



Connected Spaces

A WPI Strategy report for Vodafone UK

July 2024

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About Vodafone

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

We have a strong track record as a tech pioneer, making the UK's first mobile phone call, sending the first text message, and making the UK's first live holographic call using 5G in 2018. We were also the first to start carrying live 5G traffic from a site in Salford, Greater Manchester. As of July 2024, our 5G network is available in 236 cities in 8 European markets, whilst our 4G network coverage currently reaches over 99% of the UK population.

Today, Vodafone serves more than 18 million mobile and fixed-line customers in the UK. To help deliver Gigabit UK, our full-fibre roll-out programme now covers 26 UK towns and cities, rising to 35 over the coming months, through partnerships with CityFibre and Openreach.

We're working to cut carbon emissions from our UK operations to net zero by 2027. We're investing millions into energy-efficient equipment; powering our network, offices and stores with 100% renewable electricity; and ensuring our fleet vehicles are all electric. We're also working with our suppliers to significantly reduce their emissions. By 2040, Vodafone will be net zero across its full carbon footprint globally.

We are part of Vodafone Group, one of the world's largest telecommunications companies, with mobile operations in 21 countries, partnerships with mobile networks in 42 more, and fixed broadband operations in 17 markets. As of July 2024, Vodafone Group has approximately 330+ million mobile customers, 21 million fixed broadband customers and 17 million TV customers, including all of the customers in Vodafone's joint ventures and associates.

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

Introduction

Public buildings such as schools, libraries or leisure centres are usually one of the first and most visible day-to-day interfaces that most people have with their local authority, as they access public services. These are the buildings around which our community life is often structured - where we learn, work and play, and where people receive essential care, education and recreation. In fact, over half (57%) of UK adults say public buildings bring their community together in a positive way.

However, in a climate of rising energy costs and reductions in local government funding, the running of these buildings is often a significant financial outgoing for local councils, with the inflation of energy costs alone adding over £95 million to the total council spending bills in 2023/24.¹ According to recent polling, 74% of people say their local council is facing financial pressure and 92% of people are worried about the future of their local facilities, with 77% of respondents reporting that they have already seen libraries, leisure centres and even schools close due to a lack of council funding.

As we rapidly approach the UK's internationally agreed 2030 emissions reduction target for its public sector buildings, as set out in its Net Zero Government Initiative, we must embrace a variety of solutions to support decarbonisation. Pressure has also come from the UK's Climate Change Committee (CCC) in their most recent report, which states that “urgent action is needed to get on track for the UK's 2030 target”.²

In the UK, public buildings make up 9% of the total direct greenhouse gas emissions from buildings.³ So, while the importance of modernising the UK's public buildings through retrofit measures such as insulation or the installation of heat pumps cannot be understated, towns across the UK should also look to technological innovations to make the most efficient use of their existing space and maximise cost savings.

Our research has found that digital technologies, supported by a nationwide standalone 5G network, can make significant reductions to the emissions and operating costs of public buildings across the UK, **generating as much as a 17% reduction in energy usage**. We modelled how this could benefit struggling towns served by one of each typical public building: an NHS hospital, a school, a council building, a town hall, a police station, a library, a leisure centre, and a courthouse. **The estimated total cost savings for these buildings servicing an average town of 40,000 residents is up to £350,000 every year.**

From Truro to Crosby, Bangor to St Andrews, **towns across the UK could make significant savings totalling £580 million across the UK every year**. In addition, **these technologies can also deliver carbon emission savings of 1.43 million tonnes of CO₂e per year, equivalent to almost 300,000 homes' electricity use for one year.**

These savings on energy bills could be instead reinvested into local budgets – per town this could equate to enough funding for 15 new nurses, 12 new police officers, or 12 new teachers.

The recent Labour manifesto committed to reaching national 5G coverage by 2030. Small and medium-sized towns across the UK stand to be significant beneficiaries of this ambition, enabling them to capitalise on the availability of 5G-enabled technologies to protect local services, progress towards vital decarbonisation targets and save scarce local funds.

Vodafone's proposed merger with Three UK will enable a joint network which goes over and above the ambitions of the Wireless Infrastructure Strategy and will achieve more than 99% population coverage with standalone 5G by 2034, and over 95% population coverage by 2030, as well as ensuring coverage in every school and hospital across the country – bringing vital innovations to where they are needed most, and helping the new government deliver on its manifesto commitments.

