Lost in Migration?

Attributing carbon when outsourcing to data centres and cloud

October 2019

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Abstract

This discussion paper explores how we can go about attributing carbon to the activity we outsource to third party data centres and providers. The objective is not to advocate cloud adoption or provide a calculation methodology, but to identify ways in which customers can understand these impacts, or at least estimate them robustly enough to inform their decision making.

This paper is aimed at customers trying to compare cloud services with current infrastructure, customers procuring cloud and wanting to know what questions to ask potential suppliers, and customers already using cloud and wanting better energy and carbon data from their current providers.

In the first instance, customers should ask cloud providers for carbon data relating to their individual requirement, ideally at the procurement stage. This is already being requested in UK government tenders and will soon become more widespread. Failing that, footprinting assessments provide an alternative but can be costly and limited in scope. If actual numbers aren't needed and the objective is simply to establish whether outsourcing to the cloud will be a net positive activity, then simple rules of thumb can be applied. Assessing factors like cost, energy source, utilisation, PUE (a measure of data centre efficiency) and server refresh intervals should, in combination, allow a customer to assess this with a reasonable degree of confidence. There is also a growing resource available to aid decision making in the form of research reports, studies and case studies.

We must all work together towards the UN's Sustainable Development Goals and the UK's net zero targets. These are driving organisations to demand greater transparency of their scope 3 emissions. For the moment, however, the objective of this paper is not to present a definitive view but to start the conversation.

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I. Introduction

When organisations outsource digital activity to third party data centres or cloud service providers, there is a general assumption that efficiency improves, and that energy and carbon benefits are realised. But how do we know that this is true? When companies manage their own services, whether analogue or digital, they have access to relevant energy use data- at least in theory – firstly because they pay the bills, and secondly because they control the processes so they can attribute consumption appropriately. But when a service is outsourced to a third party the energy impact of that activity sometimes becomes much less transparent. So how can organisations demonstrate, with a reasonable degree of confidence, that their outsourcing decision is indeed delivering environmental benefits – or even more importantly, identify occasions when it is not?

We discussed this problem with two types of organisation adopting very different outsourcing routes:

a) **Media companies** moving from physical to digital delivery – primarily from printed to digital outputs. This transition presents major challenges for businesses wanting to report carbon emissions consistently and accurately. Although internal energy consumption continues to be reported as scope 1 or scope 2[1] emissions, scope 3 reporting becomes much trickier. Previously, publishers outsourced the physical printing process to a well-established supply chain that provided a high degree of disclosure and transparency regarding energy and emissions. This made scope 3 reporting relatively straightforward. That supply chain changes fundamentally when activity is outsourced to a cloud provider, and the output becomes a digital rather than a physical product. Printed media companies report that when they make this transition, energy use becomes less transparent and the level of disclosure reduces: often they receive no information at all about the carbon. The situation is further complicated by the fact that digital content may be consumed in different ways, via different media and on different devices.

   Media organisations not traditionally associated with printed material, like broadcasters, also need to understand carbon impacts. However, they need more than an indication of their scope 3 emissions: they need enough granularity to inform their sustainability decision making. So, they need not just numbers but a breakdown of carbon between, say, network and compute, plus assumptions, conversion factors and other contextual information from their suppliers. Because media companies are struggling to capture these carbon impacts, there is an inevitable perception that reporting is incomplete.

b) **Public sector bodies** moving existing IT and in-house data centre functions to external service providers where infrastructure is usually shared between many customers. The outsourcing of public sector ICT currently follows several different routes: migration of data centre activity to third party colocation[2] providers (for instance via Crown Hosting), migration of existing applications to cloud providers and provision of new services via cloud, plus various other things that fall in between. Whilst data centre migration to a colocation provider should allow for transparency of carbon and energy impacts[3], the migration of existing applications and of analogue services to cloud may render carbon reporting much less straightforward. There are innumerable variables to consider: not just those relating to the nature of the service provided, but also multiple considerations regarding third party infrastructure and hardware configurations.

   However, public sector outsourcing presents an additional problem: in the past, not all departments conducted detailed monitoring of carbon impacts, and some public sector organisations will struggle to determine whether cloud migration is sustainable because they do not have benchmark data. Others, however, such as those engaged in GDU/STAR activities[4] do have insight into their carbon footprint and now seek more clarity on their scope 3 emissions.

