Jisc

Exploring digital carbon footprints

The hidden environmental cost of the digital revolution and the steps universities and colleges can take to address it.

Contents

Foreword

How can the education sector shape its sustainable future? There has, arguably, never been a more important or urgent question for all of us in education to address.

We have a moral imperative to heed the appeal of Steve Frampton, climate commissioner for UK higher and further education, when he urges that *"We have a duty to act now – collectively, collaboratively, with urgency and at pace to ensure that future generations can live on this planet."*

Tackling the climate emergency is a priority for Jisc and we are committed to achieving net zero, including offsetting emissions, by 2040 at the latest. As a tech organisation, this is a complex task, which includes assessing our cloud-based services and the way in which we consume and recycle technology.

However, these kinds of assessments are not the sole preserve of tech organisations. The carbon footprint of digital technologies is an aspect of sustainability that every educational institution on a journey to net zero must consider – and is too often overlooked.

That's why this special report has never been so timely. We've commissioned Scott Stonham, the independent sustainable technology analyst from Well, That's Interesting Tech! to take an in-depth look at the carbon footprint of all our digital lives and offer practical advice and guidance on reducing it.

Scott considers the challenges and opportunities digital technologies present to educational institutions as they seek to minimise their carbon footprint, with a particular emphasis on the role of IT and technology leaders in helping understand, mitigate and remove carbon emissions associated with educational use of digital technologies.

The report focuses on highlighting the source and impact of digital carbon footprints across four topic areas:

- **Procurement**
- **On-premises IT**
- **Cloud technologies**
- **Remote working**

Across each of these four areas Scott examines ideas and use cases from the commercial and educational domains. The intention is to raise awareness of digital's carbon impact, expand the conversation and inspire action, while guiding development of best practice through examples of both simple changes and strategic action.

The education sector is at a very early stage in recognising and tackling the role technology plays in carbon emissions, whether that's data storage, procurement, the sustainability of equipment or even the video conferencing tools we use to work remotely. This report is a very useful and welcome first step in addressing the challenge.

Robin Ghurbhurun
Managing director, Further education, skills and member support (FE and HE)

Executive summary

The carbon impact of digital technologies is huge and growing at an exponential rate, which has been accelerated further by the rapid digitalisation forced by the COVID-19 pandemic.

Digital is now more entwined in our lives than ever, yet it is easy to underestimate the extent of the environmental harm it can cause.

Organisations of all types, education included, are discovering that the greatest contributors to their carbon footprints are the services and products they buy. Indeed, a vast majority (approximately 80%) of IT's carbon footprint can be attributed to the manufacturing and distribution of the equipment itself. The rest comes from operational usage.

IT is often one of the biggest contributors to an education institution's own carbon footprint, with one UK college attributing 20% of its emissions to IT alone.

How we source, procure and dispose of our technology assets is the first area to address, an important part of this being how to use equipment for longer.

Increasingly, technology companies are providing solutions to these challenges by improving carbon transparency in the supply chain, or helping lower the barriers to extended technology life through refurbished, remanufactured and re-homed tech.

Operational digital carbon emissions apply to on-premises, cloud and remote technology use.

Within these areas there are opportunities for increasing awareness, measuring, communicating and improving impact.

The key to improving our digital carbon footprint is in taking informed action, which requires understanding and awareness. College and university leaders can use technologies such as carbon calculator apps and real-time energy consumption carbon emission dashboards to measure and communicate impact.

"Don't standby, turn off" awareness campaigns could make significant cumulative energy and carbon savings across on-premises, cloud and remote digital footprints.

Every 100 gigabytes of data stored in the cloud could generate 0.2 tonnes of carbon emissions per year, yet 90% of data is stored and never used again.

Each video calling platform generates different amounts of carbon emissions, some much greater than others. Yet we know that making a call in HD video is always more carbon intensive than SD, and audio is just a fraction of that still.

All in all, digital technologies are responsible for vast amounts of carbon emissions, but there are many things, large and small, that leaders can do to mitigate and reduce this.

Policy changes and best-practice sharing can help lower footprints by making simple changes, such as adapting video call habits and being mindful of how much data is retained and where it is stored.

IT managers can achieve quick-win carbon improvements to on-premises data centres with little to no investment by focusing on airflow. Alternatively, they can invest in more strategic technologies to measure and minimise the impact of each virtual machine against the UK's National Grid real-time carbon intensity values.

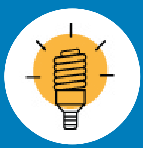
Cloud technologies companies provide organisational and user level emissions dashboards that can be used to develop detailed understandings of digital carbon footprints. But the providers must continually be challenged to make further improvements themselves.

Social media apps not only pose potential risks for mental health but also have a significant carbon footprint. Educational staff scrolling through LinkedIn could be generating up to 2,792 metric tonnes of CO_2e per year.

Technologies can help measure and inform us about energy consumption around the campus and at home, as well as automate optimisations. However, some technologies can inadvertently do more harm than good.

Document structure
This document contains information, insights and practical advice from industry leaders working to address the digital carbon footprint of technology across academic and commercial sectors.

To help you navigate, the following iconography is used to show the content type:


Tech that could help


Best practice


Important information

Why we should pay attention to our digital carbon footprint

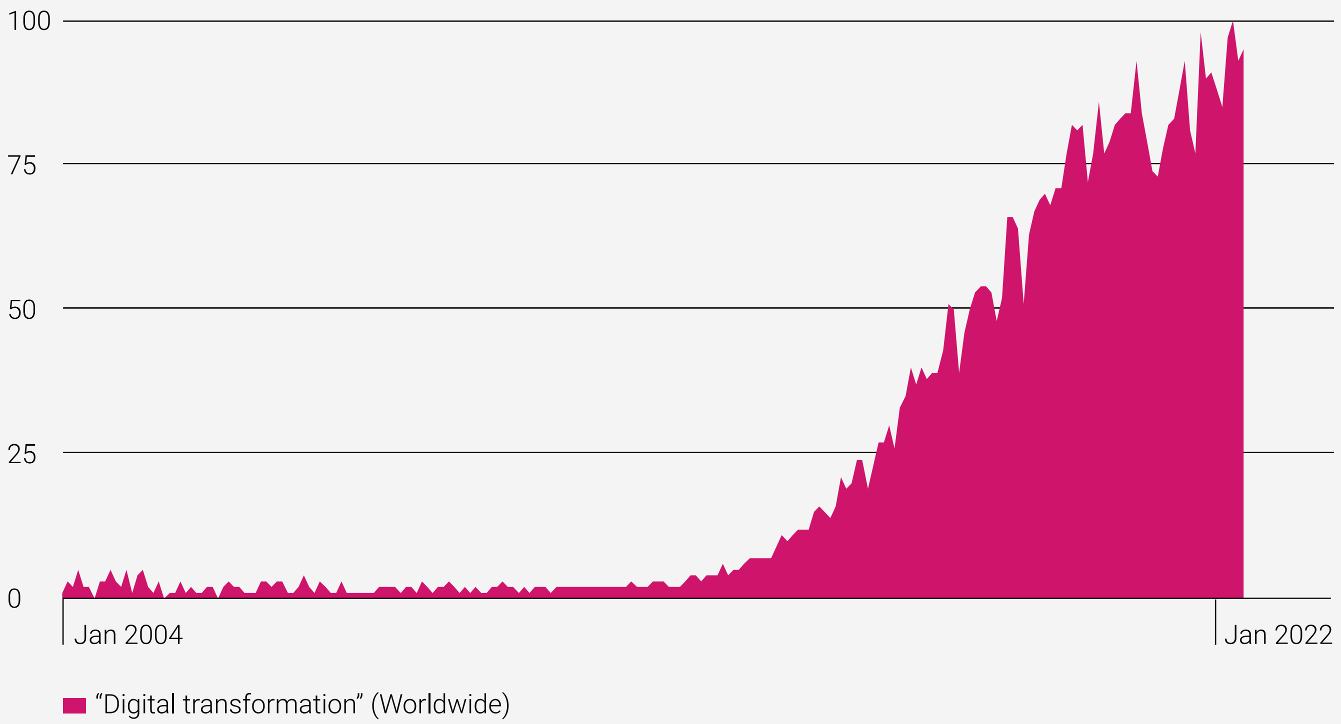
Looking at Google's trend analysis (below), it might appear that digital transformation has followed a steady, progressive path.

However, lurking beneath the broad term 'digital transformation' are details that indicate a much more rapid adoption of digital technologies, shaped by sudden changes to our shared reality. This was triggered in part by the COVID-19 pandemic but also by a growth trend that was already in motion.

To say the COVID-19 pandemic ushered in a new age of digital adoption might well be an understatement.

A 2020 McKinsey report summarises that:

Search term interest over time: "Digital transformation"



Source: ***Google trends***

"...responses to COVID-19 have speeded the adoption of digital technologies by several years—and that many of these changes could be here for the long haul.[1]

Jeff Lawson, CEO of cloud messaging and communication company Twillio, said the digitalisation of our lives was already accelerating before COVID-19, but the pandemic speeded up these existing trends by up to six years.[2]

This step-change in global digitalisation marks a significant moment in our digital futures, and with the government's digital strategy[3] aiming to develop a world-leading digital economy, we can expect a continued, exponential acceleration of digital technologies.

Digital emissions and exponential growth

Digital technologies are often thought to be greener than their physical alternatives.

While this may be true in some ways, digital might also have earned too much unwarranted acclaim when it comes to its green credentials.

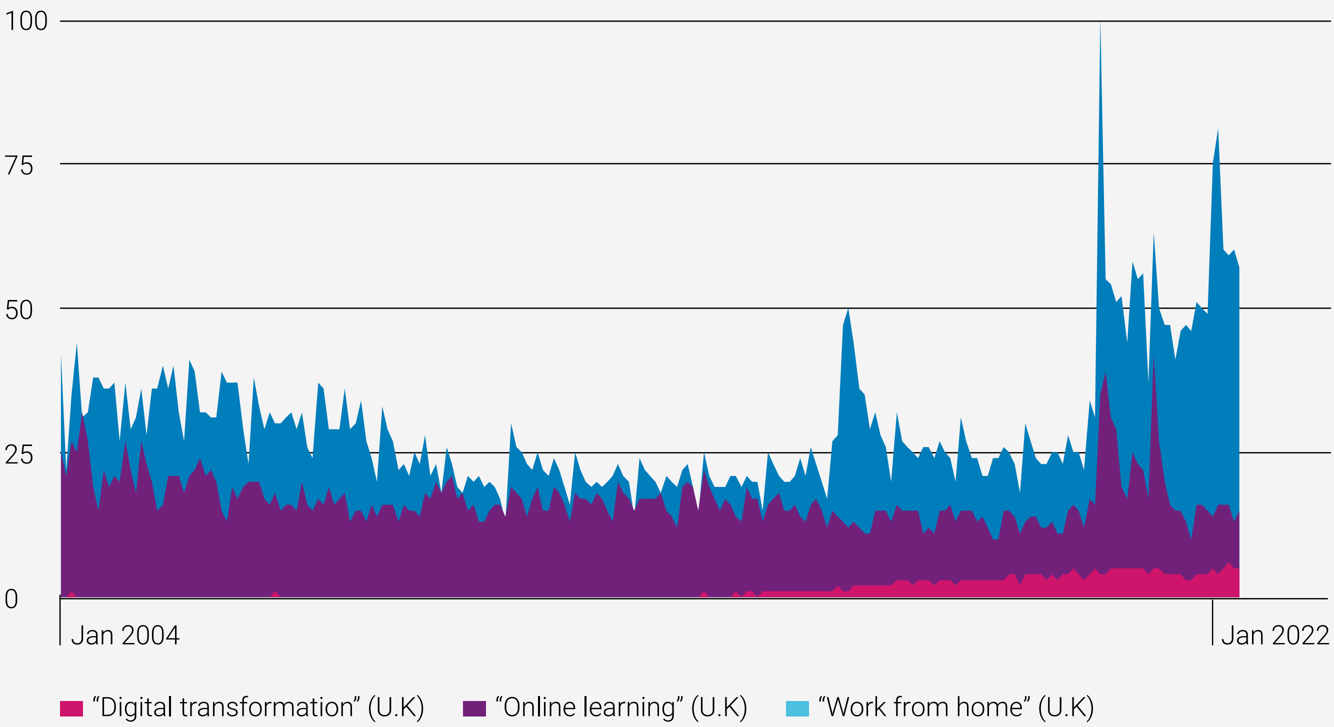
It is true that, compared to traditional media such as newspapers and magazines, a digital publication does not directly consume natural resources or seem to produce waste. Likewise, choosing to conduct a meeting using video conferencing instead of depending on participants to physically travel to a meeting location doesn't *directly* consume fossil fuels.

However, digital does have a carbon footprint, and it is not inconsequential.

In fact, **the digital carbon footprint is substantial.**

Exactly how substantial is a matter of ongoing study. Current estimates of the internet's aggregated carbon emissions are in the order of 1.7 billion tonnes of carbon dioxide

Search term interest over time: "Digital transformation"; "Online learning"; "Work from home"



Source: ***Google trends***

equivalent (CO_2e) emissions a year in 2020,[4] up from 2010 estimates of approximately 300 million tonnes – a growth rate significantly faster than doubling every year.[5]

If the internet were a nation, this level of emissions would place it as the fourth largest CO_2e emitter, behind USA, China and India, and ahead of Russia.

Other estimates broadly frame the internet's CO_2e emissions between 6% and 12%[6] of the global totals. This wide variation is in part due to ambiguities between top-down and bottom-up models and different definitions of what "the internet" includes.

> *Quantitative estimates vary widely, with literature values suggesting that consumer devices, data centres, and data networks account for anywhere from 6% to 12% of global electricity use.*
> Intergovernmental Panel on Climate Change (IPCC)

Educational IT carbon

During a conversation with a 'circular IT' business leader[7] who specialises in helping organisations mitigate their IT carbon footprint, I learned that, of the colleges his company has worked with, it is typical to find that 5-10% of their total carbon emissions are associated with IT.

However, one college eclipsed this, with 20% of its total carbon footprint being attributable to its IT.

Digital carbon footprint growth

Does accelerating global digital transformation translate into a growing digital carbon footprint?

The answer to this is yes (most likely).

Major digital infrastructure providers such as data centre operators, big tech companies like Google and Amazon, and connectivity providers including mobile operators are all pledging to migrate their energy demands to renewable energy sources.