1. Policy context

In 2022, the UK joined the international Net Zero Government Initiative as a partner and signatory, and published ambitious targets to reduce all direct emissions from public sector buildings by 50% by 2032 and by 75% by 2037, compared to 2017 levels.⁴ The UK has committed over £2.5 billion investment into upgrading public sector buildings since 2020, primarily via grant funding offered to individual decarbonisation projects through the Public Sector Decarbonisation scheme.

However, cuts in central government funding, council tax freezes and other rule changes have reduced the net spend per person by councils by 23% over the past decade.⁵ The need to protect adult and child social care has meant services and improvements related to climate and the environment have seen much more substantial reductions. But local public services are a key lynchpin in the UK's Net Zero ambition; the independent Climate Change Committee concluded that a third of the UK's emissions are dependent on sectors that are directly shaped or influenced by local authority practice or policy.⁶ Despite over 90% of local authorities in England having formal emissions reduction targets in line with the 2050 Net Zero ambition, over 300 councils across the UK have since declared a climate emergency – demonstrating the scale of the challenge facing towns across the country.⁷

Without enabling local authorities to take significant action towards reducing their own carbon emissions, we will struggle to reach our national decarbonisation goals. Finding innovative and long-term solutions to the dual financial and decarbonisation challenges facing local public services has never been more urgent, as almost 1 in 5 council leaders and chief executives think it is very or fairly likely they will need to issue a Section 114 notice of bankruptcy this year or next due to funding shortfalls.⁸



2. Technology

Buildings are responsible for 59% of the UK’s electricity consumption, stemming largely from cooling, catering and ICT equipment in non-residential buildings.⁹ The new government would be wise to recognise the importance of decarbonising our public sector building stock, given that through doing so we could save an estimated £650 million per year to 2037.¹⁰

Incorporating technologies such as IoT, 5G sensors and digital twins across our public buildings could save an additional £580 million per year, on top of any savings accrued through retrofitting measures, to continue improving the energy efficiency of the UK’s public buildings for years to come. Whilst we recognise that installing such technology is a significant upfront investment, the savings delivered mean that these technologies pay for themselves over 2-3 years, whilst simultaneously helping councils reach their decarbonisation goals.¹¹

So what do we mean when we talk about digital buildings?

Digital, or “smart” buildings use IoT (Internet of Things) technology in a range of connected devices to monitor how buildings are being used, lit, heated, cooled and ventilated, and ensure that space is being optimised and energy is not being wasted. Sensors can measure how buildings consume gas, electricity and water in detail, allowing the data to be analysed and for active and dynamic energy savings measures to be applied.

However, all of these technologies rely on a readily available, high-capacity 5G network, capable of synthesising millions of data points in real time. Our largest cities already benefit from 5G coverage, but Vodafone is eager to support uptake of these technologies in towns across the UK. Rolling out standalone 5G nationwide means that public services across the UK can be sustained by the savings that 5G-enabled digital buildings technology can provide. With patchy coverage comes an equally patchy ability for public services to benefit, and a slow or incomplete 5G rollout would likely leave councils in smaller or more remote towns worse off – and still facing high energy bills without the ability to benefit from the savings 5G-enabled technologies could bring.

Digital Twins

A digital twin is a virtual representation of a building that is designed to accurately reflect a physical object.

Digital twins enable engineers to study buildings in detail, examining where efficiencies can be made. The digital models can also help predict faults and inefficiencies within buildings and ensure that issues are dealt with in a timely manner.

Connected Spaces

The 5G Town

The cost of keeping pools running has resulted in more than **1,000** swimming pools closing their doors across England since 2010. But leisure centres across the UK could save up to **£72.1 million per year**, thanks to 5G-powered technologies.

Hospitals could save a total of **£219.7 million per year** thanks to 5G-powered digital twins – which can help engineers and hospital management staff study the hospital in detail and identify where they can drive efficiencies.

Schools find energy and water efficiency a challenge due to their size. But if schools across the UK implemented 5G-powered technology – they could save **£94 million per year**.

As buildings usually in operation 24/7, energy usage in police stations can be high. But with 5G-powered technology like smart sensors – monitoring heating, ventilation and lighting according to usage and occupancy – police stations could save **£26.1 million per year**.

Internet of Things (IoT)

The Internet of Things (IoT) works in tandem with smart sensors to receive and monitor data points across a variety of factors. For example, smart lighting can collect data on both room occupancy and on how much natural light is being let into a room to optimise the level of artificial light that is used. Smart Heating, Ventilation and Air Conditioning (HVAC) systems focus on one of the biggest drivers of energy consumption in any building, temperature control, and ensure that energy is not being used in places where it is not needed. The same IoT technology can also be used for diagnostics and predictive maintenance, helping to reduce breakdowns and maintenance costs.