UK Government departments are required to report energy usage and explain how they are reducing their respective carbon footprints and this obligation to understand and report scope 3 emissions is likely to become more widespread, given UK government commitments to climate change targets and increasing observance of UN Sustainable Development Goals (SDGs). It is also a requirement of the Science Based Targets methodology.

It is clearly time for a conversation about how carbon is attributed to cloud services, and this discussion paper explores some of the ways in which organisations can get a reliable feel for the carbon impacts of changes like these and why it is not always straightforward.

II. Cloud business model and supply chain

A cursory examination of cloud business models helps us understand why attributing carbon can be so tricky. Simplistically, customers have a choice between three levels of cloud service: IAAS, PAAS and SAAS, or a combination:

- SAAS, or Software as a Service, provides the customer with remotely managed software applications usually delivered via the internet, as well as the supporting platforms and infrastructure.
- PAAS or Platform as a Service provides the customer with a framework, or platform, that they can use to build bespoke applications. Servers, storage and networking tend to be managed by the cloud provider, but the customer's developers manage the applications.
- IAAS or Infrastructure as a Service provides an instant computing infrastructure (computers, network and storage) for customers so they do not have to buy hardware themselves, but leaves them in control of software, applications, middleware and platforms.

Figure 1

Broadly speaking, for customers who opt only for IAAS and retain control of the rest of the activity, attributing carbon is less complex.

As the level of service increases then the potential for complexity builds, because the provider may be moving workloads around, not just between facilities but between regions, and will be managing the IT dynamically.

Ability of customer to attribute carbon decreasing →

In house management of applications and data	In house management of applications and data	In house management of applications and data	SAAS provided by third party
In house middleware and developer platforms	In house middleware and developer platforms	PAAS provided by third party	PAAS provided by third party
In house provision of infrastructure servers, storage, networking	IAAS provided by third party	IAAS provided by third party	IAAS provided by third party
All functions retained in house	Infrastructure only outsourced to cloud provider	Infrastructure and platforms outsourced to cloud provider	Full suite of cloud services outsourced to cloud provider

Figure 2

SAAS, PAAS and IAAS may be provided by different third parties in a cloud service, which increases the complexity of assessing carbon very quickly.

The SAAS and PAAS providers may struggle to understand and account for the IAAS carbon within their respective supply chains

Ability of cloud provider to attribute carbon decreasing →

SAAS provided by third party	SAAS provided by third party	SAAS provided by third party	SAAS provided by third party
PAAS provided by the same third party	PAAS provided by the same third party	PAAS provided by a second supplier	PAAS provided by a second supplier
IAAS provided by the same third party	IAAS provided by a second supplier	IAAS provided by the same second supplier	IAAS provided by a third supplier
Cloud provider delivers all three levels of service	Cloud provider delivers SAAS and PAAS but uses third party IAAS	Cloud provider delivers SAAS only, using third party PAAS and IAAS	Cloud provider delivers SAAS and uses two different third parties for PAAS and IAAS

