centres. The UK's data centre sector is globally important and growing – with each new data centre contributing between £397m and £436m GVA per year to the UK economy. Commercial data centres are electricity intensive, consuming 2.89TWh of energy a year. This represents around 0.8% of the UK electricity supply and about 0.3% of primary energy, and approximately doubling when enterprise data centres are taken into consideration.[21] Through the effective deployment of smart meters, data centres consumption can be more efficiently managed and renewable energy channelled in an efficient and effective way that reduces demand and ultimately emissions.

Economic impact

In 2019, the average annual consumer electricity bill was around £645 in the UK, and this is expected to rise to £820 in 2030 (values are in 2015 prices). The adoption of connected grids and connected homes (e.g. through smart meters) powered by IoT and AI can improve energy efficiency and operation of networks, as well as reduce home energy usage. It is estimated that increased adoption of smart grids and smart meters could reduce the average annual consumer electricity bill by 1.4%, to £808 in 2030, through energy efficiency gains, compared to a scenario without increased adoption. For an expected 30.6m UK households in 2030, aggregated electricity bill savings will equal around £354m.[22]

Figure 7. Impact of smart grids on consumer electricity bills in 2030

Average annual consumer electricity bills (£)

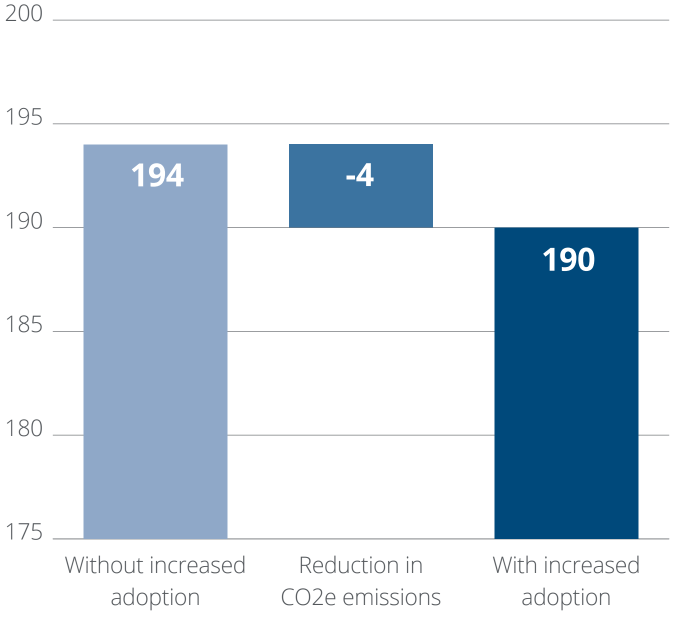


Environmental impact

It is estimated that the energy and utilities sector, including fossil fuel used for generating electricity, currently accounts for 324 Mt CO2e, approximately 72% of total emissions in the UK. Improving energy efficiency is important to improve overall resource efficiency and relieve stress on energy networks, as well as reducing emissions and decoupling economic growth from environmental degradation.[23] Based on historical trends, CO2e emissions from the energy and utilities sector are expected to drop to 194 Mt CO2e in 2030. However, the increased deployment of smart grids could further support improving energy efficiency, and increase the renewable energy share in the UK, contributing towards the UK's net zero target by 2050.[24] Smart grids use digital technologies and communication to detect local changes in usage, and manage supply and demand accordingly. An increased adoption of these technologies could decrease energy intensity in 2030 by around 2%. This represents an estimated drop of 4 Mt CO2e, compared to a scenario without increased adoption of smart grids.

Figure 8. Impact of smart grids on energy CO2e emissions

Emissions (Mt CO2e)



Case studies

ENGIE are an UK based energy and services company that developed software and rolled out sensors to help domestic customers and property managers manage the energy performance of their properties more easily. This energy management system has to date analysed over 2.5 million energy bills across 70,000 buildings and has recently deployed its services at Plymouth University, which saw energy wastage decrease, assisting progress towards their target of reaching net zero by 2030.[25]

Intel worked with energy companies to build a smart monitoring system for electrical substations. They equipped substations with sensors and edge analytics to measure low and medium voltage, current, environmental data and medium-voltage short-circuit indicators, and which transmit that data in real-time intervals. The data is locally analysed by industrial PCs and headline statistics were sent to a control centre, which enabled the energy company to react to changes in demand for power generation.[26]

Google worked with DeepMind to develop an AI-powered recommendation system to improve the energy efficiency of Google's data centres. Every five minutes, a cloud-based AI pulled a snapshot of the data centre cooling system from thousands of sensors and fed it into neural networks, which predicted how different combinations of potential actions would affect future energy consumption. The AI system then identified which actions would minimise the energy consumption while satisfying a robust set of safety constraints. Those actions were sent back to the data centre, where the actions were verified by the local control system and then implemented. The system is delivering consistent energy savings of around 30% on average, with further improvements expected.[27]

Looking forward
The energy and utilities sector will play a significant role in the UK's transition to a net zero carbon economy. By electrifying energy and utilities, and backing this electrification with renewable energy sources, the electrification of other sectors will follow, catalysing market transition towards net zero.

Through this transition, we can expect a continued focus on reducing the carbon impact of the current system. Machine learning and AI can support energy and resource efficiency measures by optimising operating conditions, improving transmission and management of supply and demand.

Machine learning can also facilitate research into alternative forms of downstream transmission and distribution of energy across the network, such as wireless transmission, efficient fibre transmission systems and network fibre access architecture.

Utilising technological developments will allow the grid to become more flexible, responding to peaks in demand. Advancements in energy storage will catalyse this and support fluctuations in demand, which can be further supported and optimised by AI and machine learning.

In 2019, the average annual consumer electricity bill was around £645 in the UK, and is expected to rise to £820 in 2030 (values are in 2015 prices).