Some of these companies, such as Microsoft, have not just pledged to mitigate their future carbon footprints through the switch to 100% renewable energy sources but have committed to carbon-removal projects equivalent to their entire historic emission output.

Since these global organisations power so much of our daily digital lives, the actions alone act as a multiplier, helping to passively reduce each of our digital carbon footprints.

However, as we will see later, reducing operational energy consumption is only a small part of the story. Manufacturing, storing and shipping devices contributes massively.

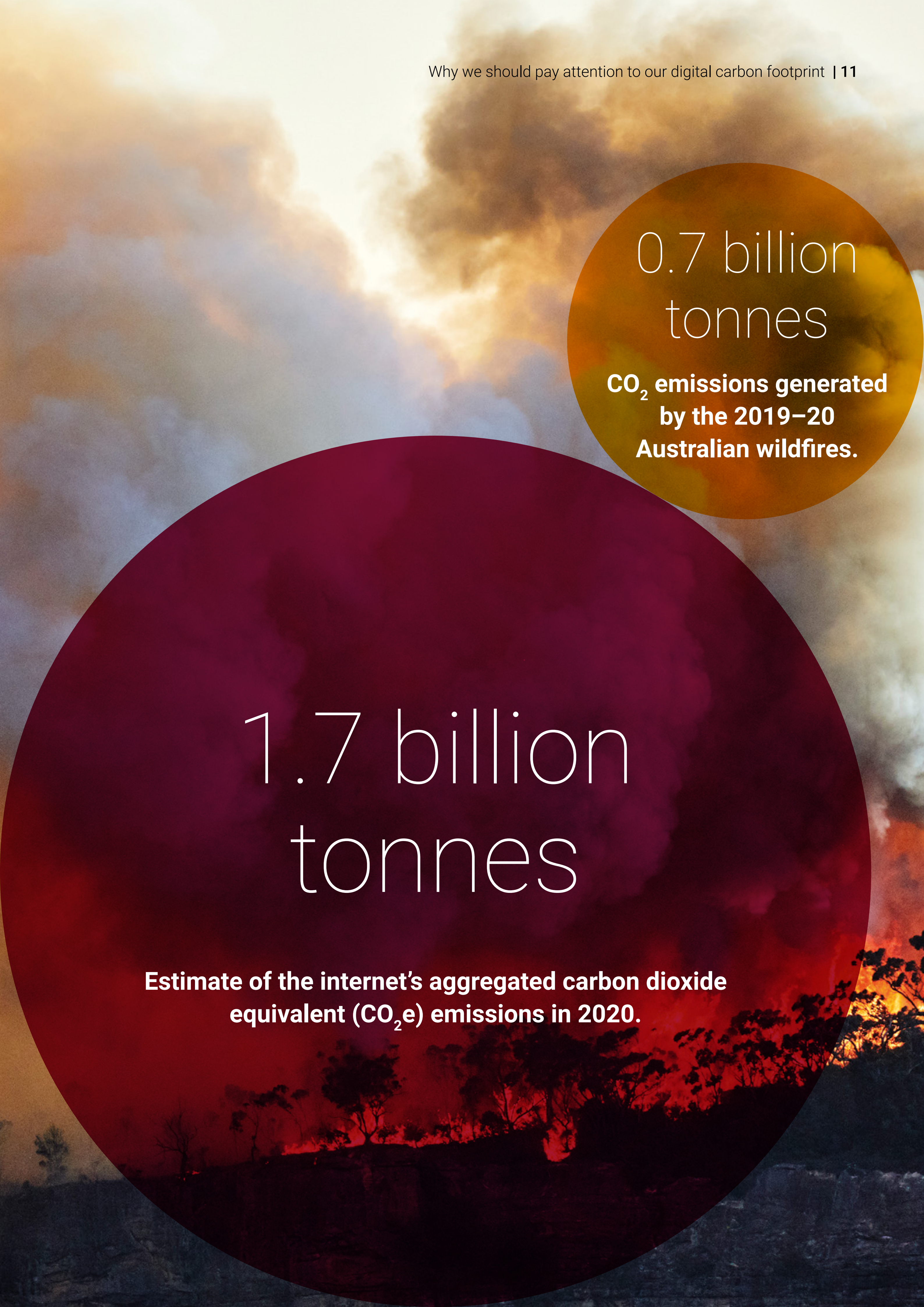
Accordingly, many equipment manufacturers have also been working to reduce CO_2e emissions during manufacture and optimise their products to consume less energy.

Yet, the Intergovernmental Panel on Climate Change (IPCC) is not optimistic we will see an organic reduction of the digital carbon footprint any time soon.

In its sixth report,[8] the IPCC highlighted that, despite the measures taken by the industry, *"there is growing concern that remaining energy efficiency improvements might be outpaced by rising demand for digital services…"*

It is therefore essential that, as purchasers and users of digital technology, we are mindful of the environmental impact that our individual and collective use can cause, and measures we can take to mitigate it.

In the following section we outline some of the hidden and perhaps less obvious sources of digital carbon emissions.



0.7 billion tonnes

CO_2 emissions generated by the 2019–20 Australian wildfires.

1.7 billion tonnes

Estimate of the internet's aggregated carbon dioxide equivalent (CO_2e) emissions in 2020.

Exposing emissions in purchasing

The uncertainty surrounding the carbon emissions of the internet and our digital lifestyles is due, in part, to confusions in definitions as well as a lack of consistent, trustworthy data across the spectrum of digital ecosystems.

Many organisations are looking to help in this area.

In the education sector, the Higher Education Supply Chain Emissions (HESCET)[9] tool is helping procurement organisations develop ways to help their members better understand and act on supply chain sustainability.

Organisations such as Advanced Procurement for Universities and Colleges (APUC) are creating tighter correlations between Department for Environment Food and Rural Affairs (Defra) defined categories and those more commonly used across the education sector.

Together, these tools are helping education procurement leaders identify and work on carbon hotspots within their supply network.

In the private sector, many companies are partnering with academics to extend current capabilities and shine a light on areas of supply chain emissions that are currently unknown or uncertain.

One such company is German tech startup WorldWatchers.org,[10] which is building product-level carbon analysis to help designers make material choices based on carbon costs. Another is CO2Analysis,[11] and we'll hear more from them later in this document.

Carbon emissions start to accrue in the research and design phase of digital technologies, intensify through manufacture and distribution, multiply through operational use and continue after the primary use cases. This is known as e-waste.

We can have a positive impact at each stage of this lifecycle by asking questions of our suppliers, changing behaviours and considering end-of-life well in advance.

Procuring and sourcing climate consciously

Supply chains are often a significant contributor to an organisation's carbon footprint. Decisions made at the procurement stage influence the amount of greenhouse gases (GHG) emitted during the entire process of delivering the product or service. This influence goes beyond manufacture and distribution.

Climate change and sustainability goals are being implemented by the UK, EU and other governments using a trickle-down strategy. Larger organisations are mandated to declare, report on and adhere to specific sustainability and/or climate change standards and certifications, such as ISO 14001 or the Global Reporting Initiative (GRI).

Many of these standards require larger companies to put an emphasis on their suppliers for climate and sustainability reporting and, as such, smaller organisations through the supply chain end up needing to implement and report on their sustainability programmes and credentials.

In this way, setting clear organisational climate and sustainability guidelines that apply to procurement and purchasing ensures that suppliers understand the need to measure, implement and improve their impact, but also that more sustainable solutions are sourced in the first place.

With this trickle-down approach, suppliers will make more sustainable decisions during their research, design, manufacture and distribution processes.

Emission scopes

Building sustainability into the procurement activities of an organisation is critical for the long term.

An organisation's greenhouse gas emissions are classified in three scopes; Scope 1, Scope 2 and Scope 3.

Scope 1 and Scope 2 are currently mandatory for many companies to report on and are the easiest to determine, relatively speaking.

Scope 1 covers emissions generated directly by the organisation, such as those from vehicles, buildings, manufacturing processes or leaks from equipment.

Scope 2 is more broad and extends to cover the indirect emissions generated by purchased energies, such as electricity, steam, heat and cooling. This scope also includes the emissions generated by the electricity consumed by end users.

Scope 3 is where it gets tricky and where a great deal of investment is going today. Scope 3 covers all other emissions, including the energy used by the utilities in the transmission and delivery of the energy, transportation (suppliers and customers), employee commuting, waste, investments, capital goods, franchises and much more.

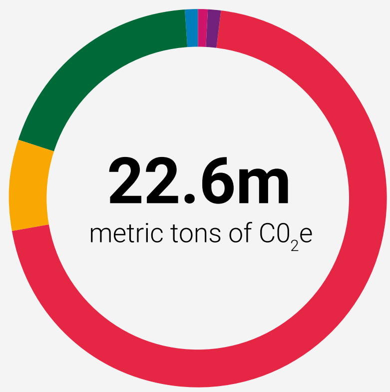
Scope 3 is generally the hardest to determine, but also the most impactful. Generally, as we will see throughout this report, **Scope 3 typically accounts for around 80% of an organisation's impact.**

A complete guide to Scope 3 can be found on the GHG Protocols website, https://ghgprotocol.org.

Example: Apple

Apple reported in its 2020 Environmental Progress Report a carbon footprint of 22.6 million metric tons of CO_2e for 2020.[12] Of this, less than 1% was Scope 1 and there was zero Scope 2, **leaving nearly all of it attributable to Scope 3**, with 71% coming from manufacturing.

Apple's 2020 carbon footprint



Scope 1
- Direct emissions, <1%

Scope 2
- Emissions from electricity, 0%

Scope 3
- Business travel / employee commute, 1%
- Product manufacturing, 71%
- Product transport, 8%
- Product use, 19%
- Material recovery, <1%

Source: Apple's 2020 Environmental Progress Report

Importantly, Scope 3 incorporates emissions related to purchased goods and services. As such, helping suppliers become greener and cleaner will help influence reductions in an organisation's own emissions targets.

Through an understanding of the supply chain's carbon impact, and encouraging improvements, it is possible to influence reduction in carbon emissions from the manufacturing and distribution processes, but also to source products and services that themselves generate fewer emissions during their operation.

Therefore, from a digital point of view, Scope 3 offers a tremendous scope for impact. But, first, we must find a way to engage with suppliers.

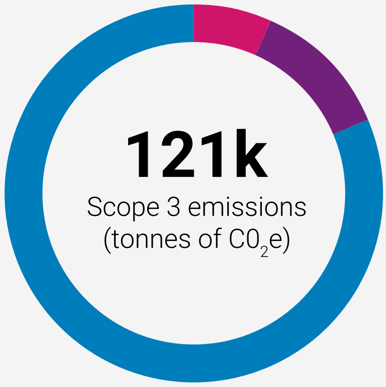
Delving into Scope 3 with technology

Understanding and mitigating Scope 3 emissions is critical, yet highly complex. It involves developing a detailed understanding about not only your impact but those who you serve, on whom you depend, the things you buy and dispose of, and how you move people and things around. On top of this, Scope 3 also includes how your investments are allocated and the impact they have.

Apple's chart above indicates that Scope 3 is the scope that accounts for nearly all its environmental impact.

Newcastle University echoes this finding in its 2020 sustainability report.[13]

Newcastle University
Emissions by scope 1, 2 and 3

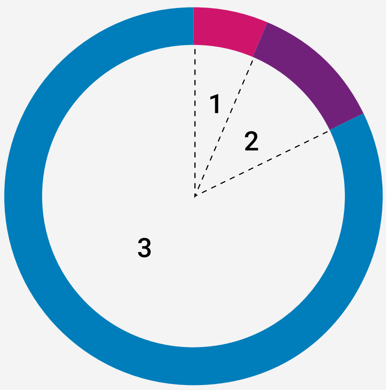


- Scope 1 emissions
- Scope 2 emissions
- Scope 3 emissions

Source: Newcastle University Scope: Screening report. 31 March 2020

The University of Salford follows a similar pattern in its 2021 report.[14]

University of Salford
Carbon emissions scope 1, 2 and 3 (tCO_2e)



Scope 1
- Gas, 2988

Scope 2
- Electricity, 5496

Scope 3
- Procurement, student commuting, Staff commuting, Electricity and Gas Scope 3, Business travel, Student accommodation, other Scope 3: 39,857

Source: Univeristy of Salford Scope 3 Emissions Report: Baseline Scope 1, 2 and 3 emissions totals. June 2021

How technology can help
There are many ways technology can help, from simple things such as online questionnaires and polls, through to the use of artificial intelligence (AI) to uncover hard-to-find insights.

Engage collaboratively with suppliers
The United States Environmental Protection Agency offers four high-level tips for developing conversations with suppliers in a way that fosters engagement rather than circumvention or pushback: keep the questions simple, build trust, provide training and embark on pilot initiatives with key suppliers.

Echoing the advice for simple questions, the World Wildlife Fund provides guidance through a simple supplier questionnaire.[15] Its questionnaire tries to increase engagement with suppliers through the use of non-confrontational wording and a relaxed style, informing the supplier that it's ok to not know, or not have all the answers.

This is a point we will come on to again later in this document – we must all act swiftly to quash and repair damaging behaviours, even in absence of complete information. It is too easy to get stuck in analysis paralysis, fearful of making decisions that in the long run turn out to be more damaging than good.

The simple, approachable questionnaire approach helps create an understanding of the status quo, and a baseline against which improvement can be measured – even if the improvements are better understandings of the status quo.

SupplyShift[16] is a cloud technology company specialising in questionnaire-based supplier assessments that can cascade through the supply chain.

Its technology enables organisations to assess their supplier network across multiple assessment standards and frameworks, including Scope 3 greenhouse gas (GHG) emissions, human rights and environmental, social and governance reporting (ESG).

Analyse supply chain
One of the biggest hurdles for understanding Scope 3 is that much of the data required to complete the calculations doesn't exist.

As the market matures with both academic research and venture-led startups investing heavily into the area, these data sources will emerge.

In the meantime, organisations must leverage the tools, techniques and data available to make best-effort estimates, and create a baseline for ongoing, continuous improvement.

CO2Analysis[17] is a tech company helping organisations do this and it was selected by Microsoft for inclusion in its 2022 ClimateTech cohort of artificial intelligence (AI) startups.

CO2Analysis has been working with NHS Trusts and local government to help create a more detailed understanding of where their Scope 3 emissions are coming from, and therefore which areas to focus on with the most priority.

The AI technology behind the solution came about through a knowledge transfer partnership with the University of Reading and Goldsmiths, University of London.

