The Internet Is Not Run By Magic

Data Centre FAQs

March 2022

At techUK we are asked lots of questions about data centres, by journalists, by politicians and other policy makers, by colleagues and by friends and family. In 2021 we ran a schools outreach activity and our engineers and technicians fielded thousands of questions from hundreds of schoolchildren keen to learn about the internet and how digital infrastructure works. Although there were lots of different questions, collectively they told us two things: firstly that most people struggle to understand what data centres are, and secondly that we are not explaining our industry well enough. We have therefore compiled a list of the most frequently asked questions, together with brief answers and links to further information.

We have organised our questions very roughly into two categories. Firstly we cover the basics, including a couple of questions about data centres in the UK. Many questions were about energy and sustainability so these make up the second category.

Section 1: WHAT'S THE POINT OF DATA CENTRES?

Q1 What are data centres?

Data centres are the buildings that house the internet.

Data centres store, process, receive and transmit data. Together with communications, they form our digital infrastructure.

Data centres underpin all digital activity - this means everything from backing up the photos on our phones to processing huge datasets for weather forecasting.

Q2 Aren't data centres mainly for social media and streaming?

No. Data centres are not just for storing cat videos

The internet, and the data centres that support it, are not just for social media. Just think how much you use the internet: working, shopping, banking, studying, accessing government services, submitting (and calculating!) tax returns, organising travel and getting directions, making appointments, catching up with news, listening to music, watching sport. Keeping in touch with family and friends is really important but it is only a small part of our online activity.

The real work that data centres do is supporting our economy: business transactions, public sector services, academic research, logistics, the list is endless. Data centres underpin our economy and almost every aspect of our daily lives. That's a lot more than cat videos.

Q3 Why do we need data centres?

Data centres are the most important industry you've never heard of.

Combined with communications networks, data centres provide the core digital infrastructure that makes the internet work. 65% of GDP is digitized, and that means it goes through at least one data centre somewhere. Data centres underpin government services, business processes, academic research, entertainment, supermarket supply, transport logistics, weather forecasting, climate monitoring and modelling – and of course processing all those huge datasets needed for medical research like vaccine development.

Data centres underpin almost every aspect of our daily lives: the internet has become an essential utility that we take for granted.

Q4 Why do we need such big data centres?

Because the internet is so important that we need it to work – all the time!

Modern data centres are built on an industrial scale to make sure the internet keeps working. They need to be secure and highly resilient – we don't want our data housed in someone's leaky garage, we need to know that our online transactions are safe, that we can access services when we need them, that our personal information remains personal, and that our photos are backed up.

Also, although it might seem strange, big data centres are efficient. Consolidating activity into large, purpose-built facilities delivers economies of scale and enables power consumption to be optimised. As well as massively improving efficiency compared to server rooms, energy use is more transparent and accountable. In the UK our commercial operators – the people who operate big data centres - report both energy and carbon publicly.

Q5 Why do we need data centres when we have the cloud?

The cloud is not a cloud – it is a data centre somewhere

Cloud computing really means accessing applications and computing resources via the internet. So instead of storing data on devices like phones and laptops it is kept in data centres. Cloud computing needs physical infrastructure to make it work. Communication networks and data centres are the infrastructure that enable us to do so many things with our phones, tablets, and personal computers.

Q6 Why does my smartphone need a data centre?

Because your smartphone is your portal to the internet, and the internet lives in data centres

Phones have changed over the last two decades – in the past we used them to call people, and that was that. Now a smartphone is not just a phone – it is a portal to the internet and many of the apps on your phone are not actually inside the phone – there wouldn't be enough storage space. So they are in data centres. Your phone doesn't need one data centre - it will actually use many data centres every day.

Q7 How many data centres are there in the UK – and where are they?

The number of data centres depends on how you define a data centre, but….

In the UK we have probably the second largest commercial data centre sector in the world, and certainly the largest in Europe - around 200 sites. These provide data centre services for organisations across the UK

economy and overseas, including Government. Around 70% of the market is clustered around London. The next biggest cluster is in Manchester. Our commercial data centre sector is globally important - an amazing success story for the UK.

In terms of energy consumption, these sites collectively use 3.6TWh of power a year. We know this because we measure it. This equates to just over 1% of our UK electricity consumption and about 0.25% of the UK's total energy demand (remember electricity and energy are not the same thing[1]).

We also have probably the same number of data centres that are run in-house by businesses. We don't know the exact number but we do know it is declining as more organisations outsource. There are also many, many server rooms within office premises, but these are not data centres – see below.