Focus sector: Mobility

According to latest government figures, the transport sector accounts for around one third of all greenhouse gas emissions in the UK – the most of any sector in our economy. The main source of those emissions comes from the use of petrol and diesel in road transport.[28]

However, this emissions profile is expected to significantly reduce in the coming years, with continuing improvements in the fuel efficiency of petrol and diesel cars and the increased uptake in electric vehicles (EVs). The UK government recently announced that the ban on the sale of new carbon emitting vehicles has been accelerated by five years, to 2035.

Digital technology is of course critical to the roll-out of EVs, as it is both inherent in the software that manages the vehicle, and in monitoring and managing the EV charging network.

Alongside supporting the transition to EVs, digital technology is increasingly deployed both in the UK and around the world to support traffic flow management. Intelligent traffic systems are becoming key components of 'smart cities,'. These deploy IoT and AI to optimise and regulate traffic flows through a city, using automated lights, signals and sensors to increase efficiency and therefore reduce emissions.

Digital technology has a range of other applications to reduce emissions in the mobility sector. For example, IoT sensors can be deployed to enable intelligent parking space routing. Mobile platforms are increasingly used to enable carpooling, optimise public transport information routing, replace paper tickets and encourage inter-modality. Fleet telematics and cloud-enabled smart fleet management are deployed to optimise delivery routing. And, of course, digital technologies such as drone delivery, video conferencing and VR simulations are eliminating the need for transport altogether.[29] IIn all of these ways, digital technologies are transforming the mobility sector to be more efficient and sustainable.

Economic impact

UK drivers lost an average of 174 hours in congestion last year, with London being one of the top 10 most congested cities in the world. Based on historical trends, it is expected that this figure will increase to 218 hours in 2030. Increased congestion can lead to increased pollution and carbon emissions, as vehicles spend more time stationary or at reduced speed where engine efficiency is low. However, the presence of congestion also results in wasted time as more time has to be spent travelling instead of doing other productive activities or leisure time.[30] According to estimates from the UK Department for Transport (DfT), drivers are willing to pay on average £13.93 in 2030 to reduce travel time by an hour.[31] The increased adoption of intelligent traffic systems (ITS), including real-time traffic flow management systems, connected cars and predictive maintenance of infrastructure, could save on average almost 2.5 hours per driver in 2030 through increased traffic efficiency. This is equivalent to a value of £33.10 per driver per year. With an expected 30m cars registered in cities and communities by 2030 in the UK, the aggregated value of time saved will be around £1bn.[32]

Environmental impact

By 2030, it is estimated that 86.3% of the UK's population will live in urban areas compared with 83.9% today.[33] As cities continue to grow in size and density, the environmental impact of road emissions could also increase, particularly through the increase in particulate matter (PM2.5 and PM10) from tailpipe emissions, creating atmospheric air pollution.

Technologies such as traffic signal controls, connected cars or real-time traffic flow management systems have the potential to reduce environmental impacts in cities due to increased traffic efficiency. Based on historical trends, it is estimated that urban emissions will decrease to 54 Mt CO2e in 2030. The increased adoption of intelligent traffic systems has further potential to save around 1 Mt CO2e, compared to a scenario without increased adoption.

This analysis only quantifies the impact of intelligent traffic systems on urban CO2e emissions. However, other technologies in the mobility sector that have not been included in this analysis, such as the European Train Control System (ETCS)[34], have the potential to further increase transport efficiency and to reduce CO2e emissions.

Figure 9. Impact of intelligent traffic systems (ITS) on journey time in congested conditions in 2030

Average annual hours spent in congestion

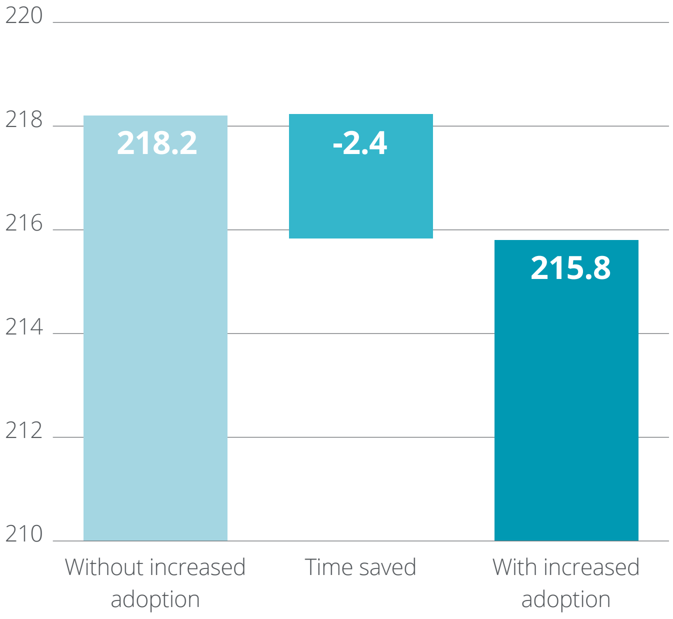
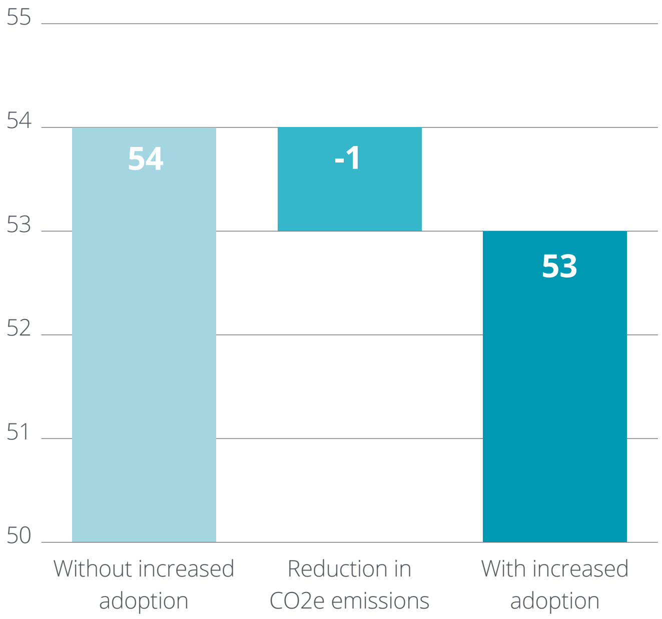