IoT particularly benefits from 5G SA with its potential to receive and action thousands of data points in real-time without the risk of interruption and overload that comes with standard 4G or 5G.

Smart Sensors

Connected spaces and technologies, enabled by low latency 5G and IoT, enable buildings to shift between low and high occupancy usage between different hours as well as days. Public buildings can collect data and provide instant actions in response to areas of an office being vacated or occupied. The wide range and usage of 5G-enabled sensors can also allow councils to increase the operational efficiency of their work environments- determining patterns of work and productivity.

Facilitating the monitoring of key inputs, smart sensors benefit from a network that can process data at a quicker rate. This allows for more nuanced control, increasing the efficiency of a building's energy usage as well as providing more scope for the use of renewable energy sources.¹²

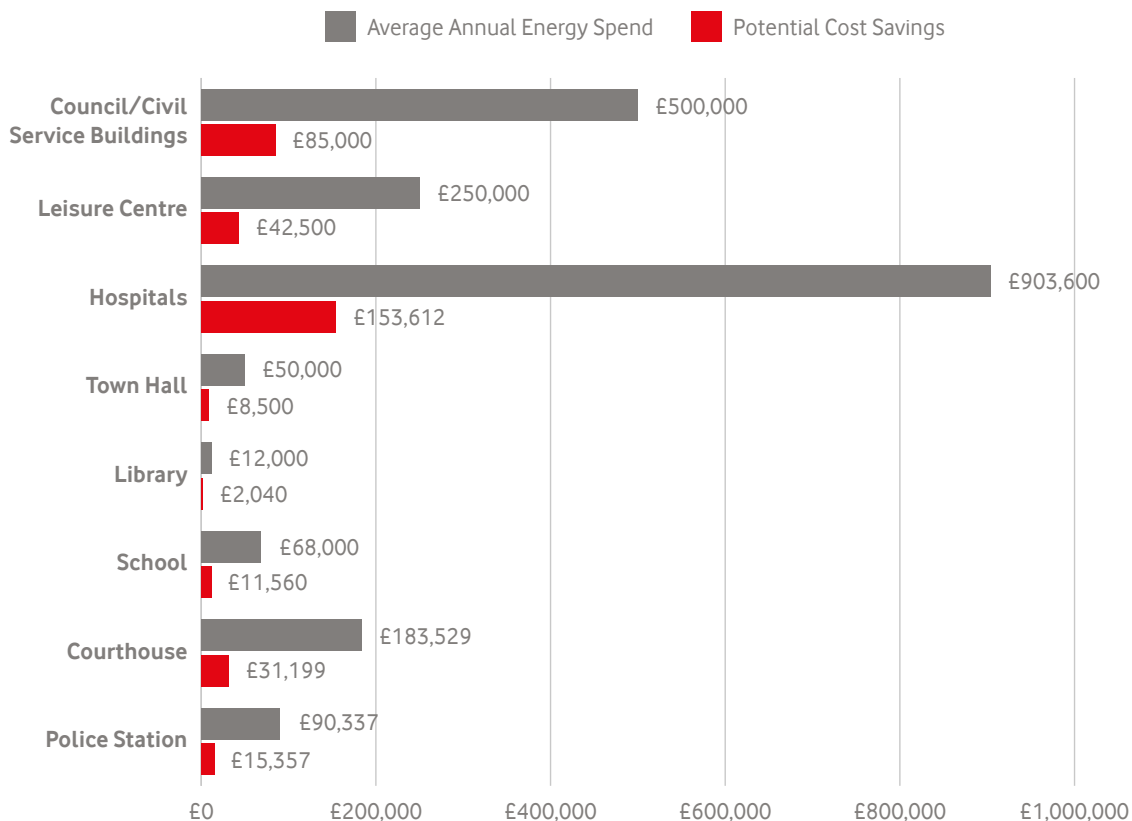


3. Savings

In order to provide an illustrative example of the public buildings in an average, medium sized UK town, we have selected eight that are commonly found in them. From lower cost buildings such as libraries to energy intensive leisure centres, a meta-analysis of the empirical literature suggests that new efficiencies in 5G-enhanced technologies can create energy savings of as much as 17% - equivalent to the average town saving £350,000 on energy bills every year. Towns the size of Scarborough, Kendal, Wilmslow and Frome stand to make significant cost savings across their public buildings, if supported by a national standalone 5G network.