Q8 What is a server room – is it a data centre?

No, just like a car is not a bus: a server room is not a data centre

A server room is not really a data centre although it does similar things. A server room is usually located within the offices of the organisation it supports. It therefore does not consolidate IT functions into a purpose-built facility. Think of a private car compared to a bus; they both do the same thing - move people around – but are different classes of transport. It's much more efficient to transport 50 people in one bus than in lots of cars.

There are physical differences too. Server rooms are likely to be small and usually have enough back-up batteries to shut down safely in the event of a power cut, but no generating capacity to run independently. They also tend to be much less efficient than data centres, which can invest in the latest technologies and achieve economies of scale.

Server rooms are not data centres but their energy consumption is still part of the ICT footprint. The big problem with server rooms is that there are lots of them and they don't tend to report their energy so their carbon impact is unknown.

Q8 What did data centres do during the pandemic?

Data centres kept the economy going: data services are not like loo paper, fortunately

During the pandemic we realised how much we depend on digital infrastructure. Almost overnight, activity shifted online – business, government, education, entertainment; suddenly we were working and being educated from home and meeting via Teams, or Google or Zoom (Zoom users alone increased by 5000% in 2020!) Could the supply chain have delivered if the same had applied to loo paper….?

It was possible because enough capacity could be made available, because the sector can respond fast, and is resilient. However, it required huge effort: our operators rose to the challenge, our engineers and technicians worked round the clock to keep things running. We aren't frontline health services but nevertheless we are immensely proud that we played some part in keeping the economy going and helping people stay in touch.

And don't forget that one of the reasons vaccines were developed in months and not years was because we had the computing power available to manage the huge datasets involved. Ten years ago it would have taken a decade.

[1] In the UK our total energy demand is around 1500TWh, whereas our electricity consumption is around 300TWh. Many people confuse energy and electricity but 1% of UK energy is five times more than 1% of electricity.

Q10 How much do you think data centre will change in the next ten years?

We think that data volumes will continue to increase, but much of it will not need to be stored

Volumes of data will massively increase but much of this will not need to be stored – it will be instantaneous. So we will see new types of data centres (so-called edge facilities) to manage this, smaller and closer to where the data is needed.

In future we think data centres can play a leading role in helping the UK decarbonize – firstly they underpin the process of digitalization that will be so critical. Secondly, the data centre sector has already committed to decarbonizing its own activity. Thirdly data centres could play a more active role in the energy market. By adopting new energy technologies like fuel cells they could be prosumers instead of just consumers. They could provide load balancing and enable a more distributed grid with more renewable generation. This won't happen overnight but there is good progress being made.

Section 2: ENERGY AND SUSTAINABILITY

Q11 Doesn't the internet have a huge hidden energy impact?

The internet is run by physics, not by magic: nothing secret about that

Of course the internet uses energy – it relies on physical infrastructure. Not all energy consumption is obvious, but it is not a secret. The parts of the internet that you can't see – communications networks and data centres – together account for under 50% of the energy of the internet. Over 50% is used by end-user devices (smartphones, tablets, laptops etc) - and this share increases quite significantly if you include TVs. This may seem a lot because digital devices are efficient and each one consumes so little, but there are billions of them and it all adds up - so collectively they dwarf the other parts.

Nobody really knows how many devices there are or how they are used, so that data has to be modelled, and is always an estimate.

Q12 Are data centres secretly consuming huge amounts of electricity?

Data centres consume around 2% of our electricity in the UK. We know this because we measure it. It's not secret though - we report it publicly

No. There is nothing secret about data centre power consumption – in the UK we measure the energy consumption of the commercial sector and report it publicly. Yes, data centres are energy intensive but they are efficient and consume less power than you might think.

The UK's commercial data centre sector consumes 3.6TWh of power a year[2], just over 1% of UK electricity, which equates to 0.25% of overall UK energy demand[3]. In-house data centres don't report energy in the same way but we think they use about the same – taking the total to around 2% of electricity, 0.5% of total energy demand.

[2] This is reported to BEIS via the Climate Change Agreement for Data Centres

[3] The UK's primary energy consumption is around 1500 TWh a year, five times more than the electricity. Obviously, some of this is used to generate electricity but the majority is

Compared to other critical sectors like transport, which accounts for around 25% of total energy use, this isn't bad, considering how much we rely on the internet.