Figure 10. Impact of intelligent traffic systems (ITS) on urban CO2e emissions in 2030

Urban GHG emission (metric Mt CO2e)



Case studies

BT and Milton Keynes Council deployed digital technology to deliver a better way for drivers to park. There are 25,000 parking spaces in Milton Keynes, with an additional 12,000 required by 2020. Milton Keynes Council wanted to use smart technology to make sure current capacity was being fully optimised. As a trial, BT and Deteq installed sensors in each of the train station parking bays that send information over the air to lamppost mounted, solar powered repeaters, which aggregated and sent the information to the MK Data Hub. There it was processed and analysed, before being sent to drivers via the Milton Keynes Council public information dashboard, or a Google Maps overlay that displays bay status as red (occupied) or green (free). This initiative is part of the wider MK:Smart initiative, forecast to save 3% in energy use – smart parking will contribute significantly to the target of reducing congestion by 50%, with corresponding benefits in reducing fuel use and emissions.

Verizon offered an advanced traffic management service for public agencies. The service leveraged in-ground wireless vehicle detection sensors and intelligent, cloud based data collection systems managed by Verizon. It helped public agencies optimise signal timing and traffic flow, on the basis of real-time traffic data. Overall, this led to 40% fewer traffic delays, 5% less travel time, 10% fuel savings and 22% fewer emissions.[35]

Nestle developed a SmartTruck service which allowing professional drivers to access applications like mobile refuelling, fuel consumption optimisation, GPS positioning, and tachograph data transfer optimisation. The Nestle app also allowed for in-app payment, making refuelling faster and safer, and its connected health solution allowed for monitoring of the wear and tear of the fleet in order to carry out both preventative measures and essential repairs, saving time and cost. This system helped both drivers and managers plan, and drive individual HGVs and the fleet more efficiently, reducing vehicle fuel consumption by up to 15% and therefore abating emissions.

Looking forward

Whilst the roll out of EVs across the market continues, machine learning and AI can process big data to target infrastructure and charging point requirements across the country.

Ongoing developments in route optimisation and growth in ride-sharing practices will continue to improve efficiency. Connected and autonomous vehicles will lead to quicker, cleaner journeys that utilise smart vehicle traffic tracking systems and satellite navigation for efficient route optimisation. Autonomous vehicles will also increase the 'productivity' of mobility, as other tasks can replace the act of driving.

In the logistics and commercial sector, intelligent convoys, data driven automation of supply chain management and more efficient drivers will deliver further savings.

The expansion of digital railways will further increase capacity on the rail network by allowing trains to run closer together and enable drivers to reduce fuel consumption. Machine learning will also be deployed to improve predictive maintenance of trains to reduce the time they are out of service.

Finally, disruptive technologies that are based on machine learning could reduce or replace transportation demand altogether. For example, additive manufacturing (3D printing) has the potential to reduce freight transport by producing lighter goods and enabling production closer to the consumer.

By 2030, it is estimated that 86.3% of the UK's population will live in urban areas compared with 83.9% today.

Focus sector: Buildings

The buildings sector in the UK currently accounts for 18% of total emissions. Whilst emissions in this sector have reduced against their 1990 level largely due to the decarbonisation of the grid and increased insulation installation between 2008 and 2012, buildings and heating policy continues to lag behind the radical levels of change required to reach net zero emissions in 2050.

Whilst the Future Homes Standard will mean that new homes must be built to be net zero from 2025, over two million homes have been built since the Climate Change Act was passed. This increases the reliance upon retrofitting of existing homes to satisfy net zero requirements.[36]

Digital technology has the potential to contribute to reducing emissions through smart buildings. Smart buildings use sensors, actuators and microchips that enable automated processes to control the building's operations such as heating, air conditioning, lighting or security. These tools can be used to improve efficiencies, reducing the need for heat and energy. They can also improve worker productivity through increased comfort – for example, ventilation and temperature control systems ensure optimal air quality and can help to avoid tiredness, and smart lighting systems that adjusts the colours and brightness levels to imitate sunlight can help to avoid headaches and sleeping disorders.[37] In addition to operational efficiencies, there is potential to further decarbonise the sector through changes in energy supply. As the proportion of renewable electricity on the grid continues to rise, buildings and their management teams can further benefit from renewable electricity sourcing through long term agreements such as Renewable Guarantee of Origin (REGO) backing, Power Purchase Agreements (PPAs) and on-site generation.

In addition to electricity, direct emissions from the use of fossil fuels (primarily gas) for heating make up almost half of the building sector's emissions, with 10% of the UK's total carbon footprint arising from heating in 2016. Low-carbon heat options include air and ground-source heat pumps, district heating systems using low-carbon sources such as waste heat, biomass boilers, and solar thermal hot water. Reaching net zero will require near-complete decarbonisation of heat.[38]

Finally, the processes and materials involved in construction are emissions intensive, both in the use of fossil fuel powered machinery and the 'embodied carbon' inherent in new components. Perhaps more important than implementing low-carbon practices in new constructions, the UK has the opportunity to promote renovation rather than demolition, encouraging upgrades to existing buildings to mitigate the carbon impacts of construction.