Below is a breakdown of the potential savings available to different types of public buildings through the installation of 5G digital building technologies:

Public Building	Local authority responsible	Average Annual Energy Spend (£)	Potential Cost Savings (£) ¹⁵
Council/Civil Service Buildings	All council types	500,000	85,000
Leisure Centre	District councils/unitary authority	250,000	42,500
Hospitals	NHS Health Board	903,600	153,612
Town Hall	Town councils/unitary authority	50,000	8,500
Library	County councils/unitary authority	12,000	2,040
School	County councils/unitary authority	68,000	11,560
Courthouse	HM Courts and Tribunals Service	183,529	31,199
Police Station	PCC	90,337	15,357
Total	-	2,057,466	349,769



Overall, this could offer annual savings of up to £580 million to the UK's public buildings per year, once technology has been installed.¹⁴

As population and climate change place a greater strain on existing resources, the implementation of innovative technologies such as those in digital buildings can play a key role in tackling environmental as well as financial issues. Alongside the cost savings demonstrated above, our model also estimates that the rollout of 5G technologies across public buildings could save 1.43 million tonnes of CO₂e per year, equivalent to the annual emissions of almost 350,000 petrol and diesel cars.¹⁵ As councils face increasing pressure to account for the climate in budgets and long-term planning, 5G technologies can play a crucial role in reducing both financial and environmental pressures. In fact, research suggests that the upfront cost of implementing these technologies will be recouped within 2-3 years, further extending the practicalities of investment.



Conclusion

Public buildings perform key functions within local communities, delivering universal service as well as providing spaces for families and individuals to connect. In order to support local councils to continue providing these vital services, we must also consider innovative solutions such as 5G-enabled technologies, to urgently facilitate efficiencies and cost savings across the public estate.

However, these technologies rely on an uninterrupted, high-capacity 5G network that will only be possible through the full, nationwide rollout of standalone 5G. Standalone 5G operates on a separate ultra low-latency network to existing 4G infrastructure, supporting high-capacity usage which can be split into a dedicated network slice, to ensure that systems monitoring can continue uninterrupted by power outages or insecure connections.

Vodafone UK's proposed merger with Three UK would create the necessary market conditions to secure a nationwide standalone 5G network that can support public services in every town across the country, large or small. The combined network will reach more than 99% population coverage with 5G standalone by 2034, and over 95% population coverage by 2030, as well as ensuring coverage in every school and hospital across the country helping to deliver on Labour's manifesto commitment to reach national 5G coverage by 2030.

The combined business will invest over £6 billion in the first five years, and more than £11 billion for the overall ten-year plan, to create the UK's biggest 5G network, bringing significant emissions and productivity savings to businesses and buildings across the country; safeguarding the lifblood of communities for future generations.



Appendix

Estimating the energy costs of a typical UK town

A per capita energy cost (for both electricity and gas) was calculated for the following buildings using primarily central and local government financial reports and sources. This was then applied to a typical town of 40,000 residents, with one building each, per town, represented.

School (of 500 students) estimated energy cost per year - £68,000

Total savings across UK per year: £94.0 million

- **Source:** [LA and school expenditure, Financial year 2022-23](#)
- **Calculations:** The ONS provide a cost per pupil here for energy – a total spend of £485.3 million in 2022/23 across all LA managed schools (nursery, primary, secondary, specialist etc) is £136 per student.

NHS hospital (servicing 40,000 residents) estimated energy cost per year - £903,600

Total savings across UK per year: £219.7 million

- **Source:** [Estates Returns Information Collection, Summary page and dataset for ERIC 2022/23 - NHS England Digital](#)
- **Calculations:** The total spend on energy in 2022/23 for electricity and gas was £1,134.6 million across England, or £22.59 per person when accounting for the English population of 59.6 million.

Library estimated energy cost per year - £12,000 and Town hall - £50,000

Total savings across UK per year: £3.5 million and £14.4 million

- **Source:** [Council energy consumption - data.gov.uk](#)
- **Calculations:** Though there is not a nationwide dataset covering financial reporting for libraries and town halls, Leeds City Council published the energy costs of the libraries and town halls it maintained in 2021. To create a per capita cost, we aggregated the average energy costs from smaller libraries serving towns within Leeds, and then recalculated this for a library that would serve 40,000 residents. We also based these costs in current prices rather than on the 2019/20 financial year reported.