In an interview with Lyn Duncan[18], the company's CEO, she concurred with the information above, and shared that Scope 3 typically accounted for more than 90% of all emissions across her company's clients, and more than 98% of those organisations' budgets.

This means that, typically, 98% of an organisation's budget was funding carbon emissions.

Scope 3 emissions are so big, they present a perfect opportunity for reduction. The biggest challenge is where to start.

In today's environments, people are more likely to adjust their behaviour if they know it has a positive impact on sustainability, rather than simply saving the company money.

Many supply chain Scope 3 analyses that focus on the money flow (also known as economic studies) are approximate calculations that factor in the supplying company type (using its standard industrial classification (SIC) code), company location and pre-defined carbon intensity values, as found on the UK's Office of National Statistics.[19]

While this is useful as a starting point, it leaves room for inaccuracy. Networking equipment that was manufactured in Germany and laptop computers manufactured in China from the same supplier, would each have the same carbon intensity.

As such, technologies such as those from CO2Analysis that breakdown Scope 3 into product level analysis should be preferred.

Other supply chain analysis technologies to consider:

- **SINAI**
- **Watershed**
- **Emitwize**

Sustainability can be a powerful motivator

The procurement processes and systems of many organisations have evolved over many years, and as such can sometimes be convoluted, cumbersome and frustrating to use.

When conflated with workplace habits, pressures on time and *"we've always done it that way"* attitudes, corners are sometimes cut in the processes allowing inefficiencies to creep in.

One such example is of a local government where an office manager simply hit the 'reorder' at the end of the month to top up the office supplies. Sitting in the corner of the office was a filling cabinet full of unused Tipp-ex.

Having product-level awareness of Scope 3 enables individuals to have an understanding not just of the financial reasons why they should use, consume or dispose of the specific product with care, but also the environmental and sustainable impact.

E-waste emissions

A report from EcoWatch and the World Economic Forum highlighted that 57.4 million tonnes of electronic waste was expected to be generated in 2021 – heavier than the Great Wall of China.[20]

By 2030, that number is expected to reach 74 million tonnes, an annual growth rate of 3-4%.

From an IT point of view, these e-waste mountains consist of everything from SIM cards to hard disks, cables, laptops, monitors, server racks and other technologies required to operate them, including air conditioning and cooling systems, lighting and Internet of Things (IoT) sensors.

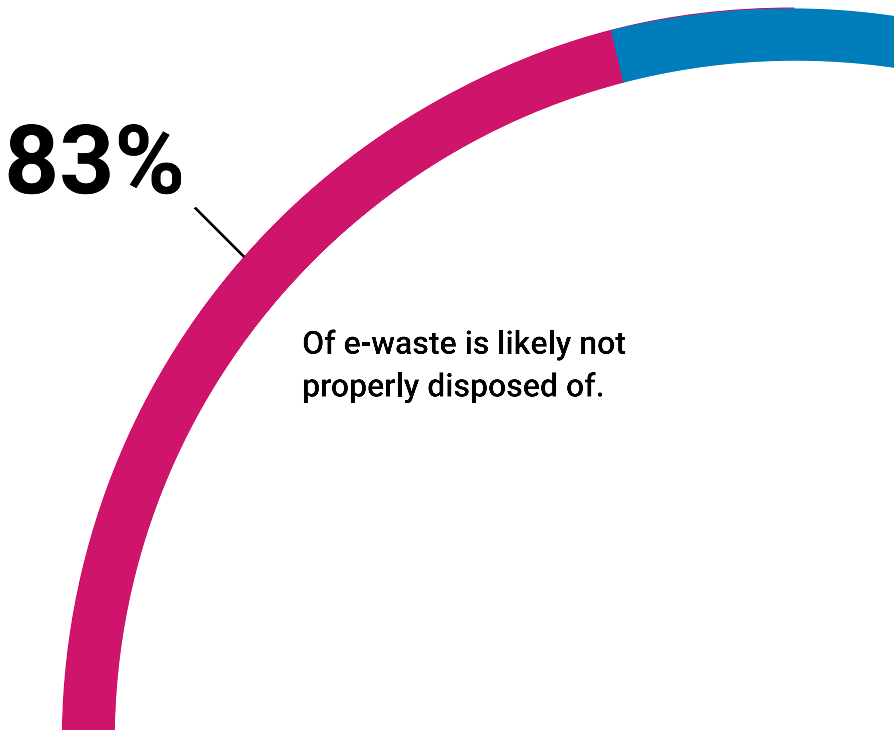
The Greenhouse Gas Protocol[21] points to three important greenhouse gases generated from e-waste. These come about from the decomposition and degradation of fossil fuel-based and biogenic carbon and are principally CO_2, CH4 and hydrofluorocarbons (HFCs) – some of the more powerful greenhouse gases.

In its 2020 report[22] on e-waste, the International Telecommunication Union (ITU) estimates that, in 2019, 98 million tonnes of CO_2e were emitted due to refrigerants contained in some e-waste, and that, conversely, 15 million tonnes of CO_2e was averted by the recovery of iron, aluminium and copper from processed e-waste.

The ITU report also disclosed that less than 18% of all e-waste can be accounted for, meaning that almost 83% of e-waste is likely not properly disposed of and, according to two years' study by the Basel Action Network,[23] much of this ends up being shipped to villages across Africa and China, which lack facilities to safely manage the waste.

Beyond climate-impacting emissions, e-waste contains materials that can, when disposed of without proper care, cause significant harm to humans, the environment and biodiversity.

From a human health point of view, noxious emissions can cause birth and growth impacts including lung, cardiovascular, DNA and gene expression damage.



> The best way to cut emissions due to digital activities is to keep devices much longer and buy less.

Benoit Petit, founder of ***hubblo.org****, an open-source software company helping discover the digital carbon footprint of software.*[24]

Use IT longer

About 80% of IT's carbon footprint comes not from operational use, but from the manufacture and supply of equipment.[25] Therefore, our biggest impact can be to stop buying new equipment, and use already manufactured equipment longer.

Many universities and colleges have already extended IT lifetimes from the typical three years to five, or even seven. But could more be done?

Traditionally, hardware needed to be updated at regular intervals in order to keep up with the demands of new software. However, around 2015-2016, the confluence of cloud and connectivity started a shift of processing power from laptops and desktops to the network.

Today, the primary function of end-user devices is to capture, communicate and display data.

This has given rise to the increase in use of "thin" computing such as Chromebooks. Since the computing power and storage is in the cloud, which can scale at its own pace, thin computing has amplified the opportunity to use technology for longer.

However, end-user devices, network and networking equipment all suffer from wear and tear, and are prone to damage, so this is where refurbishing and remanufacturing come into play.

Refurbished and remanufactured technologies

Refurbishing and remanufacturing gives equipment a new lease of life without the cost and environmental overhead of building something new from scratch.

As such, refurbished and remanufactured technology can provide educational institutions with a way to reduce carbon footprint and costs, without compromising quality, performance or support.

The two approaches are often confused but can be quite different. The biggest difference between remanufactured and refurbished comes down to trust and confidence.

Remanufacturing of network, computing and display technology is most often completed by the original manufacturer. The process results in equipment that is as good as, and sometimes better, than the original, including manufacturer-backed warranties.

However, refurbishing may or may not be completed by the manufacturer. It could be completed by a recommended partner but could also be done by less-qualified outfits. This leads to generally higher rates of returns for refurbished compared to remanufactured equipment.

According to Steve Haskew, who heads sustainability at Circular Computing, return rates for remanufactured devices should be at least equal to that of the original equipment manufacturer (OEM). In its case it is 2.79%, whereas an industry average for refurbished products can be ten times higher.

The potential for increased uncertainty with refurbished means that organisations should be wary where they rely on this technology – it might be acceptable for end-user smartphones, but should not be relied on for mission critical equipment.

Compared to buying new equipment, both approaches will save up to 80% of the attributed carbon footprint, and will save purchase costs. Beyond the carbon savings, financially, remanufactured equipment could be 30-40% cheaper than a new product with a similar specification and guarantee.

The recommendation is to look for original equipment manufacturer-backed warranties and for industry certifications such as the BSI 'kitemark' or Carbon Footprint Standard certifications.[26]

Operating at scale

Circular IT companies often get asked about whether they can provide equipment at scale. Speaking with both Circular Computing[27] and Circularity First,[28] scale doesn't seem to be a problem. One company recently provided millions of devices to help a couple of large global consulting companies migrate to a more sustainable IT purchasing model, and the other recently refitted an entire aircraft carrier with remanufactured devices, saving the UK's Ministry of Defence more than £50 million in the process.

Cyber Essentials Plus, the issue of security and support

You can't talk about remanufactured or refurbished equipment without addressing the Cyber Essentials challenge.

Extending the life of IT assets has numerous benefits, from reducing costs, significantly mitigating carbon emissions to making IT more accessible for all.

However, there are a few 'gotchas' to watch for, and one of those relates to the requirements stipulated by Cyber Essentials Plus.

The requirements set out by Cyber Essentials and Cyber Essentials Plus, are there for good reason – cyber crime, like digital, is growing rapidly. Regrettably, many education facilities have already felt the pain and cost of a cyber incident.[29]

One of the challenges comes down to warranties and support.

While there might be risks perceived with "out of support" elements of IT products, such as firmware on laptops, there are often alternative solutions or approaches that could help maintain the usable lifetime of the asset.

These could include negotiation of longer support periods or moving at-risk items out of scope in the Cyber Essentials appraisal.

Anthony Levy from Circularity First suggests that older equipment tends to be more trusted and secure since it has had longer to be updated and patched. Further, in 15 years of operation they have had no security related incidents. In fact, military and space programmes often prefer to keep old IT longer in part for these very reasons.

Steve Haskew from Circular Computing commented that support and product life times are not equal among vendors and their products. While some vendors might warn of cyber risk associated with extending product use beyond their typical three or five year support periods, in practice many are supported beyond these timeframes. In particular, one machine the Circular Computing team still see a lot of is the HP EliteBook 840-G3, which is a 2013 machine that is still under support.

Remanufactured and refurbished equipment has so much to offer in terms of cost and carbon savings that it simply should not be ignored. While there might be challenges that need careful consideration, these conversations and requirements must be presented firmly to suppliers, with their importance clearly emphasised through scoring and weighting factors in the procurement process.

Planning environmental consequences of IT end of life

What happens to our technology at the end of its life is a question that needs to be carefully planned and budgeted for even before the items have been acquired.

Far from being just an overhead or cost, much IT can generate ancillary revenues after its end of life.

IT products such as mobile phones, tablets, desktops, laptops, TV screens and monitors are often written off over a period of years, yet many will still be functioning long after that.

Refurbishing and remanufacturing will get even more life from these devices, but at some point there will be a need to "dispose" of the equipment.

Many IT companies now offer "circular" sustainability solutions to help manage and monetise IT assets once they have been written off.

According to Anthony Levy of Circular First, if they get to the point of needing to dispose of equipment through recycling, they've failed.

They focus on extending the workable life of products through remanufacturing and refurbishing, and when that path comes to an end in the organisation, they look to re-home.

Re-homing can take many forms; from reselling the devices to staff and students, to donating to those in need and charities.

Richard Ellis, founder of RellTek, told me that his approach when finding new homes for working devices is to focus on minimising the "asset journey".

The asset journey is how far the devices have to travel before they are re-homed, repaired or recycled. The journey typically involves ground transport at the least, with some embarking on international sea journeys.

Relltek minimises this by setting up pop-up shops using an ecommerce platform and a local pick-up centre on the campus of the organisation to facilitate employees, or other stakeholders, to buy used and securely cleaned equipment at significant discounts.

This approach not only extends the usable life of the equipment, but also generates additional revenue back to the organisation. It makes it easier to buy used items rather than new – which is good for users, organisations and the planet.

Relltek is among a number of companies that help organisations plan for and monetise IT end of life. Others include WiseTek, Klyk, Circularity First and Circular Computing.

Consumer trends will drive awareness and capacity

The marketplace for refurbished and remanufactured IT is growing rapidly.

Many of the circular IT companies mentioned above have been operating for many years but are now experiencing significant growth. The limit on how much can be remanufactured apparently lies with how much capacity the original equipment manufacturer allocates to the activity.

One of the leaders interviewed above shared, *"Cisco allocates up to 10% of their production facilities to support remanufacturing. I asked them why not more, and was told that it's possible but customers are not asking for more"*. Therefore, the more we ask our suppliers to provide remanufactured equipment, the more capacity they will provide.

As more consumers find it easier to adopt refurbished technology, awareness will grow and changing attitudes will find their way into the workplace.

57.4 million tonnes

Electronic waste expected to be generated in 2021

Anthony Levy, CEO of Circularity First, leads his company by example, and was talking to me on his pre-2016 iPhone 6. It has had three new batteries, but the rest of the phone works just as well as it did in 2015.

Historically, the consumer market for refurbished IT has grown slowly on platforms such as eBay and Facebook. This slow growth can be attributed to lack of confidence and transparency, dubious quality and minimal or no guarantees.

However, acceptance and adoption of refurbished IT by consumers, particularly mobile phones, is on a growth curve. Leading this trend are companies such as Back Market, which is just one of a number specialising in reselling refurbished IT with warranties and support.

Back Market is a French startup founded in 2014, which raised $845 million between 2021 and 2022, and is now valued at more than $5.7bn.

Why is this important?
When Apple entered the smartphone market, RIM's Blackberry was king and telecom executives mocked the new kid on the block, with many doubting the longevity of the keyboardless, less secure 'iPhone'.

IT departments refused to allow or support iPhones as company phones, citing security issues. After a while executives started demanding iPhones as the cool-factor crept in, and the rest is history.

Consumer behaviour shaped executive needs, killing the telecom industry's most trusted provider.

But Apple's toppling of RIM wasn't just about mobile phones. It ushered in data plans, opened up the mobile internet from the mobile operator-controlled "walled garden" internet experience to full internet and app stores. These evolutions, among others, were rapid and defined our modern connected world.

All of it started with consumer demands.

Carbon footprints on the ground, emissions and on-premises IT

While cloud is all the rage and does have huge benefits, there are still valid reasons why some IT remains securely on the ground.

These reasons include the fact that some equipment simply has to be local, such as computers, monitors, networking, phones (mobile and fixed), printers, building control systems and much more.

In addition to these physical IT assets that simply can't exist in the cloud, colleges and universities often have servers running bespoke applications or containing highly sensitive information that must stay within the bounds of campus control.

As mentioned in the previous section, each one of these items will have its own carbon footprint that is associated with its manufacture and distribution.