Economic impact

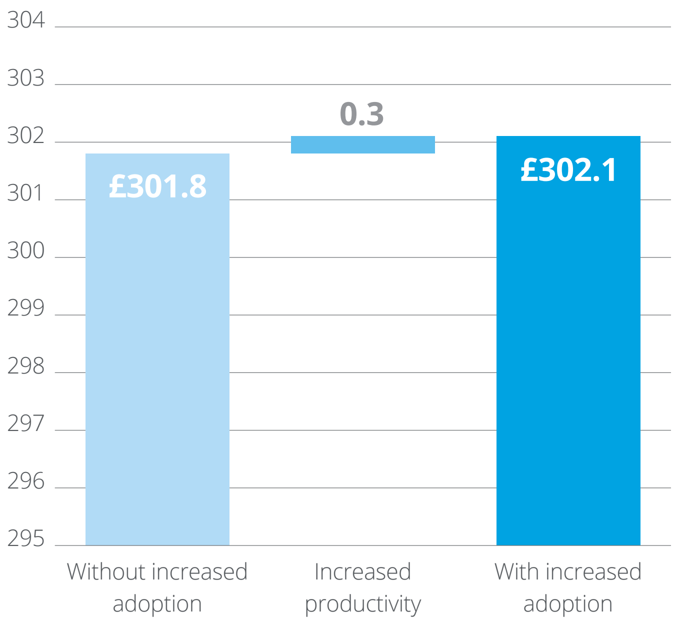
Before the coronavirus pandemic, an increasing number of workers had office-based jobs in the UK, with financial, professional and business services being the largest employers in London.[39] It is estimated that major office-based activity within key industries (e.g. financial and insurance activities, legal and accounting activities or computer programming and consultancy) contributed around £222bn to the UK economy in 2018 in GVA, equivalent to 11% of the total GVA across all sectors of the UK economy.

Based on historical trends and not accounting for the impact of the coronavirus pandemic, GVA from office activity in office-based industries (accounting for smaller firms that may not be based in traditional offices[40] and remote working within larger firms[41]) is expected to increase to £302bn in 2030. It is also estimated that smart temperature and lighting control in buildings can increase office-based productivity by around 1%, with the interior environment more adapted and flexible to the needs of the workforce.[42] Based on these estimates, an increased adoption of smart building technologies could contribute an additional £289m to the UK economy in 2030, compared to a scenario without increased adoption.

This analysis only considers the temperature and lighting control aspects of smart buildings whilst greater use of digital connectivity in aspects such as security and space utilisation may increase productivity further.[43] Additionally, the impact would not be limited to the industries highlighted, as other industries involve office-based activity, however this is more difficult to capture in industry statistics.

Figure 11. Impact of increased smart building technologies adoption on office workers' productivity in 2030

Gross Value Added (GVA, constant 2015 prices, £ millions)



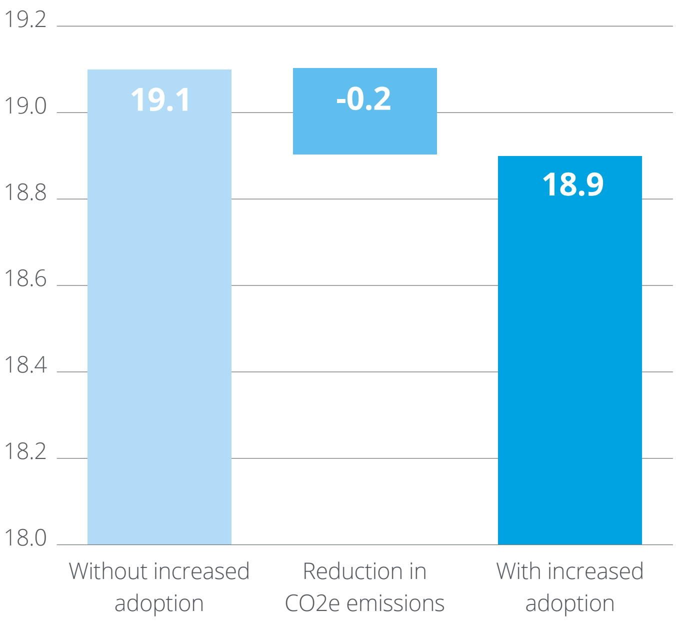
Environmental impact

It is estimated that commercial buildings will account for around 19.1 Mt CO2e in the UK in 2030, approximately 5%[44] of total CO2e emissions in the UK.[45] Smart lighting systems and temperature control systems can help to increase energy efficiency through optimisation of energy usage for light and heating and hence reduce CO2e emissions. It is estimated that these technologies can improve building energy consumption by around 10%.[46] The increased adoption of smart building technologies powered by IoT sensors and AI systems has the potential to reduce CO2e emissions by a further 223 Kt CO2e in 2030, compared to a scenario without increased adoption.

> It is estimated that commercial buildings will account for around 19.1 Mt CO2e in the UK in 2030, approximately 5% of total CO2e emissions in the UK.

Figure 12. Impact of increased smart building technologies on CO2e emissions in 2030

Emissions (Mt CO2e)



Case studies

Deloitte's new headquarters at 1 New Street Square, EC4, was at the time of opening the largest office in the world to achieve leading certifications for being both an exemplar green building and one designed to enhance the wellbeing of its people. The flagship office achieved the highest score globally for sustainability of any commercial building fit-out. Using BREEAM, the leading green-building certification, Deloitte's office scored a record 94%, far exceeding the 'Outstanding' threshold and, in doing so, became the highest scoring BREEAM 2014 Refurbishment & Fit-out project in the world. The firm also attained WELL Certified™ Gold, an award recognising workplaces that enhance people's health and wellbeing. The office earned the distinction based on seven categories of building and operational performance including air, water, light, nourishment, fitness, comfort and mind.[47]

Northgate Public Services are currently delivering BEIS' Home Energy Project, providing a responsive and cost effective platform for continuing Green Deal activity, and supporting the introduction of the Minimum Energy Efficiency Standards (MEES) whereby landlords are obliged to bring their properties up to a minimum EPC rating of E or better. Modern technology enabled more responsive implementation of energy policies, allowing new schemes to be created through the existing platform rather than having to design from scratch. In collaboration with Elmhurst Energy Systems, Northgate developed systems to calculate Energy Efficiency in 42 Housing Organisations. Properties were banded according to their energy efficiency. Carbon emissions and energy costs were also produced against each property and the software made recommendations to improve energy efficiency. The software allows for data input to the calculation to be modelled and can suggest the most cost effective way to improve efficiencies.[48]