Council building campus estimated energy cost per year - £500,000

Total savings across UK per year: £144.3 million

- **Source:** [Box Report - Box Power](#)
- **Calculations:** This was aggregated from Box Power data which collates FOI responses on councils' energy usage in their buildings. We aggregated the average energy costs from the smaller councils that primarily serve towns, and then recalculated this for a building that would serve 40,000 residents.

Courthouse estimated energy cost per year - £183,529

Total savings across UK per year: £6.0 million

- **Source:** [HM Courts & Tribunals Service Annual Report and Accounts 2022-23](#)
- **Calculations:** Courts in England and Wales spent £31.2 million on energy in 2022/23, so we calculated the average energy cost of one of the 170 county courthouses operating in these nations, and extrapolated this to the UK population to create a per capita figure.

Police station estimated energy cost per year - £90,337

Total savings across UK per year: £26.1 million

- **Source:** [Cost of gas and electricity measured in kWh from January 2018 to October 2022 | Metropolitan Police](#)
- **Calculations:** Though there is not a nationwide dataset covering financial reporting for energy costs across all of the UK's police force, the Metropolitan Police have disclosed its energy costs for the 2021/22 financial year. It serves 8.9 million people in the Greater London area and it had a 2022 calendar year spend of £20.1 million, which is roughly equivalent to £2.26 per person.

Leisure centre estimated energy cost per year - £250,000

Total savings across UK per year: £72.1 million

- **Sources:** [Wadebridge Community Leisure Centre 'staggered' by energy price hike](#) Wadebridge Community Leisure Centre (£250,000), [Exmouth \(£300,000 – Exmouth Leisure Centre Highlights Rising Energy Costs](#); private leisure centre chains (£300,000 - [Leisure chain introduces 'extraordinary' limits at 200 centres amid high energy bills - CityAM](#)). Though there is not a dataset covering public leisure centre energy costs, a per capita cost was aggregated using a range of news reports on the rising energy costs for these buildings across large towns.

Estimating how public buildings use energy

We aggregated the breakdown of the average energy in UK buildings by use by the type of output as follows:

- Heating (33%)
- ICT and office devices (25%)
- Ventilation, cooling and air conditioning (15%)
- Lighting (10%)

This was weighted through an analysis of other research into how the UK's and other countries' buildings use energy:

BRE Study on Energy Use by Air-conditioning (2016)	Ventilation and air conditioning made up 10% of electricity use across non-domestic buildings in the UK
Carbon Trust (2021)	Though the intensity of non-domestic energy sources will vary place by place, the largest on average for all UK offices and non-residential buildings are: heating (33.1%), ICT equipment (25.1%), lighting (9.4%) and cooling and ventilation (8.2%).
Torres et al (2023)	HVAC (heating, ventilation and air conditioning) systems are the most consuming energy source worldwide for commercial/office sectors (47%). For the EU, devices including ICT equipment used around 17%, lighting 9%, and HVAC as much as 60%.
US Energy Information Administration (2023)	Found the breakdown of energy usage in US commercial buildings was similar for heating (32%) and lighting (10%), but higher for air conditioning (20% - of which ventilation 11% and cooling 9%), and lower for ICT equipment (5%).

Estimating how digital technologies can reduce energy usage and emissions in the UK's public buildings by up to 17%

This was conducted through a meta-analysis of the empirical evidence on how technologies that are especially successful on a 5G network can save energy in buildings, and considered against how the UK's public buildings use their energy:

<p>Cavendish Engineers (2022)</p>	<p>Used sensors for air quality, humidity, temperature and door and window controls to create a fully automated system for a central London office complex on an IoT network, resulting in a 42% reduction in air handling, a 15% gas reduction and a 10% reduction in electricity consumption in its first two years. For our weighted UK buildings' energy use, this would be an overall energy reduction of 21.3% (10% electricity reduction plus the 15% gas reduction, which is c.33% of a building's energy use and the 42% reduction in air handling, which is c.15% of a building's energy usage).</p>
<p>Transforma Insights (2022)</p>	<p>Empirical review of new and emerging digital technologies found that digital building solutions for HVAC and lighting systems could reduce overall energy consumption by 10-20%.</p>
<p>King & Perry (2017)</p>	<p>Found a similar figure - automating HVAC and lighting systems alone can see an energy reduction of 23% - or 17.3% of this energy for UK offices in our breakdown.</p>
<p>Jradi (2024)</p>	<p>Empirical review of sensors and digital energy management saw an overall energy reduction of 17% across a sample of offices in South Korea using a range of these technologies</p>
<p>Hobson & Gunay (2022)</p>	<p>Occupant-centric controls which use sensors to collect and monitor data on room capacities and worker energy patterns and behaviours saved 30.6% of annual heating and 9.6% of cooling energy, respectively. Taking our UK buildings' composition of energy use, this would be an energy reduction of 11.5%.</p>
<p>ESSMag (2022)</p>	<p>Basic automated controls could save a building 10-15% of its energy, or 15-25% with more advanced functionality. Of this, HVAC & lighting are 8-18% of savings.</p>