Beyond this, day to day usage has its own significant impact on carbon emissions.

Let's look at some of the IT factors that influence carbon footprints during everyday use across colleges and universities, from mobile phones and small energy appliances to computers, racks and on-premises data centres.

Carbon emissions for mobile phone usage

The calculation of how much CO_2e is generated using a mobile phone is complex and outside the scope of this paper.

Beyond the manufacture and supply impact of a mobile phone, which is included in the Scope 3 discussion above, the operational impact is a confluence of the phone charger's power rating, its charging efficiency, the age and performance of the battery, the efficiency of the smartphone's hardware and software, the specific chipsets and communication protocols used (Wi-Fi, 2G, 3G, 4G, 5G), the efficiency of the Wi-Fi or mobile infrastructure from access point, through core networks and out to the backhaul, interconnect and data centres.

Then add location, weather and time of day, because all of these can impact the efficiency of everything in that complex chain.

However, to gain a sense of the impact and give us some indication of best practice, we can look towards manufacturers' climate declarations and smartphone usage studies.

App usage and CO_2e

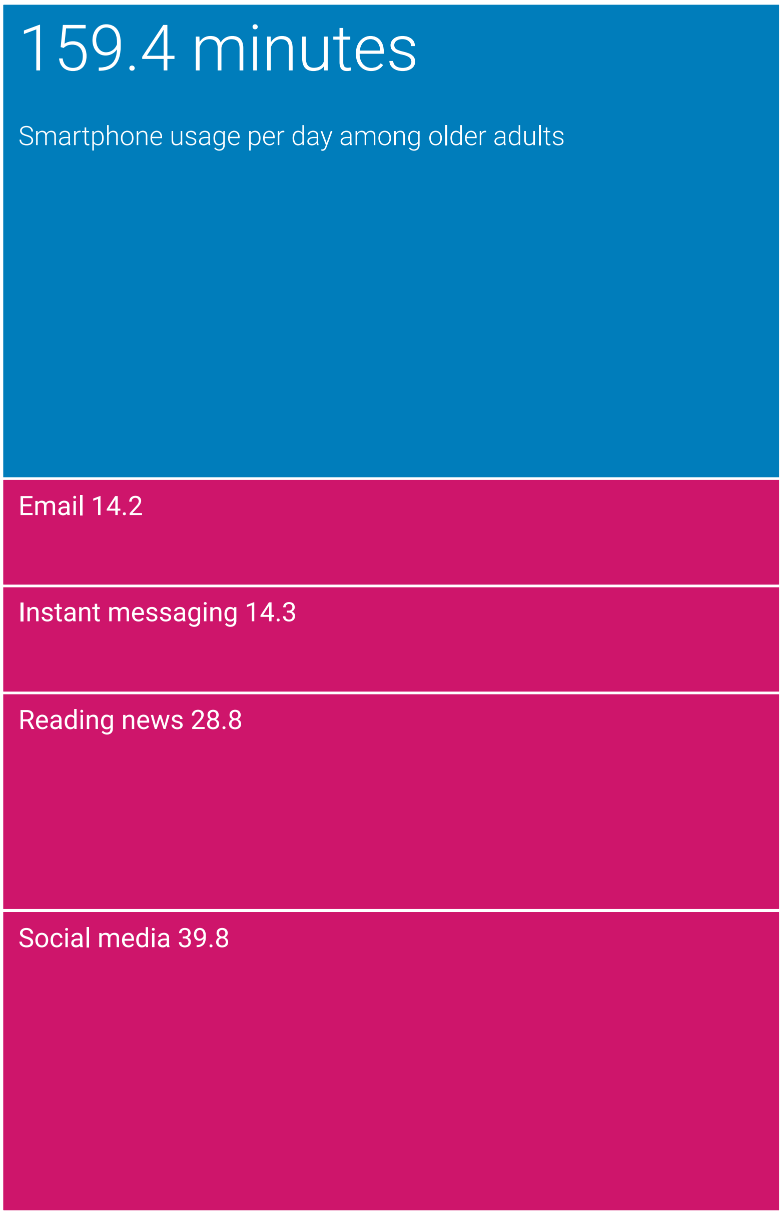
A study by reviews.org[30] concluded that, on average, people pick up their mobile phones 344 times a day, using their devices for an average of 174 minutes every day.

In a separate study[31] with a specific focus on smartphone use among older adults (because most studies tend to focus on younger generations), a similar number emerged: 159.4 minutes of smartphone use per day.

This study showed that social media topped usage trends, followed by reading the news, and communication via instant messaging tools (such as iMessage, Skype, Whatsapp) and email.

Greenspector's 2021 report[32] studied the carbon impact of the world's leading social media platforms and ranked them on CO_2e emissions per minute of use.

Topping the list of most environmentally harmful apps was the world's fastest growing social media platform, TikTok. This was closely, and surprisingly, followed by Reddit, generating 2.63g and 2.48g of CO_2e per minute of use.



LinkedIn, which claims almost half of the UK's population (33 million[33]) as users, comes in as the fourth best, generating 0.71g of CO_2e per minute of use.

A LinkedIn search shows more than 950,000 profiles of people currently working in educational institutions in the UK. If each of these were to use LinkedIn for 39.8 minutes a day, twice a week, that could potentially generate 2,792 metric tonnes of CO_2e per year. This is equivalent to more than 6.9 million miles driven by an average petrol-powered car.[34]

During an interview, Jon Lindén, CEO Ekkono.ai, said:

> *The transmission, or communication, of data is the single biggest energy consuming function of most connected devices.*[35]

A report by the GSMA quantifies this, stating that the radio access network (RAN) accounts for 73% of the energy consumption of mobile data traffic, with mobile operator data centres contributing just 9%.[36]

Compared to 4G/LTE cellular technologies, Wi-Fi can be at least 50% more energy efficient than cellular communications.[37]

If only a quarter of mobile phone use switched to Wi-Fi, the impact of using LinkedIn by educational staff could drop by almost 350 Mt CO_2e per year.

What about 5G?

5G incorporates many energy saving features, but most are yet to be realised as full 5G rollout continues.

Currently, the IEA reports[38] that while 4G is five times more energy efficient than 3G, and 50 times better than 2G, 5G antennas (the mobile network side of the connectivity, not the mobile phone) consume three times more energy than a 4G antenna.

As the 5G rollout gathers pace and more of the features are deployed by mobile networks, it is expected that 5G could actually be 10 to 20 times more efficient that 4G by 2030.

So in summary, 5G will help, but not just yet.

Small energy consumption

"Small energy" is defined as the energy required to power smaller electrical equipment such as computers, monitors, smart phone chargers, printers, vending machines and other office equipment.

A Loughborough University study[39] asserts that more than 20% of an office building's energy consumption can be attributed to these devices.

The report provides information on power consumption for some of the devices when in active use and when idle, as well as the typical number of hours of use per day.

Using this information we can construct a picture of where energy is potentially being consumed while doing nothing.

Personal computers (laptop and desktop) are typically used for around four hours of the day. Considering only desktop computers, which are unlikely to be removed from the office, we can assume that they are not used at weekends and therefore spend 148 hours a week idle.

The report measured the idle power consumption of desktop computers as between 1.9 to 2.0 watts, which over a week would be 281.2 to 296 watt-hours of energy per desktop computer.

In an office with just 10 desktop computers this would be approximately 145 kWhs of electricity used to do nothing.

The UK average[40] CO_2e emission per kWh is 0.23kg, meaning just 10 desktops generate 33kg of carbon a year to sit idle.

The numbers are somewhat better for laptops and monitors, but much worse for printers (which spend more time idle, with higher power consumption during idle) and vending machines.

How technology can help
While technology is indeed the source of the problem in this scenario, technology can also play a significant role in the solution.

Awareness: inter-department gamification
As part of a multi-faceted sustainability programme, in 2018 Harvard University became one of the first organisations to set science-based climate goals. In 2016 it had already achieved a 30% reduction in fossil fuels, and plans to be neutral by 2026 and entirely free of fossil energy by 2050.

A powerful enabler of its progress has been through student and staff behavioural change driven by awareness and action campaigns.

Harvard's portfolio of climate-focused actions is extensive, spanning from posters that encourage greener behaviour, such as composting and double-sided printing, to smarter building management systems and on-premises renewable energies.

In Harvard's "Reducing laboratory energy use through data-driven behaviour change campaigns" whitepaper[41] it explores the importance of awareness, measurement, communication and gamification as steps towards driving positive behavioural change.

In one such campaign, the implementation of real-time consumption displays, along with digital dashboards, and an inter-departmental competition saw energy consumption drop by 76%, which resulted in a longer-term reduction of 30-40%.

Measure and communicate
In order to drive change, a starting point needs to be established against which progress can be measured. In Harvard's campaigns it established annual baselines, against which its competitions were scored, and long-term progress monitored.

Harvard installed submetering, enabling it to capture and display real-time data. However, submetering might not be applicable for all institutions.

In the absence of this, other technologies could prove useful.

Measure and track small energy
As mentioned above, 'small energy' is responsible for potentially 20% of an office building's consumption.

Measurable.energy has pioneered a hardware plus software solution that enables automated data capture and reporting, along with AI powered optimisation.

Its hardware solution consists of replacement electrical outlet sockets compatible with UK standard 13 amp wall sockets. Unlike traditional sockets, these contain IoT technologies enabling remote monitoring, centralised control and user feedback using on-socket indicators.

The on-socket indicators inform users when the power they are consuming is coming from green or brown energy supplies, thereby helping influence behavioural change on top of automated savings.

Its studies have shown that deployment across 5,000 sockets can deliver financial savings of £127,000 as well as a reduction in greenhouse gas emissions of up to 159 Mt CO_2e.[42]

A key differentiator of the measurable.energy sockets is their low power consumption when idle of just 0.1 watt, on average, and, as we'll see below, this is an important metric for smart socket solutions.

Off-campus smart sockets
Where it is not possible to replace wall sockets, other smart socket solutions can also provide educational value as well as reductions on consumption, but these need to be chosen with care.

I use off-the-shelf smart sockets that I purchased from an online retailer. I use these to provide insights into my household and office energy consumption and time-based control to prevent accidental wasted usage.

However, I have measured these sockets as consuming between two and three watts when idle. Since, in order to function, these sockets are plugged in and powered continuously, they are consuming a minimum of 48 watt-hours a day when doing nothing, resulting in a potential of 17kWh over a period of year – the equivalent of 7.6 Mt CO_2e.

It is therefore essential that the idle power consumption of smart sockets is understood and carefully balanced with the potential savings. In my instance, the data captured helps drive my own accountability through transparent, public dashboards,[43] as well as influencing my offsetting and removal programmes.

Moreover, the appliances I have chosen to connect to these sockets would have a significantly greater consumption if accidentally left on – the equivalent of 20 watts per hour at the best case, or 109 watts per hour worst case.

Awareness: collective carbon footprints
Tools that help individuals understand their own carbon footprint have grown in popularity recently.

Organisations such as NatWest and Experian are partnering with carbon footprint calculator companies such as Cogo,[44] using application programming interfaces (APIs) to create integrations with their business applications that help consumers understand their carbon footprint based on their spending patterns.

Other organisations work with technology providers such as Giki[45] to provide tools for employees to understand their footprint, then track and compete with others on their progress towards reduction.

In its 2022 impact report,[46] B Corp certified development agency Kyan said,

> *We understand that in the modern work environment, company carbon is often emitted outside of the workplace. We are committed to helping our team understand their impact on the planet, and that is why we use Giki Zero, which helps our team to incrementally change their behaviour and live more sustainably.*

Carbon footprint apps could help colleges and universities develop a better understanding of their Scope 3 emissions by collecting insights from employees, colleagues and students. Additionally, these tools encourage positive behavioural change through peer-to-peer competition and sector benchmarking.

On-premises IT equipment

Beyond automating outlets and gamifying reduced usage, IT departments can help reduce digital emissions in a variety of ways – some small, some larger.

Guest Wi-Fi

As mentioned above, newer cellular technologies such as 5G and 6G will reduce the carbon footprint of the mobile ecosystem. However, right now Wi-Fi can lead to significant reduction in energy consumption of mobile devices at a campus-wide level.

IT departments should encourage Wi-Fi use by providing frictionless (simple, or no registration), secure and energy efficient Wi-Fi access, such as Jisc's eduroam.[47]

Policies and defaults

Centralised IT control can provide numerous possibilities for helping reduce the collective carbon emissions of IT estates.

As the CEO of Perform Green, Barney Smith, told me in an interview:

> *One of the most impactful things you can do with IT is allow things to turn off.* [48]

Before establishing Perform Green, Barney spent time as the CIO of Natural England. During this time, he implemented several waste reduction initiatives including reducing paper use by decreasing default margins across all printers and Microsoft Office applications.

Beyond paper waste, Barney set account defaults to disable screensavers in favour of blank screens, allowing screens and computers to enter sleep states sooner.

Additional impactful policy changes include:

- **Screen brightness:** reduce default monitor and screen brightness. 25-45% brightness is suitable for most indoor use, and significantly reduces energy consumption. As an example, reducing the brightness of an HD display from 95% to 40% is still perfectly usable in an office and can reduce consumption by 10W per screen
- **Dark themes:** on a similar thread to screen brightness, studies[49] have shown that "dark mode" themes on mobile phones can reduce power drain, and therefore reduce the amount of energy required to operate. Encourage the use of dark themes on mobiles and computers where possible
- **Intelligent power off:** implement more intelligent sleep, hibernate and power-off schedules across IT equipment. Schedule software updates to occur on specific days and allow user machines to power off

Sending or receiving just 70 emails a day can contribute up to 84kg CO_2e per year.

during others. Enforcing weekend power-off schedules for staff devices could also help address work-life-balance issues within the workplace

Don't stand by, turn off

Many of us have become accustomed to letting our devices go into standby or sleep mode automatically, and believe this to be a good enough approach to cutting energy consumption.

However, devices still consume power when in standby mode. For example, Apple's Mac Mini has long been seen as a powerful, compact and energy efficient computing platform. Its latest M1 powered Mac Mini provides even more efficiency, consuming less power when active than previous non-M1 models did in standby.

Nonetheless, a M1 Mac Mini consumes 6.8W when idle.[50] For one computer left idle, that would be almost 60kW per year, and 7.39 kg CO_2e/year – the equivalent charging a smartphone almost 900 times or driving 18 miles in a car.[51]

Where possible, automation should be used to manage the power state of devices, shutting things down when not needed and, restarting them on, or slightly ahead of, demand.