British Gas partnered with the Welsh Government and the Hywel Dda Health Board to enter the Guaranteed Energy Savings Initiative. This intends to modernise the aging energy assets of four hospitals in Wales and use the latest technology to reduce emissions, make patients more comfortable and save the NHS money. The partnership saw a vast range of upgrades and technology installed across the estate. New building energy management systems meant the hospital staff could use web based tools and real time monitoring to manage energy usage and the benefits extended beyond environmental savings. The results of the contract were impressive, guaranteeing an annual saving of £862,000 and a 30% reduction in energy consumption.[49]

Looking forward

As the climate continues to change, several million properties are in areas at risk of flooding. Additionally, the risk of overheating remains high, particularly in social housing. Indeed, one in five homes is in England are in danger of overheating even in a cool summer.[50] In this context, the UK will have to focus on retrofitting existing buildings, particularly with low-carbon cooling alternatives.[51]

But cooling is not the only challenge. Around 10,000 people die in the UK each year as a result of cold homes and, as the population increases, demand for heat is likely to increase.[52] This demands a focus on low carbon heat alternatives.

One means of decarbonising buildings will be through increasing the proportion of green gas on the grid through bio-methane injection from anaerobic digestion. Alternatively, electric heat pumps are already beginning to replace gas boilers, and British Gas and EDF Energy are undertaking trials of hybrid gas/electric pumps that will run on renewable electricity from the grid, rather than gas.

New hydrogen-based boilers are in the early phases of testing and could provide a low-carbon alternative.[53] Indeed, the CBI has recommended banning all but the sale of "hydrogen-ready" boilers or hybrid systems from 2025.[54]

Prioritising retrofitting and upgrades over new construction will also reduce the embodied carbon associated with construction, demolition and materials used across both processes. Oslo, Norway has committed to fossil free construction sites and Vancouver, Canada has mandated that embodied carbon be reduced by 40% in new buildings by 2030. Regional requirements like these are likely to grow as net zero ambitions look to be realised.[55]

Whilst there remains uncertainty around the nature of office-based working, measures to improve the environmental efficiency of large buildings are likely to return reductions in operational costs. Energy supply will be managed in a smarter, more efficient manner returning a lower carbon footprint and cost savings.

Conclusion

Climate change not only threatens our natural environment, it threatens our way of life and the basic structure of our economy. Without urgent, co-ordinated and effective action, we face a future of ever more extreme weather events, food shortages and geo-political crises. It is up to us, as policy makers, business leaders and citizens to ensure we take the necessary steps to reduce emissions and lessen the impact of a warming earth.

Digital technology provides an essential weapon in our arsenal to combat climate change. As processes become more digital, they become more electrified, which, when combined with increased renewable energy in the grid, increasingly enable the transition to net zero. As digital technology matures, the intelligent application of data to automate processes will enable ever greater efficiencies and effectiveness, reducing the use of resources, waste and demand for energy. Finally, as digital technology continues to evolve, it will continue to provide opportunities to innovate and develop new means of production and interaction that do not rely on the energy-intensive methods of old.

As the UK looks to meet its commitment to reach net zero by 2050, clean technology must play a vital and important role as a growing, impactful sector. Indeed, as we set out in this report, the growth of 'clean' digital technology isn't just a win for our environment. We provide clear evidence that the growth of digital technology will return an economic benefit too.

For policy makers this report adds to the weight of evidence that their support for the growth of clean technology is truly a win-win. For business leaders, the examples we share of digital technology in action are merely the tip of the iceberg. Corporations across the five sectors we feature in this report and beyond face an urgent and important task to consider how they can maximise the opportunity of clean digital technology – both to address their own climate ambitions and as an opportunity for growth. Finally, citizens as employees, investors, consumers and voters increasingly have the power to demand that the organisations with whom they interact take real steps to manage their environmental impact and direct their operations accordingly.

But without collaboration, this vision of a net zero world enabled by clean technology has no chance of being realised. Clean digital technology is, by definition, a matter of partnership between the digital technology sector and sectors across the rest of the economy. Only through the intentional development of digital technology for positive impact that is driven by both the technology companies and their clients can we reliably expect to see clean technology grow in the UK and truly deliver the impact for our environment and economy that we need to see.

Appendix

Appendix
Detailed methodology

The output of the impact analysis framework is a potential value of economic and environmental indicator or indicator proxy in 2030 without increased adoption of a certain digital technology (business-as-usual scenario) and a scenario with increased adoption of this technology. The **business-as-usual scenario** illustrates what the future would look like if we were to continue with the same levels of technology adoption and sophistication. This scenario is estimated using either historic trends or third party projections, on the assumption that there are no significant changes from the status quo. That is, under the business as usual projections there are no notable deviations from the current paths of technology, policy or infrastructure that would lead the variable to shift away from its current path.

Comparatively, the **digital technology scenario** assumes that digital technology adoption increases to above current levels, targeted in the places where gains can be made, such that it is able to have a material environmental and economic impact.

The approach to estimate one economic and one environmental impact of digital technology for the UK manufacturing, mobility, energy & utilities, agriculture and buildings sector:

A. **Identify variables to model**. Impacts are modelled where sufficient data is available, impact and adoption rates can be robustly defined and findings from the qualitative research identify a critical driver where digital technology can be deployed.

B. **Project data to obtain the business-as-usual (BAU) 2030 scenario**. An estimate of the indicator or indicator proxy is established using a third-party projection or historic trends where a future projection is unavailable.

C. **Establish rates of impact and adoption**. In the first instance, impact and adoption rates are based on Deloitte research, which has previously been undertaken for the Global e-Sustainability Initiative (GeSI) for the "Digital with Purpose" report.[56] A meta-analysis of control trials has been considered. In cases where this was not possible, a literature review validated by an external expert panel has been used or impacts have been informed by an expert survey. As those impact and adoption numbers were often based on estimates for developed economies in general, results from the "Digital with Purpose" report were validated by a techUK member survey for a UK context to inform this research.