Benchmarking the scale of a typical council's spending on energy

- A 17% energy saving across the UK's public buildings would create a total fiscal saving of £580 million. This scale is reasonable as previous WPI Economics analysis in the Digital Buildings, November 2020 set an upper bound of £380 million when digital building technologies save 15% of energy - but 5G and digital technologies have since advanced in their energy saving capabilities according to newer empirical evidence, and when compounded by higher energy prices in recent years, this creates now-higher public savings.

Calculating the emissions reductions

- 384.2 million tonnes of carbon dioxide equivalent (MtCO2e) was emitted in all of the UK in 2023. The CCC states that 85 MtCO2e is directly emitted by buildings, 9% of which by public buildings (or 7.65m tonnes per year). All buildings are responsible for 59% of UK electricity consumption, or 31 MtCO2e per year in indirect emissions (indirect meaning from appliances and lighting in homes, and cooling, catering and ICT equipment in nonresidential buildings). Public buildings are responsible for 2.5% of indirect emissions, or 0.775 million tonnes per year. This brings the total emitted by public buildings to 8.425 MtCO2e - so a 17% saving would be 1.432 million tonnes of CO2 per year.

Endnotes

- 1 <https://www.countycouncilsnetwork.org.uk/worse-than-austerity-councils-warn-that-any-cuts-to-their-budgets-next-year-would-mean-they-are-only-able-to-offer-the-bare-minimum-in-local-services/>
- 2 <https://www.theccc.org.uk/publication/progress-in-reducing-emissions-2024-report-to-parliament/>
- 3 <https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Buildings.pdf>
- 4 [Net Zero Government Initiative](#)
- 5 [The local climate challenge | Green Alliance](#), p. 11
- 6 [Local Authorities and the Sixth Carbon Budget](#), p. 3
- 7 [Local Authorities and the Sixth Carbon Budget](#), p. 4
- 8 [Council bankruptcy tracker: authorities under increasing financial strain - New Statesman](#)
- 9 [Sixth Carbon Budget: Buildings](#), p. 6
- 10 <https://www.gov.uk/government/news/557-million-for-public-buildings-to-switch-to-cleaner-heating-and-save-on-energy-bills>
- 11 [Using Smart Technology to Save Energy in Existing Buildings](#)
- 12 [Mobile UK, How 5G will supercharge utilities and energy, January 2023](#), p.3
- 13 These savings are per building. They are calculated using a mix of local and central government data (fully outlined in the appendix) to create a per-capita cost for each selected building type, and then applied to a town of 40,000 residents. We then assessed the updated empirical research on how much energy digital technologies can save, and then compared this to the typical energy outputs for the UK's public buildings (e.g. HVAC vs. lighting).
- 14 Extrapolating the £2.06 million spent on energy for these buildings per 40,000 residents across England's total population, where national data is not available, would equal £2.99 billion, when each building is only assumed as one per town. To benchmark the scale of this expenditure. All LA budget for public service expenditure in 2023/24 is £117.5 billion ([Local authority revenue expenditure and financing: 2023-24 budget, England - GOV.UK](#)).
- 15 384.2 million tonnes of carbon dioxide equivalent (MtCO₂e) was emitted in all of the UK in 2023 ([Office for National Statistics](#)). The CCC states that 85 MtCO₂e is directly emitted by buildings, 9% of which by public buildings (7.65m tonnes), and a further 31 MtCO₂e per year in indirect emissions (indirect meaning from appliances and lighting in homes, and cooling, catering and ICT equipment in nonresidential buildings). Public buildings are responsible for 2.5% of indirect emissions, or 0.775 million tonnes. This brings the total emitted by public buildings to 8.425 MtCO₂e - so a 17% saving would be 1.432 million tonnes of CO₂ per year, or 0.37% of all UK emissions ([Sixth Carbon Budget, building](#))



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