Yet automation isn't possible in every case, so users need to be made aware of the energy and carbon reduction opportunity from turning things off instead of just letting them slip into stand-by - *"Don't standby, turn off!"*

Reducing email

In the previous section, we looked at the carbon impact of LinkedIn. While LinkedIn is used on average 39.8 minutes a day, I assumed that not all educational staff were daily users.

The same is unlikely to be true for email, and email is used on average for more than 14 minutes per day.

CWJobs.co.uk's[52] handy email carbon calculator provides a high-level indication of the impact of our email behaviour. The calculator uses data from acclaimed carbon counting book How Bad are Bananas? (2010) by Lancaster University's Mike Berners-Lees.[53]

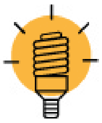
The calculator shows that sending/receiving just 70 emails a day can contribute up to 84kg CO_2e per year.

The impact of an individual email can vary considerably. The biggest impact comes from emails with large attachments – either documents, graphics or unoptimised email signatures.

Email signatures

One of the quickest, possibly easiest areas for improvement is with email signatures.

- Educate staff and students on the need to minimise emails and unnecessary attachments, including images in signatures
- Remove unnecessary images
- Any remaining images should be highly optimised and compressed. This is often best achieved by providing a library of approved email signatures that have already been processed by the IT team
- Where possible, use a more lightweight, text only signature for replies within an email thread and for internal emails.



How technology can help
IT departments can help reduce the carbon impact of email through a variety of approaches.

Reduce email payload sizes
Many email servers and desktop applications now support sending attachments as links to files, instead of the actual file. Making sure these options are enabled on the servers and clients by default can save significant email traffic.

Reduce unnecessary emails: reply-all
Microsoft's Reply-All Storm Protection is aimed at reducing hits in productivity through the prevention of massive amounts of network traffic created by users replying to all. This feature can not only prevent email overload, but also prevent excessive email generated carbon emissions.

Reduce unnecessary emails: newsletters
Gmail automatically identifies newsletters and users should be encouraged to unsubscribe from newsletters they haven't read in a while.

On-premises IT racks and servers

Power utilisation efficiency (PUE) is one of the industry's benchmarks for optimising energy consumption in data centres.

PUE represents the amount of power used to run IT equipment, compared with the total power used to run the facility.

$$\text{PUE} = \frac{\text{Total facility power}}{\text{IT equipment energy usage}}$$

The closer to 1.0 the result, the more energy efficient the set-up.

Data from Statista[54] shows that data centre PUEs plummeted between 2007 and 2013 but have since remained relatively constant at a ratio of approximately 1.6.

IT managers can learn from the best practices of these hyperscalers.

Informa recently launched its sustainability certification programme for data centres, called DEEP.

This programme looks to assess data centres across 70 best practices, in four categories, to understand their emissions, water use and e-waste. These categories can provide useful insights and ideas for IT managers.

The four categories, are: airflow management, electrical systems, mechanical systems and processes (shown below).

Like DEEP, CEEDA[55] (Certified Energy Efficient Datacenter Award) is an independent evaluation and global certification programme that recognises energy efficiency best practices in data centres.

The University of St Andrews followed some of the CEEDA recommendations to implement energy savings that helped it scale for increased demand without increasing energy consumption and emissions.

> *Through following some of the CEEDA elements, the reduction of energy usage has been a measurable factor, at the same time as computing load has been increasing, we've managed to deliver more for less.*
> Steve Watt, CIO, University of St. Andrews

Processes

Improving electrical and mechanical systems in data centres can be costly. For those on restricted budgets, the biggest gains can be found through a review of processes and airflow.

On the basis of "what is measured can be managed", it is important to set a baseline for operational and equipment efficiency, against which future decisions can be made.

Best practice examples

Airflow management	Electrical systems	Mechanical systems	Processes
• Containment	• Smart rPDU	• Free air cooling	• DCIM/BMS
• Rack inlet Temperatures	• High efficiency UPS	• Variable speed fans	• Zero waste recycling program
• Perforated tiles	• Energy Star rated IT	• AI/ML software	• PUE monitoring
• IT device temperature monitoring	• Automated electrical reporting	• Teamed CRAHs	• Environmental training for staff
• Seal open spaces in rows	• Virtualisation of power	• Waterside economisers	• Purchase of refurbished equipment
• Dropped ceiling	• Energy management system	• Chiller optimisation/set points	

Processes and audits should allow identification of under-used equipment and resource, operating temperature profiles and tolerances, ageing equipment, equipment that is not "green labelled" by recognised standards, plus opportunities for virtualisation of servers on existing hardware.

Recognised green labelling standards include EPEAT, Energy Star, Blue Angel and TCO Certified.

A focus of this work should be to better understand:

- Where existing hardware can be consolidated using virtualisation – thereby either freeing up hardware for other use and lower requirements for new hardware
- How much energy is being consumed by the compute power – helping to determine the PUE
- Whether hardware will tolerate warmer operating conditions – influencing decisions around reductions in cooling
- Server use profiles – to help understand which servers can be shut down for what periods, eg servers used only during working hours or term time can be scheduled to shut down/wake up at appropriate times
- A full inventory of network, hardware, compute, storage, backup and power equipment to better inform end-of-life decisions and prioritise replacement of less carbon/energy-efficient equipment

Following the findings in the previous sections, as mentioned in a report by Green IT,[56] and echoed by the French institution Ademe in 2019,[57] up to 80% of our digital carbon footprint comes during manufacture and distribution of hardware. It is therefore essential we maximise use and life span, and put in place responsible, sustainable plans for managing equipment at the end of its serviceable life. See the E-waste emissions section for more.

Dropped ceilings

IBM recommend that the minimum ceiling height[58] in data centres be between eight and nine feet. Ceilings higher than this result in additional demands on cooling.

Lowering ceilings in data centres not only helps reduce the volume of air that needs to be cooled, but can also help reduce lighting demands. The higher the lighting fixtures, the more powerful they need to be in order to provide adequate lighting for the operators and staff.

AI and free air cooling

Free air cooling uses external air (typically when lower than 21°C) to cool IT systems, instead of more energy hungry air conditioning units. There are two approaches to this, indirect and direct air, the difference being how much processing takes place before the air reaches the servers.

Indirect air provides additional filtration and humidity controls compared to direct air, and is a marginally more popular choice for data centre managers (84% vs 74%).[59]

The biggest gains are to be had when artificial intelligence (AI) is used to manage the data centre temperatures in real time. Instead of setting the air conditioning to run all the time, AI can take into consideration external weather conditions, current IT equipment loads and temperatures and historical performance data to finely manage cooling parameters in real time.

Turn things off

In a similar vein to Barney Smith's advice above, IT managers should look to allow systems to sleep and explicitly turn things off when not needed.

The first step of this process is to run energy and utilisation audits. Non-critical, non-production servers and systems that are not used out of hours should, like lights, be turned off when not in use.

Optimising on-premises low-hanging fruit
Improvements in airflow are some of the lower-hanging fruits that can be achieved with little or no investment.

Best practice tips include:

- Inspect underfloor spaces and remove obstructions such as cables, trays and ducting
- Keep track of the static pressure under the floor, investigate variations
- Make sure cool air is not escaping through seams between walls/servers and the raised floor or cable trunkings. Use horsehair brushes to prevent leaks
- Measure air temperature and humidity in as many places as you can throughout the facility
- Match the floor tile flow rates with the demands of the cabinets they serve
- Match the ceiling tile flow rates with the demands of the cabinets they serve
- Install variable speed air handling units in racks and use the manufacture's information to choose a fan speed that optimises power consumption vs throughput. For example, a fan might deliver 90% of throughput at just 60% of the power

How technology can help

User level VM resource usage, tracking and dashboards
The BBC R&D team implemented a project to monitor the carbon emissions of its data centres and of users' workloads.[60]

This project used data from the UK's National Grid ESO AI-powered "carbon intensity API" to create real-time carbon emission calculations based on workload and the National Grid's current energy mix.

The result was a more detailed, user-level dashboard that displayed CO_2e emissions per virtual machine.

VM dashboard

virtual-machine-1	project-1	46.5 kWh	10.6 kgCO2
virtual-machine-2	project-2	45.1 kWh	10.3 kgCO2
virtual-machine-3	project-3	40.7 kWh	9.32 kgCO2
virtual-machine-4	project-4	30.0 kWh	6.87 kgCO2
virtual-machine-5	project-5	29.2 kWh	6.65 kgCO2
Virtual-machine-6	project-6	27.9 kWh	6.41 kgCO2
virtual-machine-7	project-7	27.8 kWh	6.49 kgCO2
virtual-machine-8	project-8	27.7 kWh	6.35 kgCO2
virtual-machine-9	project-9	27.2 kWh	6.19 kgCO2
virtual-machine-10	project-10	27.1 kWh	6.21 kgCO2
virtual-machine-11	project-11	26.7 kWh	6.12 kgCO2
virtual-machine-12	project-12	25.3 kWh	5.86 kgCO2

Building control – an adjacent IT domain

Buildings represent a significant proportion of a college or university's energy consumption and carbon footprint.

While buildings are not the traditional domain of IT, technology is increasingly being used to minimise the operational carbon impact of buildings.

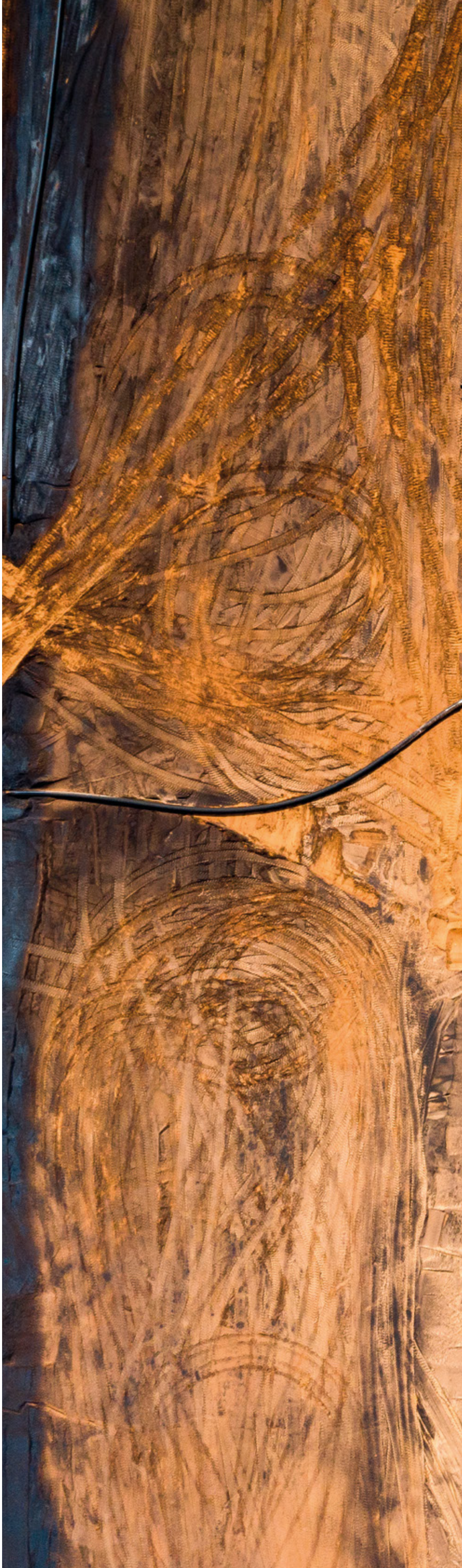
Internet of Things (IoT) and AI technologies are able to intelligently optimise lighting, heating and cooling of buildings and spaces within buildings, such as labs, common rooms and offices based on awareness of schedules and real-time information about occupancy and use.

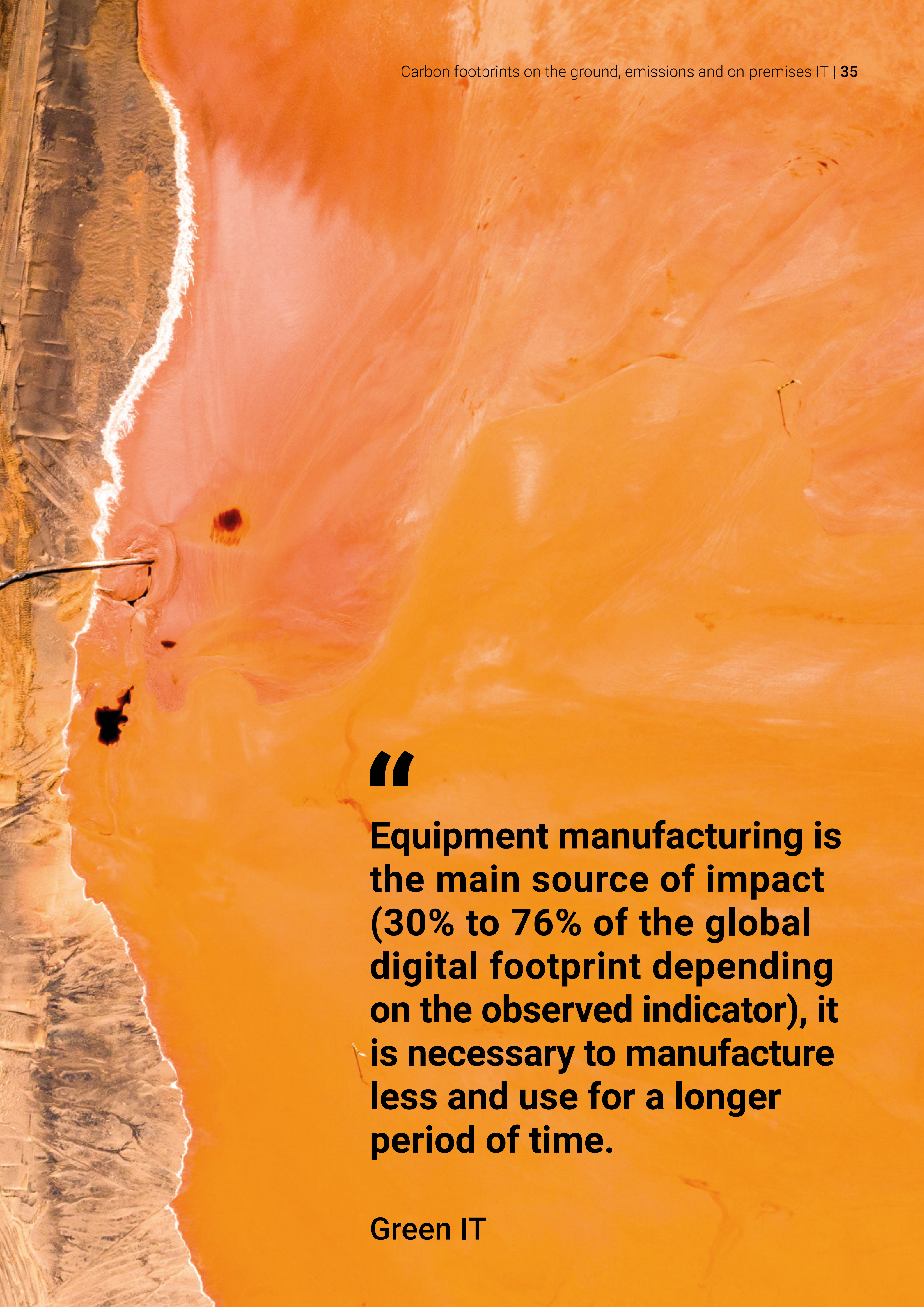
In addition to sensing and control technologies, big tech players are finding new ways to extend their capabilities into building management and control.