This total does not include server rooms in offices because they are not data centres. However, there are lots of them, and they don't report their energy so their impact is unknown. We would like to see more transparency of server room energy, especially in government.

Q13 Is data centre power demand growing exponentially?

No, because data is not like cheese

Data centre energy use is not growing exponentially but the demand for digital data IS growing exponentially. Managing all that data without a parallel increase in data centre energy demand is a huge challenge. We are doing well and keeping overall data centre power demand relatively flat. This is because:

1. Data is not cheese: if we wanted more cheese we would need more cows, but processor and network efficiencies have improved by orders of magnitude. So we can currently support more digital activity without a parallel increase in our energy demand.
2. New business models like cloud computing and technologies like virtualization help us do more for the same amount of power.
3. The efficiency of our supporting infrastructure is also improving all the time, but more incrementally.
4. Activity is migrating to where it can be done more efficiently: Old facilities and inefficient server rooms are being decommissioned and work consolidated in modern facilities and/or outsourced to cloud providers. This can deliver orders of magnitude improvements in efficiency.

Q14 Is video streaming a bad thing?

Not necessarily: streaming video does have an energy impact, but it is low compared to other activities

Video streaming does have an energy impact but it's less than you might think and is low compared to other activities. In Europe, the Carbon Trust calculated an average of 55g CO_2 for an hour, which is equivalent to microwaving 3.5 bags of popcorn or driving 250 m in a car.

The biggest share of streaming emissions is usually attributable to the viewing device: the energy impact of viewing on a 50 inch TV is 90 times greater than on a mobile phone. The grid mix of the country or countries where it takes place also a very significant factor in terms of carbon.

Surprisingly, streaming in HD doesn't make much difference: if there is capacity more data can flow with little impact. In contrast, if we put more cars on our road network, more fuel is burned, but data is not like cars.

However, if demand for streaming increases to such an extent that we have to expand the infrastructure, then there would be a significant impact. So it's still important not to be profligate in the way we consume video.

Q15 What are data centres doing to improve energy efficiency?

Just like a house where an efficient boiler is only part of the answer, a data centre is a system

Data centres are complex systems where different elements must work together optimally to minimize energy use, just like a house where a state of the art boiler will not make it efficient if the building isn't insulated, or if you leave all the doors open, or insist on setting the thermostat at 28°C.

Balancing multiple elements is very complex in data centres but simplistically we look at efficiency in two areas: the computing operation (the IT) and the supporting infrastructure (the building).

1. Computing efficiency improves as chips (processors) and computer servers get better. Approaches like virtualization and cloud optimize the use of IT hardware.
2. The efficiency of the supporting infrastructure to reduce the energy overhead of the facility itself on the core function. Our operators work incredibly hard to make these facilities efficient – standards, metrics, cooling, water reuse, heat reuse. We measure and report energy and meet efficiency targets set by government.

There is always more to do: energy efficiency is a constantly moving target for data centre operators because new technologies are emerging all the time.

Q16 What do you mean by processor efficiency?

Massive efficiency improvements in data processing: Imagine if you could fly to New York on 3 teaspoons of Calpol – would you fly more?

We mean the efficiency of computer chips. Over the last 30 years they have improved processing power by around six orders of magnitude.

That's a million times more efficient in a few decades – no wonder we use ICT more and more….However, most people think that this rate of improvement can't last for ever.

So if you applied that to aviation, you could fly a jumbo to New York on 15 ml of fuel. That's the equivalent of three teaspoons of Calpol. Yes, it's a terrible comparison for many reasons, but it gives an idea of what has been achieved.

Q17 What are data centres doing to improve sustainability, besides energy efficiency?

Data centres are helping fund renewables, minimizing water and waste and applying circular economy principles

Data centres are adopting renewables, funding additional renewable generation and exploring new power sources that would take them off grid. Data centres are reducing water use and using rainwater collecting and closed loop water systems. Data centres are exploring ways to reuse their waste heat and operators are also applying circular economy principles to servers – some used closed loop systems and others are offering servers as a service.

Q18 How are data centres working towards net zero?

In time, data centres will become energy prosumers and anchor customers for new tech

Data centres are working towards net zero in multiple ways. Larger operators are committing to science based targets and self regulating climate neutrality by 2030.

At operational level, data centres are:

- Improving computing and operational efficiency: the most sustainable energy is the energy you don't use.
- Purchasing renewables – over 90% of the power consumed by UK sector is certified renewable.
- Adopting power purchase agreements: funding additional, utility scale renewable generation. Data centres are perfect for this, but there are lots of challenges.