- The impact is obtained on the assumption of 100% adoption of the digital technology. Therefore, this impact is scaled down with an assumption on adoption rates, i.e. what proportion of the relevant population will be using this technology in 2030 compared with today.

- Assumptions regarding the adoption rates are obtained using the approach above, or in the event that a reputable international organisation provides an estimate, this value is used.

Figure 13. Establish rates of impact and adoption

Digital with Purpose values

1

Meta-analysis of controlled trials. The relationship between the impact of a digital technology intervention observed in randomised control trials in the academic literature is estimated using a simple regression model.

2

Literature review with expert survey validation. Desk research is conducted to obtain a collection of observed impacts from the use case, albeit where the impacts have not been tested in a controlling setting. These observed impacts, typically making the distinction between developed or developing countries, are tested against an expert survey.

Validation of values – techUK member survey

3

The estimated impact and adoption values for "Digital with Purpose" have been validated for the UK context. The panel of techUK members are tested on their expectation of the size of an impact and the impact applied in the analysis is a simple average of these values.

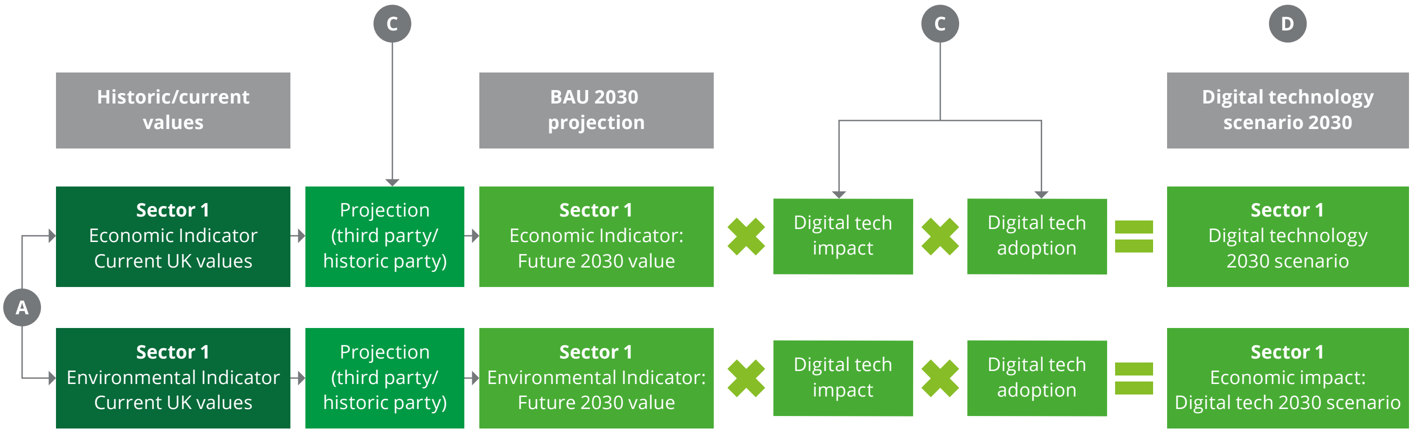
D. **Apply impacts and adoption to BAU to obtain Digital Technology 2030 scenario**. The potential impact on the 2030 BAU scenario (without increased adoption of a digital technology) is estimated using the established rates of impact and adoption.

  - The impacts obtained in step C can be interpreted as a total impact rate, that is, 'the impact of digital technology with 100% adoption'. Therefore, the impact needs to be scaled for the expected change in the rate of adoption in 2030.
  - The difference between the current and future adoption, multiplied by the total impact rate, gives the impact rate that is applied to the variable to give the difference between the BAU and digital technology scenarios.

Figure 14. Impact 2030 quantification

A high level overview of this framework is presented in Figure 15, where the letters in the figure relate to each of the four steps.

Figure 15. Steps in the quantitative impact analysis



Appendix
Economic and environmental impact for each sector

Table 1 and 2 present the estimated impact of each digital technology for the five UK sectors.

Table 1. Current and future economic indicator estimates and extent of digital technology impact

Sector	Digital technology	Indicator	Estimated 2019 value	Without increased adoption in 2030	With increased adoption in 2030	Impact (%)	Impact
Manufacturing	Industry 4.0	Gross Value Added (GVA)	£158bn	£166bn	£179bn	8%	£13.3bn
Agriculture	Precision Agriculture	Gross Value Added (GVA)	£1.91bn	£3.04bn	£3.16bn	4%	£120m
Energy & Utilities	Smart grids	Electricity bills	£17.9bn	£25.1bn	£24.7bn	1.4%	£354m
Mobility	Intelligent traffic systems	Value of time saved	174 hours per driver	218 hours per driver	215 hours per driver	1.1%	£1bn
Buildings	Smart buildings	Gross Value Added (GVA)	£222.3bn	£301.8bn	£302.1bn	0.1%	£289m

Table 2. Current and future environmental indicator estimates and extent of digital technology mitigation

Sector	Technology	Indicator	Estimated 2019 value	Without increased adoption in 2030	With increased adoption in 2030	Mitigation (%)	Mitigation
Manufacturing	Industry 4.0	CO2e emissions	55 Mt CO2e	24 Mt CO2e	22 Mt CO2e	7%	1.7 Mt CO2e
Agriculture	Precision Agriculture	CO2e emissions	20.8 Mt CO2e	20.8 Mt CO2e	19.9 Mt CO2e	4%	0.9 Mt CO2e
Energy & Utilities	Smart grids	CO2e emissions	324 Mt CO2e	194 Mt CO2e	190 Mt CO2e	1.9%	3.7 Mt CO2e
Mobility	Intelligent traffic systems	CO2e emissions	107 Mt CO2e	54 Mt CO2e	53 Mt CO2e	1.2%	0.7 Mt CO2e
Buildings	Smart buildings	CO2e emissions	23.2 Mt CO2e	19.1 Mt CO2e	18.9 Mt CO2e	1.2%	0.2 Mt CO2e

Appendix

Impact analysis sources

Given the breadth of the impacts estimated in this report, there is a wide range of sources called upon. All variables have been sourced from international agencies and the assumptions on impact and adoption rates come from either previous Deloitte research for the "Digital with Purpose" report, existing literature or public data sources and are validated by a survey of experts.