For example, Cisco now offers a power-over-ethernet (POE) solution for controlling lower power, LED lighting and other devices such as displays, door entry systems and laptops.[61]

While out of scope of this report, this area will become of increasing relevance for IT departments as many of these solutions require connectivity, storage, processing and integration with other data sources.

Due to this, IT departments will have additional services to include in their footprint calculations, but also be responsible for energy and carbon optimisations beyond their traditional domains.





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Equipment manufacturing is the main source of impact (30% to 76% of the global digital footprint depending on the observed indicator), it is necessary to manufacture less and use for a longer period of time.

Green IT

Clouds of carbon

While cloud computing has many advantages, and without it the pandemic-spurred digital transformation would not have been possible, it should not be considered a panacea for carbon emissions.

Indeed, as previously mentioned, the carbon footprint of our digital lives and the internet is very significant.

Data centres themselves are vaguely estimated to account for 1-1.5% of the global energy consumption, and data transmission networks a further 1%.[62] According to an IEEE article,[63] cloud as a portion of that footprint accounts for 1% and this is expected to grow exponentially, reaching 8% by 2030.

But this is just the operational energy usage. As we've seen in the previous sections, up to 80% of a data centre's carbon emissions can occur in the manufacture and distribution of the equipment.

In other words, if 20% of a data centre's operational energy (Scope 1 and 2) accounts for 1% of the global energy use, the procurement of products and services used by the data centres (Scope 3) could be up to four times greater: 4% today and 32% by 2030.

It is unlikely that it will actually reach those numbers because research in more energy efficient technologies is rapidly commercialising, but still, the IPCC has warned that it doesn't expect gains in energy efficiency to outpace, or even keep up with gains in digital growth.

Therefore, we must be mindful about the use of cloud, and not treat it as "fire and forget" or "out of sight, out of mind".

Bytes of carbon

By now, it should not be a surprise to learn that each byte of data carries a carbon overhead. This carbon overhead begins before even the byte was created, but then grows through its creation, storage, transmission and use. Data has a carbon cost both in rest and transit.

As mentioned in the Jisc Sow a Seed video,[64] only 6% of cloud data is used regularly, so what is the rest doing?

There are many other shocking statistics about wasted or redundant data to be found across the web. Gerry McGovern, author of World Wide Waste, cites analyst reports that claim 90% of stored data is never accessed once stored, and 90% of IoT data is never used.

This habit of data hoarding comes from two beliefs: 1) it's pretty much free to store data and 2) someday AI might find some use for all this data.

Both of those points can be challenged. However, when it comes to cost, there is a cost we're just not thinking of when signing up for a bigger data storage plan.

The Stanford Magazine[65] suggests that storing 100 gigabytes of data in the cloud could be responsible for approximately 0.18 to 0.2 tonnes of CO_2e per year – again, that is operational and excludes Scope 3.

We could calculate the carbon footprint of each and every college or university, and it would most likely be larger than expected. However, it might be more helpful to focus on how easy it could be to reduce the carbon footprint of cloud storage.

Let's think in terms of 10 and 100 gigabyte chunks – where could we find 10s or 100s of GBs of data that could be scrapped?

Device backups:

- Computers often contain hard drives of several hundreds of gigabytes and, backups specialist Chron[66] recommends backup disks larger than 200GB for Windows-based laptops

- The storage capacity of mobile phones is also in the 100GBs category, with a chunk of this often occupied by selfies, accidental screenshots and blurry photos

- Android and Apple phones automatically back up installed apps and these can eat away at cloud storage very easily with little value, since they are readily re-downloadable via the appropriate app store

- Recommendation:

    - Regularly purge online backups of managed devices, don't keep backups for devices that are no longer owned, or for users that have moved on
    - Set default mobile phone backup locations to local devices, not manufacturer-preferred options such as iCloud or Google Drive

Filesharing:

- Sharepoint, Teams, Google Drive and Dropbox all encourage users to store as much as they can and to upgrade as soon as space is low

- It is often far simpler to upgrade to the next storage tranche than investigate what can be removed

- Recommendation:

    - Restrict quotas on online storage
    - Consolidate storage options to make accounting easier
    - Use tools to help users find out of date, old documents and files
    - Implement ephemeral file sharing for short-lived transfer of files Sharepoint[67] provides admin tools to expire links, and webtools such as WeTransfer automatically delete files after seven days

10GB and 100GB files are easy to find daily and represent quick wins that the scarce resources of IT departments can focus on. However, each of us must take an active role in cleaning up duplicate, backup or old files from online repositories and in our mail.

Data retention policies

Organisations implement long-term data retention policies for many reasons, including business analysis, disaster recovery, member or student support, freedom of information (FOI) requests and regulatory requirements.

Data retention, and thereby deletion plans, should look to ensure data that is due for deletion is expunged from all locations: physical, local, cloud and backups. Additionally, they should find opportunities for less time-critical data to be stored on less carbon-intensive media, such as magnetic tape or optical.

Choosing video calling providers

We will look into video calling and distributed working practices in more detail later in this report. However, while discussing the digital carbon footprints of cloud, it should be noted that not all video calling platforms are created equal.

For the time being, there is no simple way to compare the actual carbon footprint of a video call, but over time we expect this to evolve as data becomes available and CO_2e becomes a stronger buying consideration.

In absence of that, and in the presence of vague claims from providers of running on "100% renewable", we can begin to understand relative impacts of the various providers by studying the data transmission of the various technologies.

A 2021 study by GreenSpector[68] identifies the data exchanged by 19 video conferencing tools. It suggests BigBlueButtons, Tixeo and Google Meet as the most efficient platforms for video calls. The worst performer, with approximately 40MB of data exchanged in one minute, is Discord, compared to BigBlueButton's ~3MB.

Other popular meeting platforms such as Microsoft Teams and Zoom came in fifth and thirteenth places, respectively, generating approximately 10MBs and 22MBs during the one-minute test.

The report empirically measured data transmission while using an Android smartphone. Of course, a video call always consists of more than one person so these numbers would need to be doubled, at least.

Comparing published bandwidth requirements for both Zoom and Teams gives a similar picture, one that can help us understand the desktop client impact, as well as that for mobile.

Zoom's published bandwidth data[69] indicates a two-person HD (1080p) video call generates 3.8Mbps when broadcasting and 3.0Mbps when receiving. That equates to 6.8Mbps for each participant, equalling 408Mb/51MB over the 60 second call.

Microsoft's published bandwidth requirements[70] indicate that by using the 'recommended' settings which may result in 1080p HD video, the application would generate 1.5Mbps in both directions. Choosing the 'best performance' setting would increase this to 4Mbps in both directions.

Translating this, a one-minute video call on Teams using 'recommended' settings could generate 180Mbp/22.5MB, almost half of that from Zoom – a similar result as in the GreenSpector data.

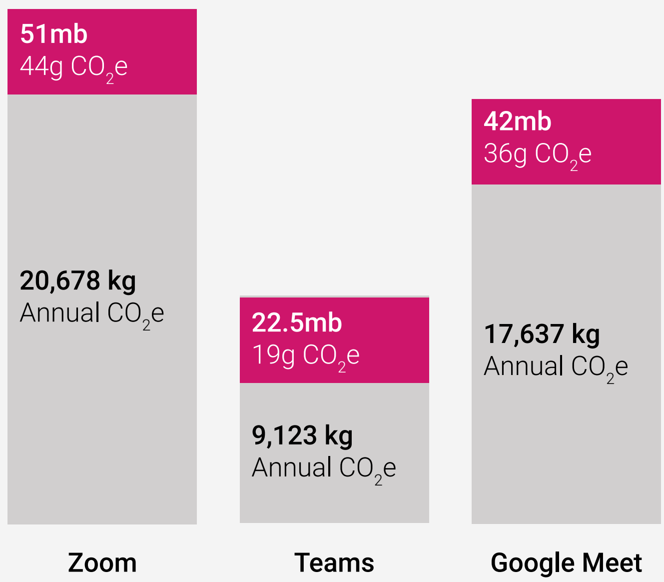
Google Meet requires 5.6Mbs for a two-person meeting, resulting in a 60-second two-way Google Meet HD video call generating 42MB of data.[71]

Common baseline

The bandwidth analysis approach has many shortcomings, yet this approach enables us to create a common denominator against which to make more informed decisions about our video conference call platform of choice.

Video calling providers

Comparison of a two-person, 60 second call



- Calculated gCO_2e[72] based on UK carbon intensity of $165gCO_2/kWh$[73]
- Annual CO_2e based on 100 staff, 2x 1-hour 2-person HD calls per week

Source: Scott Stonham. MB to CO_2e calculator by Chris Adams

In order to make a more complete calculation we would need to factor in details about the vendor's data centre, its location and power sources, its efficiency, the communication pathways between clients and the data centre, the manufacturing costs of the equipment for the clients and the server-side and much more.

Later in this document, when we look at remote working, we will address some of our video conferencing behaviours and what decisions we can each make to reduce the CO_2e overhead of our meetings.

Websites

While websites are not often thought of as cloud technologies, we should address them here as they are technologies that often run on computers hosted either in managed data centres or the cloud.

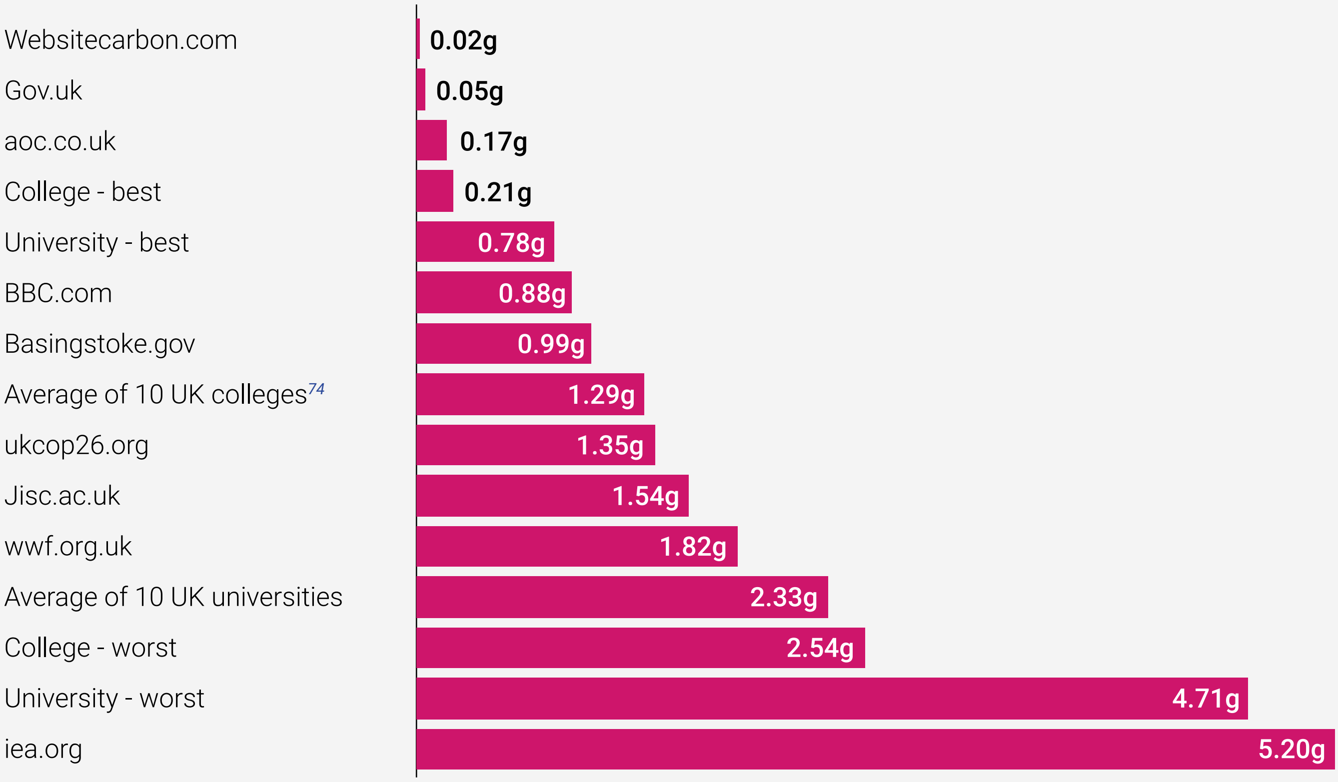
Every website has a carbon footprint, which is made up of the servers, networking, data exchange and client technologies required to host, run and browse the websites. One of the first ever website carbon calculators, websitecarbon.com, is still one of the most trusted sources.

Comparison of college, university and commercial website carbon

Using websitecarbon.com we were able to calculate the carbon footprint of the home pages of several organisations.

We randomly chose ten colleges and universities from publicly available directories, then used the calculator to determine the carbon footprint of the home page. We then took the maximum, minimum and average of these results. For comparison we also analysed the websites of other organisations.

Carbon footprint of homepages
CO_2e per web page visit



Source: ***websitecarbon.com***

Reducing website carbon

It's important to realise that these numbers are multiplied by visits, so the busier your website, the more carbon it produces.

The carbon footprint of a website can be reduced through many ways, some easier than others. They include, reducing the number of images and videos, avoiding auto-play videos, optimising source code, reducing the number of database lookups that are required to build the page, using static pages instead of dynamic content, and switching to a hosting provider that runs on green energy and has a robust procurement and e-waste policy.