In time data centres will be anchor customers of fuel cells, green hydrogen and industrial scale battery storage. Then they can become prosumers in the energy market.

And remember, data centres underpin digitalization, and by doing so, help everyone get closer to net zero.

Q19 Why aren't data centres all reusing their waste heat?

Operators are happy to share heat but need customers

Mainly because nobody wants it: there aren't enough heat networks or customers and because it is not very useful - data centres produce warm air at around 30-35°C, and they don't produce a consistent amount throughout the year.

Providing the heat also adds a slight energy overhead, so the heat has to be used productively in order for a net gain in energy productivity.

Nevertheless waste heat is already being used from data centres for things like greenhouses, desalinization, trout and lobster farms and for algae that sequester carbon dioxide.

Q20 What are the big sustainability challenges facing data centres in the UK?

As we get more efficient, demand increases

Our biggest challenge is accommodating growth in digital data without a parallel increase in data centre energy demand. We have to improve efficiency constantly just to keep pace – whilst also remaining resilient.

Rebound factors are a challenge: online activity is price elastic so the more efficient we are, the more people consume our services. This is called Jevons Paradox

And then we have to help people understand the energy impact of their online activities. Freemium and advertorial business models are great for innovation but don't send an energy signal to consumers because they are free at point of use. So we need to be better at explaining this and helping consumers be responsible digital citizens.

Further information

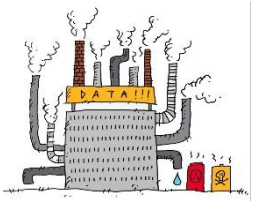
If you have questions to ask that are not covered here, please get in touch or have a look at the further information below.

The best place to start is our Directory of Publications: https://www.techuk.org/data-centres-programme/data-centres-resource-index.html Meanwhile here are some useful third party sources and references.

Third Party Sources and References

- Data Centre Energy Analysis: Past, Present and Future, explanatory video by Prof Eric Masanet, UC Santa Barbara, 2021. https://www.youtube.com/watch?v=-o8j5zIM0iA
- Electricity Intensity of Internet Data Transmission: Untangling the Estimates: Aslan, Mayers, Koomey and France; 2018: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3226029
- Does Not Compute: Avoiding Pitfalls Assessing the Internet's Carbon and Energy Impacts: Jon G Koomey and Eric Masanet, 2021: https://www.gwern.net/docs/cs/2021-koomey.pdf
- Energy Tracking Report on Data Centres and Data Transmission Networks, International Energy Agency (IEA) 2020: https://www.iea.org/reports/data-centres-and-data-transmission-networks
- IEA report: Digitalisation and Energy this explains the trade-off between ICT and broader energy savings: https://www.iea.org/reports/digitalisation-and-energy
- The Royal Society: Digital Technology and the Planet: https://royalsociety.org/topics-policy/projects/digital-technology-and-the-planet/
- The Carbon Impacts of Video Streaming: The Carbon Trust 2021 https://www.carbontrust.com/resources/carbon-impact-of-video-streaming
- Carbon brief on impact of video streaming: https://www.carbonbrief.org/factcheck-what-is-the-carbon-footprint-of-streaming-video-on-netflix

Relevant techUK Publications



- Data Centre Energy Use: The Viking Helmet
- Ten Myths About Data Centres (2019)
- Does streaming really have a dirty secret? (2020)
- Data Centres and Power: Fact and Fiction (2013)
- Data Centre Energy Routemap (2019)
- Lost in Migration: Attributing Carbon to Cloud
- CCA reports: (First Findings, Target 1 and Target 2)
- The UK Data Centre Sector: The Most Important Industry You've Never Heard of (2020)

techUK's data centre programme

techUK is proud to represent UK data centre operators. Our award-winning programme is comprehensive and influential. Our aim is to ensure that the UK is a place where the sector can flourish. We intervene on policy, we mitigate regulatory impacts and we raise awareness. To date, we have changed UK law and negotiated a tax concession worth over £200M for operators, we have reduced regulatory burdens, identified and mitigated business risks, established a community of interest and shared technical knowledge. We have educated the sector about policy and we have educated policy makers about the sector. During COVID-19 we negotiated the inclusion of data centres on the key workers list, obtained quarantine exemptions and protected construction sites. Most recently we secured a pragmatic solution for operators on changes to the taxation regime for red diesel.

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