Across the variables, the most recent available year will vary dependent on the data custodian and frequency of measurement.

This section presents all sources used in the impact analysis and comes in two parts:

- Economic impacts
- Environmental impacts

Table 3. Economic impacts

Sector	Indicator	Most recent available year	BAU approach	Sources	Impact and adoption values	Other
Manufacturing	Manufacturing productivity measures in Gross Value Added (GVA)	2017	Apply and project manufacturing GVA growth rates	Unstat database – Manufacturing value added (constant 2010 USD, billions)	Impact and adoption values are based on previous Deloitte research for the "Digital with Purpose" report. Those values have been validated by a techUK member survey for the UK context.	Constant 2010 USD have been converted to constant 2015 £, billions for the analysis.
Agriculture	Agriculture productivity measured in crop yields (cereals harvested) and Gross Value Added (GVA)	2017	Apply and project total cereal crop GVA growth rates	OECD-FAO Agriculture Outlook – total cereal (kg/ha) OECD-FAO Agriculture Outlook – GVA (constant 2004-2006 £, millions)	Impact and adoption values are based on previous Deloitte research for the "Digital with Purpose" report. Those values have been validated by a techUK member survey for the UK context.	Constant 2004-200 £, millions have been converted to constant 2015 £, millions for the analysis.
Energy & Utilities	Average annual consumer electricity bills	2019	Apply and project average annual electricity bill growth rates	Department for Business, Energy & Industrial Strategy (BEIS) – Average annual domestic standard electricity bills (£) Office for National Statistics (ONS) – Families and households table 7	Impact and adoption values are based on existing literature and Deloitte knowledge and have been validated by a techUK member survey. BEIS (2016) – Smart meter roll-out (GB)	Inflation adjusted (base year = 2015); total number of UK households is forecasted based on 3 year CAGR (Compound Annual Growth Rate)
Mobility	Average annual time spent in congested conditions per driver	2018	Apply and project average annual time spend in congested conditions per driver growth rate	Department for Transport – Road Congestion Statistics (seconds per vehicle per mile – urban roads) Department for Transport – Annual mileage (miles) per vehicle TAG book A.1.3.6 – average Willingness to Pay (WTP) per driver	Impact and adoption values are based on existing literature and Deloitte knowledge and have been validated by a techUK member survey. ITS (2016): Intelligent Transport Systems and their benefits	Seconds per vehicle per mile have been converted to annual hours per vehicle; share of urban cars is assumed to stay constant
Buildings	Gross Value Added (GVA) of office based work	2018	Apply and project GVA of office based work growth rates	Office for National Statistics (ONS) – Regional economic activity Gross Value Add (constant 2016 £ values)	Impact and adoption values are based on existing literature and Deloitte knowledge and have been validated by a techUK member survey. IEA (2019) – Energy efficiency and digitalisation JLL – The benefits of working in smart buildings	For this analysis GVA of major office based industries is considered (including computer programming and consultancy; financial and insurance activities; legal and accounting activities; head offices and management consultancy; advertising and market research; administrative and support service activities. Businesses with less than 10 employees (micro-businesses) are excluded. Share of remote-working is assumed to stay constant. Constant 2016 £ values have been converted to constant 2015 £ values for the analysis.

Table 4. Environmental impacts

Sector	Indicator	Most recent available year	BAU approach	Sources	Impact and adoption values	Other
Manufacturing	Manufacturing emissions (Mt CO2e)	2017	Apply and project manufacturing emissions growth rates	Worldbank – CO2e emissions from manufacturing industries and construction;	Impact and adoption values are based on previous Deloitte research for the "Digital with Purpose" report. Those values have been validated by a techUK member survey for the UK context.	Manufacturing emissions (Mt CO2e): Available for some countries from IEA (Scope 2), supplemented by World Bank construction and industry (Scope 1) dataset. The World Bank data is adjusted to capture scope 2 emissions based on IEA data then adjusted downward using known manufacturing: construction and industry ratios.
Agriculture	Emissions from enteric fermentation from livestock (Mt CO2e)	2017	Apply and project emissions from enteric fermentation from livestock growth rates	Food and Agriculture Organization of the United Nations (FAO) – livestock count and emissions per head	Impact and adoption values are based on previous Deloitte research for the "Digital with Purpose" report. Those values have been validated by a techUK member survey for the UK context.	For the agriculture sector, the analysis only considers the digital technology impact on emissions from enteric fermentation and not for other agricultural activities.
Energy & Utilities	Energy intensity (Megajoules/ GDP); emissions (Mt CO2e)	2016	Apply and project energy intensity (Megajoules per GDP) growth rates	Unstat database – Energy intensity level of primary energy (Megajoules per constant 2011purchasing power parity GDP) IEA CO2e Emissions from Fuel Combustion Highlights 2018 – CO2e emission per TPES (Total Primary Energy Supply) Worldbank – GDP (PPP, constant 2011 International USD)	Impact and adoption values are based on previous Deloitte research for the "Digital with Purpose" report. Those values have been validated by a techUK member survey for the UK context.	The reduction in energy intensity has been converted into reduction in CO2e emissions.
Mobility	Urban emissions (Mt CO2e)	2017	Apply and project urban emission growth rates	Cities Community Wide Emissions Data (CDP); UN Population at Mid-Year by Country (historic and projection)	Impact and adoption values are based on previous Deloitte research for the "Digital with Purpose" report. Those values have been validated by a techUK member survey for the UK context.	Urban emissions per capita is estimated using CDP dataset. This is extrapolated to a national level using UN estimates of urban population.
Buildings	Buildings emissions (Mt CO2e)	2016	Apply and project buildings emissions growth rates	Property Data Report (2010 – 2016)	Impact and adoption values are based on existing literature and Deloitte knowledge and have been validated by a techUK member survey.	N/A