Website compression is another technique that is often used, but it requires additional energy to compress and decompress, so instead of compression, reducing code and streamlining how that code is delivered and rendered by the devices is more impactful.

Ask questions of cloud providers, hold them accountable

In the same way cloud providers can provide greater economies of scale for computing power, they too can be a multiplier of improved carbon footprints, but this is not yet the case.

While many providers, including Google, Amazon and Microsoft, have published ambitious plans to run entirely on renewable energy sources, this addresses just a small part of the carbon footprint of their operations, mainly Scope 1 and Scope 2. The majority of their footprint is not in operational energy, it is in Scope 3.

When choosing cloud suppliers, don't take "100% renewable" pledges as sufficient enough credentials, challenge them on Scope 3, e-waste and supply chain transparency.

Many governments are implementing ESG and sustainability as trickle-down strategies, enforcing bigger, exchange-listed companies to disclose their greenhouse gas emission data, which, in turn, means their suppliers have to follow suit – and down the supply chain it trickles.

The more we collectively ask for transparency across Scope 1 to 3, the faster these changes will happen.

Collaboration vs mandates

These requirements are all still in their infancy and, as such, no one has all the answers or all the data. This means comprehensive sustainability mandates are simply not going to work, yet.

You might find it easier to make faster progress with suppliers through focused collaborative exercises, workshops, challenges and agreed milestones.

How technology can help

Bespoke real-time carbon modelling

The open-source Cloud Carbon Footprint[75] project has extensive data points to help build a more complete model using APIs. This tool can help create real-time calculators for both cloud and on-premises technologies. The tool also provides recommendations on how to reduce costs and carbon emissions for Amazon Web Services (AWS) and Google Cloud Compute (GCP).

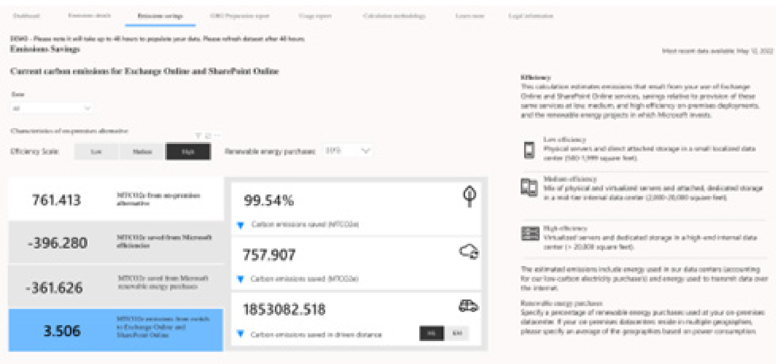
The UK's Carbon Intensity API[76] leverages open data and AI machine learning to provide real-time and forecasted carbon intensities for power in the UK.

This is currently being used to provide forecasts of lower carbon-intensive energy times, which could be used to influence behaviours and enable smart devices to adapt to reduce carbon emissions.

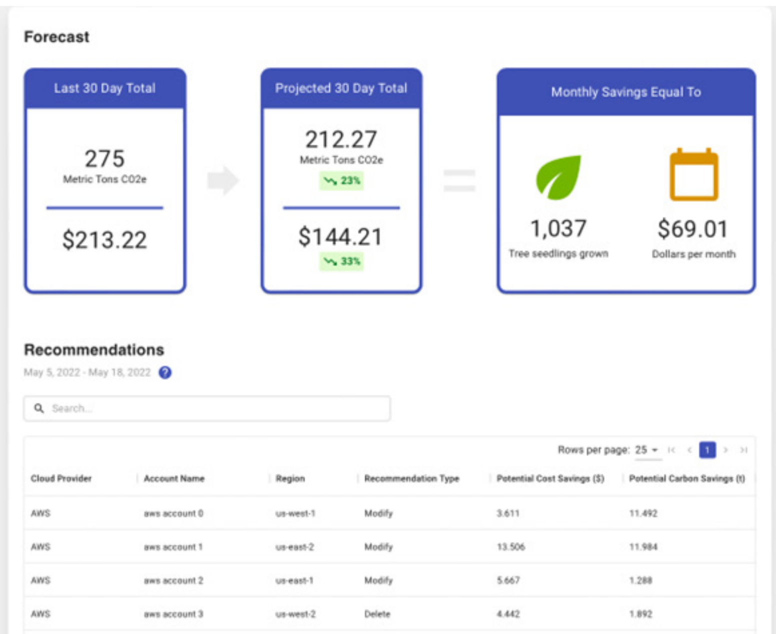
Carbon intensity API

Microsoft emissions dashboard
The dashboard uses Power BI Pro to deliver interactive charts along with export-ready data formats that can be used to feed into other reports, such as GRI.[80]

Microsoft's tool also includes a model to calculate the efficiency of its cloud compared with various types of on-premises installation.



Footprint forecast



Cloud provider carbon dashboards
Cloud providers have emissions dashboards to help organisations understand the carbon impact of the services they consume.

Before relying too heavily on the information provided in these dashboards, you should look carefully at the calculation methodologies, paying particular attention to which scopes are covered, and how often the underlying assumptions and calculation data are revised.

Also look for how e-waste and circularity feeds into their calculations.

Microsoft, Google[77] and AWS[78] are among the cloud providers with emissions dashboards.

Microsoft's emissions impact dashboard[79] calculates the carbon emissions associated with the use of Microsoft's 365 cloud solutions, covering Scope 1, 2 and 3 carbon emissions from manufacture, packaging, transportation, use, and end of life phases of data centre hardware in all Microsoft owned and leased data centres.

These dashboards can be used to create organisational, department and individual service level baselines, against which improvements can be implemented and measured.

Beyond vendor-specific emissions dashboards, cloud carbon is becoming a hot topic. Cloud Carbon Footprint[81] is a free and open source platform for aggregating carbon emission data from across AWS, Microsoft Azure and Google Cloud Compute.

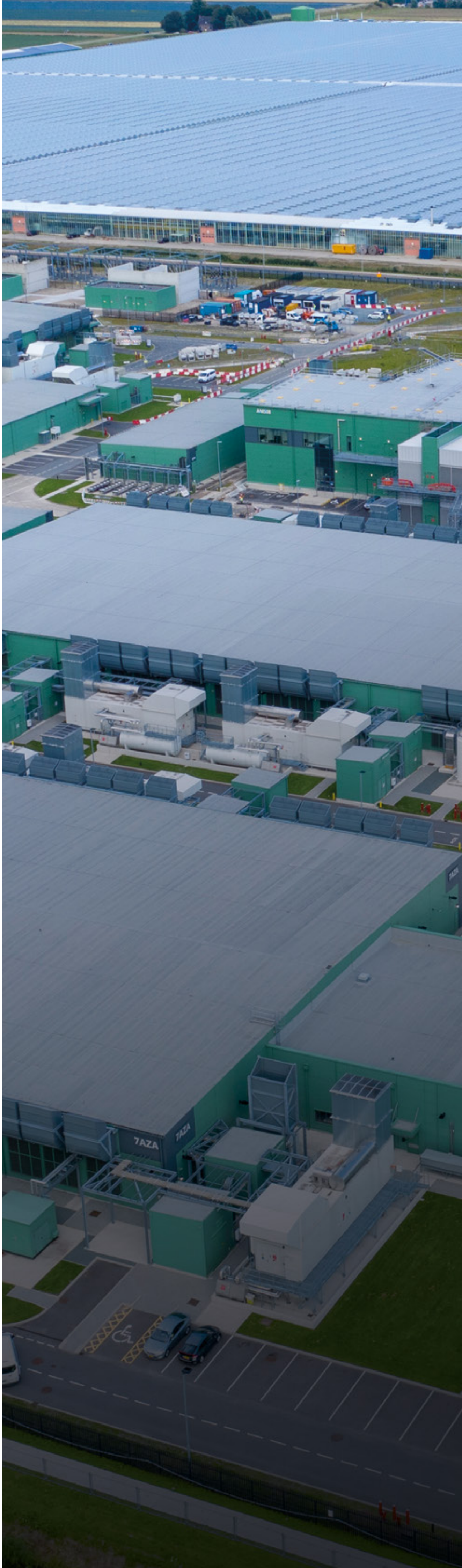
The Cloud Carbon Footprint tool reports on embodied and operational carbon emissions, as well as providing service and account level recommendations on how to reduce energy consumption and emissions.

Turn off the cloud

Earlier in this document we looked at the importance of turning off on-premises IT equipment, but what often gets missed is that cloud servers and services can also be shut down when not in use.

Combining data from the cloud provider's emissions and service utilisation dashboards, IT departments can identify which services can be shut down during which periods, and the resulting reduction in emissions.

Don't forget, cloud services are often charged on a use basis, so turning things off saves emissions and money.



Cloud providers have emissions dashboards to help organisations understand the carbon impact of the services they consume.

Remote emissions

Although there is a swing back to working from offices and students returning to classrooms, lectures and labs, the pandemic-fuelled distribution of staff and students will persist to a greater degree than in pre-COVID times.

Some colleges and universities have, or are planning to introduce, more remote working in an effort to be more accessible to more diverse demographics and to potentially help reduce operational costs and carbon emissions.

However, while the distribution of the work force might indeed mean that facilities can be temporarily shut down, resulting in reduced power demand, it must be remembered that institutions are still accountable for the carbon produced while their students and staff are off campus.

Dial down video's footprint

One of the biggest digital transformations in the 2019-2021 timeframe was the acceptance of virtual meetings and classrooms.

A key enabler for this has been the maturation and mainstream adoption of video calling technologies. Some of the impact of these technologies was discussed in the previous section, but here we look at what can be done from both an individual and IT department point of view to minimise the carbon footprint of video meetings.

Video is one of the hungriest mainstream communication technologies we have, and yet we continue to seek higher definition rates and bigger devices.

In general, the bigger the display device, the bigger the energy requirement and footprint. The higher definition you transmit or receive, the bigger the carbon emissions.

Opting for standard definition (SD) video during calls can half the bandwidth requirement compared to HD and, since many laptop cameras do not exceed 720p resolutions, SD should be a default option for all users.

Beyond that, users should be encouraged to be mindful of video use. While the ability to see each other and share screens remotely has been immensely helpful during the pandemic, there are many instances when audio only is perfectly acceptable.

For example, during meetings participants could be encouraged to turn off their video after initial introductions, and only re-enable it when called upon or if they are leading the conversation.

Two-person, 60 second video call footprint

	Zoom	Teams	Google Meet
Total data exchanged	51MB	22.5MB	42MB
Calculated gCO_2e[82] (based on UK carbon intensity of $165gCO_2/kWh$[83])	44	19	36
Annual CO_2e (based on 100 staff, 2x 1-hour 2-person HD calls a week)	20,678kg	9,123kg	17,637kg
Audio only (data)	60kbps	58kbps	30kbps
Audio only (gCO_2e)	0.778	0.753	0.39
Audio only annual CO_2e (based on 100 staff, 2x 1-hour 2-person HD calls a week)	364kg	352kg	182kg

User awareness and action

The purpose of this entire document is awareness and influencing change.

If there are only three things you take away from it, they should be:

1. The carbon footprint of our digital dependency is substantial and growing
2. This footprint is intricate, interwoven and currently often indeterminable
3. Collective change across individual behaviours can make a difference

In order to achieve point 3, we must help users discover and decipher points 1 and 2.

Like enterprises, educational institutions have an opportunity to scale their influence beyond the confines of their campus, into the lives and homes of students and staff.

Much of this will be done through the organisation's existing procedures, including trickle-down management incentives and objectives, institution-wide awareness campaigns, dedicated classes or lectures and thematic discussions or activities.

However, there are tools that colleges and universities can use to raise awareness of their individual and collective carbon impact.

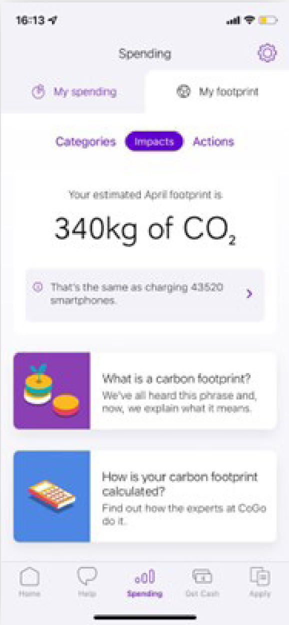
How technology can help

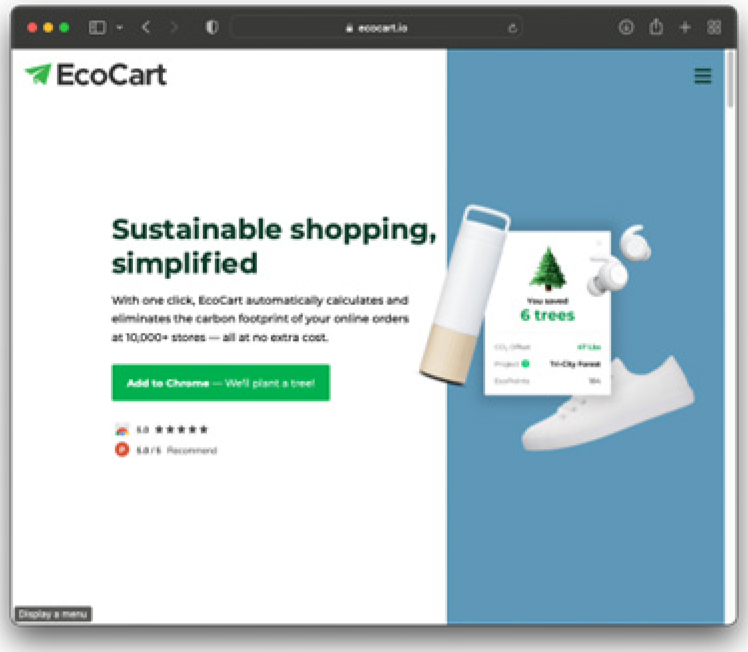
Consumer-focused carbon calculators are blossoming, with users being offered the opportunity to calculate their carbon footprints from their banks to their shopping carts. For example, NatWest has launched a carbon footprint calculator in its banking app, and there is a Chrome extension to help people understand the carbon footprint of their online shopping.

These tools are available for everyone, and some can be customised to align with an organisation's goals and even help gamify improvement across departments and teams.

A Guildford-based design and development agency, Kyan, rolled out a tool by Giki[84] to help increase employee awareness, and gamify action between teams to reduce their collective footprint.