Endnotes

1 See GeSI and Deloitte (2019), ‘Digital with Purpose: Delivering a SMARTer2030’, p.182.
2 GVA is a measure of economic activity that represents the difference between the total value of goods and services produced by an industry less the cost of inputs (e.g. raw materials, factors of production). In this way, GVA measures the ‘value added’ by the industry in turning intermediate products into final products (or other intermediate products for consumption in other industries). GDP is equal to GVA plus product taxes and less product subsidies. See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/868760/Productivity_2018_with_industry_data_for_January_Digest_1.pdf
3 All GVA figures are presented in terms of 2015 prices.
4 This refers to industries with activities primarily based in offices, such as legal and accounting services, rather than the construction industry.
5 https://www.ons.gov.uk/economy/grossvalueaddedgva/timeseries/abml/pn2
6 https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/nominalandrealregionalgrossvalueaddedbalancedbyindustry
7 https://www.forbes.com/sites/angelicakrystledonati/2020/02/21/what-areas-should-you-be-excited-about-in-smart-building-tech/#103807452464
8 https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2018
9 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf
10 https://webstore.iea.org/Content/Images/uploaded/CO2Highlights2019-Excel%20file.XLS
11 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf
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18 https://www.weforum.org/agenda/2019/12/technology-artificial-intelligence-ai-drone-trees-deforestation
19 https://newsroom.ibm.com/2019-04-26-Yara-and-IBM-join-forces-to-transform-the-future-of-farming
20 https://www.business.att.com/content/dam/attbusiness/reports/iot-precision-king-case-study.pdf
21 https://digitalrealty.box.com/s/bserfy44rne36jxupnnnirdcbwdcvp7f
22 Number of UK 2030 households is forecasted based on historical trends from ONS: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2019
23 https://www.eea.europa.eu/soer/2015/synthesis/report/4-resourceefficiency
24 https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law
25 https://www.bitc.org.uk/case-study/the-fujitsu-digital-innovation-award-engie/
26 https://www.intel.co.uk/content/www/uk/en/energy/smart-grid.html
27 https://deepmind.com/blog/article/safety-first-ai-autonomous-data-centre-cooling-and-industrial-control
28 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf
29 https://sustainabledevelopment.un.org/content/documents/8656Analysis%20of%20transport%20relevance%20of%20SDGs.pdf
30 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/51125/An_introduction_into_the_Department_for_Transport_s_congestion_statistics.pdf
31 Willingness to pay (WTP) is an economic concept which represents the maximum amount of money that an individual is willing to pay in order to obtain a good, commodity or service. In this case, it refers to the valuing of travel time. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/470229/vtts-phase-2-report-non-technical-summary-issue-august-2015.pdf
32 Amount of cars in cities and communities is forecasted based on historical trends from the Department for Transport (DfT): https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars
33 https://population.un.org/wup/Country-Profiles/
34 http://digitalrailway.co.uk/wp-content/uploads/2018/07/153821-NWR-REP-ESE-000005-ETCS-Onboard-System-Definition-v1.0.pdf
35 https://enterprise.verizon.com/en-gb/products/internet-of-things/smart-cities-and-communities/intelligent-traffic-management/
36 https://www.theccc.org.uk/wp-content/uploads/2020/06/Reducing-UK-emissions-Progress-Report-to-Parliament-Committee-on-Cli.._-002-1.pdf
37 https://www.smartcitylab.com/blog/urban-environment/smart-buildings-for-smart-workers-improving-the-efficiency-of-workers-and-buildings/
38 https://www.theccc.org.uk/wp-content/uploads/2014/08/Fact-sheet-buildings-updated-July-2015.pdf
39 https://www.cityoflondon.gov.uk/business/economic-research-and-information/new-research/Documents/city-of-london-jobs-factsheet.pdf
40 https://www.gov.uk/government/statistics/business-population-estimates-2019
41 https://www.regus.co.uk/work-uk/wp-content/uploads/sites/131/2017/06/GBS-Report.pdf
42 https://www.us.jll.com/en/views/the-benefits-of-working-in-smart-buildingskim
43 https://www2.deloitte.com/content/dam/Deloitte/br/Documents/financial-services/DI_Smart-buildings.pdf
44 CO2 emission from building are powered by energy generation, which has already been included in the estimates of total CO2 emissions from the energy and utilities sector.
45 https://www.bpf.org.uk/sites/default/files/resources/PIA-Property-Data-Report-2017.PDF
46 https://www.iea.org/reports/digitalisation-and-energy
47 https://www2.deloitte.com/uk/en/pages/press-releases/articles/new-deloitte-london-office.html
48 https://www.elmhurstenergy.co.uk/elmhurst-digital-strategic-asset-management-solution
49 http://www.wcn.wales.nhs.uk/news/28709
50 https://www.theccc.org.uk/wp-content/uploads/2019/02/UK-housing-Fit-for-the-future-CCC-2019.pdf
51 https://www.theccc.org.uk/wp-content/uploads/2020/06/Reducing-UK-emissions-Progress-Report-to-Parliament-Committee-on-Cli.._-002-1.pdf pg 13
52 https://www.nea.org.uk/media/news/300420-1/
53 https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat
54 https://www.cbi.org.uk/media-centre/articles/no-new-conventional-gas-boilers-in-homes-after-2025/#:~:text=A%20new%20Heat%20Commission%20convened,accounting%20for%20over%20one%2Dthird.
55 https://www.worldgbc.org/news-media/WorldGBC-embodied-carbon-report-published
56 https://gesi.org/platforms/digital-with-a-purpose-delivering-a-smarter2030

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