Giki is one of many tools that help individuals learn more about their carbon footprint and coach them through incremental improvements.





Working together as one organisation through an app like this can help create a baseline and action plan against which to track and measure improvements.

Some of these apps are specifically designed for organisations and teams to gather carbon impact data from across their broader stakeholder estates – including staff, customers, partners and suppliers.

These apps can feed into reporting systems, helping organisations develop a better understanding of their Scope 1 to Scope 3 emissions.

Other climate footprint and offset apps include:

- Footprint (footprintapp.org). Features include: internal competitions and leaderboards, impact assessment, organisational benchmarks, education materials and custom reports
- Wren (wren.co). Features include: personalised tracking and action plan, monthly subscriptions to support carbon offsetting projects, live impact dashboard, tips to help make positive lifestyle changes. Translates the individual footprint into hard-hitting statements eg *"If everyone lived like you, we'd warm the earth by 1.5°C within seven years and one month"*
- MyEarth (search on app store). Developed by the University of Wisconsin-Madison, suggests simple daily changes to implement and track reductions
- Carbon footprint and CO_2 tracker (thecapture.club). Features: can be co-branded for the organisation, gamified sustainability challenges, branded dashboards and reporting
- Klima (klima.com). Designed as a benefit to offer employees, features climate education and offsetting with a team dashboard
- Earth Hero (earthhero.org). One of the few to include topics relating to digital footprint

Climate court
A more tongue-in-cheek app that really gets people talking about their impact is Climate Court.

The Climate Court app[85] encourages people to take their friends, family and colleagues to a fictitious court to find out about their climate awareness and footprint. After a few questions the defendant is given their sentence, along with corrective measures.

No digital

Rather disappointingly, despite reaching out to more than 6,000 climate tech technologists and activists, it seems that none of the carbon calculators encourage users to think about their digital carbon footprint.

While specific calculations on individual movies watched, social media channels browsed, games played and emails sent might be a long way away, it would seem to be a shortcoming in the market to not share some of the tips mentioned in this document, such as reducing video quality, or choosing audio calls over video.

This is an area to watch, as it will surely change soon – perhaps even led by a college or university.

Remote energy consumption

In the wake of the pandemic, many college and university leaders will be looking to capitalise on the lessons learnt and behaviours changed.

One opportunity will be to adopt more remote working practices by formalising working from home, encouraging students to work off campus and even closing down buildings or departments for a day a week.

Closing down buildings for a day a week will certainly help reduce energy consumption, which at the time of writing is an increasing concern for all. However, this does not rid the institutions of their carbon obligations.

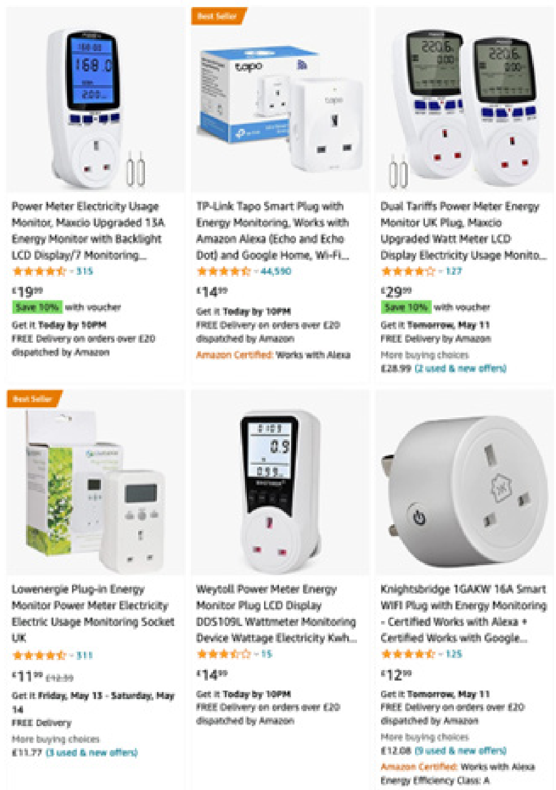
The Scope 3 emissions for colleges and universities includes the energy consumed by staff and students while working remotely.

Gaining insights into energy consumption from people's homes is a sensitive topic, and one that Tom Greenwood, and author, entrepreneur and managing director, struggled with when applying for his B Corp certification.

In an interview on wellthatsinteresting.tech, Tom described how he was able to incentivise his staff to disclose this data by providing additional benefits, and how, ultimately, this led to nearly all of his employees switching to renewable energy suppliers at home, multiplying his impact beyond the business and across many residential homes.

How technology can help

While solutions such as measurable.energy present a coherent approach to understanding campus-wide energy data, these solutions are not suitable to send home with staff or students.



However, there are many consumer smart plug devices available that can help end users understand and track energy consumption at an individual socket level.

These devices can be used to understand power consumption of study-related activities by plugging into the socket that powers their laptop and other desk devices, such as phone chargers.

This socket-level approach mitigates the challenges of disclosing sensitive household data, yet provides easily readable data that can be reported and tracked.

Note on idle power usage
As mentioned previously in this report, these devices consume power even when the devices they are powering are switched off. This always-on behaviour has the potential to consume power 24x7. Therefore, it should be recommended that students or staff physically unplug the entire device at the end of their study or work day.

The sockets I use are from a company called Teckin. These allow me to measure my energy consumption and control devices through automation and voice commands. Through empirical measurements, I discovered that these devices consume between 1-3 watts when 'off'. Giving a conservative baseline energy estimate of 24 watt/hours that equals 8.76kWh per year for one socket. At today's best prices (37.27p/kWh), **that's £3.27 or 1.1 kg CO_2e[86] a year for one socket doing nothing.**

Remote user equipment

In addition to energy usage, remote users will have digital carbon footprints attributable to the equipment they use.

There are opportunities to minimise this through procurement and end of life planning.

Steve Haskew of Circular Computing shared that customers approach this in a couple of ways.

First, equipment that has reached its end of usable life within the campus is offered to employees for steep discounts, or donated to local primary schools or charities.

Second, remote staff that rely on their remanufactured devices are supported by a swap-out guarantee, which means they can get a like-for-like replacement exchanged at their doorstep on the same day. This helps mitigate carbon emissions from new equipment while also eliminating the need for the employee to make a journey to the office.

Behaviour change is critical

Changing our behaviours is critical for addressing the climate emergency and sustainability more broadly.

But we've probably all heard this many times before –turn the lights off, close windows, turn down the heating a degree, reuse bags, stop eating meat etc.

As Lyn Duncan from CO2Analysis mentioned, people are more willing to make changes that have positive environmental impact than purely for financial savings, but they need the information to make these choices.

There are two key elements to this: baselines and product (or service) level emission data.

In this report we have looked at how to capture and measure data at a product or service level from procurement through to cloud services and remote working. This data should be used to create a continuously revised baseline, against which all decisions are evaluated.

The baseline will never be perfect, but must be established, communicated and revised as newer, more accurate data is derived and discovered.

Against this, procedures, processes and people should evaluate their choices, looking at whether their action, purchase or continued use improves, or worsens against the baseline, in much the same way price and performance is currently evaluated.

Likewise, staff and students alike should be rewarded and acknowledged on not just their academic or job performance, but on their sustainability progress too.

The goal of this activity is to associate reward and prestige with sustainability improvement. We must find a way to value and celebrate "sustainable" more than we currently value "new".

A note on carbon removals

While the topic of carbon removals is beyond the scope of this report, it would be remiss not to mention this important point.

In this report we've talked a lot about carbon emission reduction, yet climate scientists are warning us that the time to avoid climate disaster through reduction plans alone has since passed.

We absolutely must slow down the rate of our carbon emissions, but we must also look to adopt policies, behaviours and technologies that can **remove carbon** from our atmosphere, too.

There are plenty of existing and nascent solutions, from natural mineral (eg olivine, basalt) and land management approaches (eg rewilding, tree planting, soil management, slivopasture) through to more complex, technological approaches such as bio-receptive concrete direct air capture (DAC) carbon capture and sequestration.

There are many opportunities for integrating carbon removal into the education sector, the details and practicalities of which might make for interesting reading in a future Jisc report.

Conclusion

We need to avoid panic and hyperbole but, at the time of writing, India and Pakistan are suffering an extreme and ongoing heatwave,[87] Italy's longest river is drying up,[88] along with several others in the USA, all resulting in the worst drought in 1,200 years.[89]

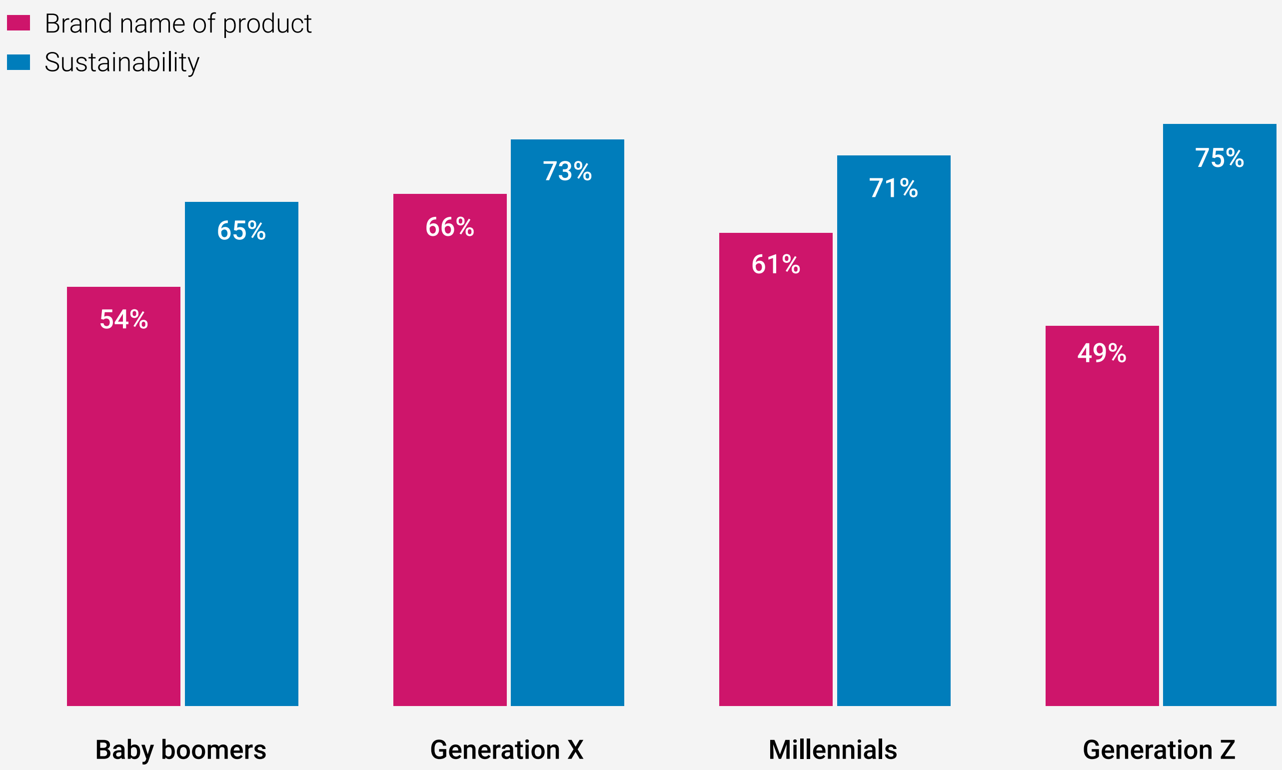
Many of us have already begun making changes and are addressing carbon footprints in our lives and work. However, the impact of our digital activities on carbon emissions has had less attention and action.

Yet digital, like money, is a global phenomena, shared, depended on and frustrated by our collective actions, and is set for continued exponential growth.

As organisations working towards a better future, colleges and universities have a unique opportunity to create immediate and long-term climate impact.

Our collective work not only focuses on the future but actively builds it, shaping and guiding the minds of millions of learners who will construct, live and thrive in the very futures we help imagine. With this, there is tremendous opportunity to amplify and accelerate action on digital carbon footprints.

Q: How do you rate the importance of these factors when making a purchase?



Source: Generation Z sustainability lifestyle buying decisions, ***weforum***

Generation Z have already asserted that sustainability is a major factor in their decision-making[90] and are influencing the behaviour of previous generations.

As the first generation to enter adulthood amid the most critical time period of the climate emergency, Generation Alpha are anticipated to continue to put sustainability at the forefront of their decision making.[91]

Having transparent, genuine and inclusive sustainability strategies, particularly with regards to digital, will be crucial when engaging and working with these generations.

What to do next

Many educational institutions have already begun enacting sustainability plans with great impact. Digital carbon footprints should be incorporated into these if not already.

Baselines are crucial not just for understanding and communicating progress, but also in creating decision and reward frameworks to inspire action. So, begin to create digital carbon footprint baselines across technology domains.

There are several quick wins mentioned in this document that could help you make near-term impacts on your digital carbon footprint:

Quick wins

- Perhaps start by experimenting with plug-in smart sockets or energy meters to better understand workstation power consumption when video conferencing with and without video enabled

- Monitor, measure and communicate energy usage between buildings, departments or labs. Use carbonintensity.org.uk to convert real-time energy usage into real-time carbon emissions

- Accumulated unused data can not only eat away at cloud storage, but can influence the need to upgrade laptops with bigger hard drives. Conduct on-premises and cloud data usage audits to identify wasted data that can be eliminated. Review, update and act on data retention policies

- Communicate the carbon impact of social media use, and encourage reduction in time spent endlessly scrolling through feeds, or even self-imposed 'screen time' limits for social media apps

- Encourage Wi-Fi use across campus and remotely

- Don't standby, turn off. Build the habit of turning things off instead of letting them drift into standby. Investigate automation techniques to increase the scale of this impact

- Use your cloud provider's dashboards to track emission data and develop a plan to reduce it. Investigate the applicability of cloudcarbonfootrpint.org

- Test various carbon footprint apps among teams and identify which are easiest to use or provide the greatest motivation for change

- Remove unnecessary images from email footers, unsubscribe from unused newsletters. Share links rather than attachments in email

- Go dark. Switch to dark mode more frequently and turn down computer monitor brightness by 20% or 40%

- Measure your website's carbon footprint and discuss reduction plans with your supplier. Consider adding a dark-mode switch to the interface, as can be demonstrated on cloudcarbonfootrpint.org and circularity-first.com

Endnotes

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