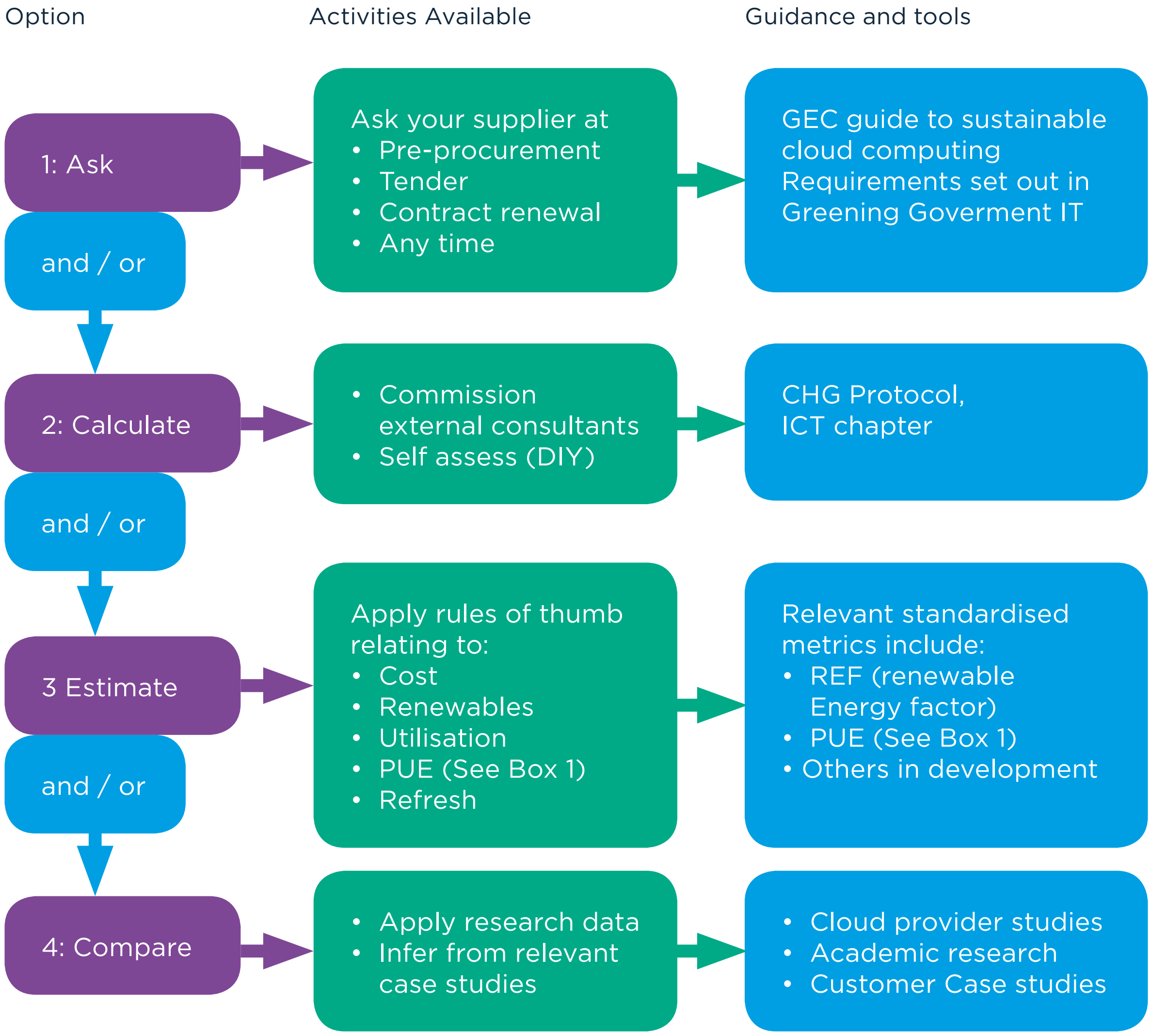
III. Options for understanding carbon impacts

This section explores four options available to cloud customers who want to understand the carbon impacts of their outsourced activity. They are:

a) Asking their supplier
b) Calculating their emissions
c) Estimating their emissions
d) Comparing their activity to existing datasets.

A summary is provided in the table below.

Figure 3: Customer checklist



a) Go on – ask your supplier...

Firstly, customers should ask the question of their service provider. Most data centre operators providing colocation services can answer this question very easily because energy tends to be a transparent part of the billing process. The provider would also have to account for PUE (see box 1) which gives a measure of the efficiency of the supporting infrastructure, and verify the energy source.

However, for cloud services the picture seems to be different and customers report that some providers are willing to attribute an energy value to their services and others are not [5]. It appears that the smaller, more bespoke providers may be readier to provide this information and the larger, international, more commoditised operators are less able to do so. We speculate that several reasons are behind this: it may be easier to allocate energy consumption in a smaller operation with a single site and a few large customers. This gets harder when processing is moved between facilities and internationally: multinationals may move batches of work around to where there is matched capacity or where energy costs are lower, and tracking all that activity can become complex very quickly.

Much also depends on how the service has been designed – it helps if the ability to attribute and report carbon at granular level is designed in at the start: it adds cost but is much easier than bolting on this kind of function retrospectively.

The feasibility of reporting also depends on the way the offering is structured (see figs 1 & 2 above). If the cloud service provider only runs the applications and is using third parties for platform and infrastructure, then things immediately become more complicated. If they handle the whole "stack", or the customer service relates to platform or infrastructure elements only, then it is less problematic, but it is still very complex.

There is also the issue that customers need the skills to understand and, if necessary, interpret the information that is being provided. Some customers just want a number and may not fully understand the assumptions it is based on. It is important that they use the data provided appropriately and account for any limitations or potential inaccuracies transparently.

Other customers make sophisticated use of the data to inform their decision making, for instance to decide which functions they will keep in-house and which they outsource. They need to know where boundaries have been set, the breakdown of carbon between IAAS, PAAS and SAAS (or storage, compute and networks), how the data has been pulled together, the assumptions that have been made, what has been excluded and the conversion factors applied.

BOX 1: PUE
PUE, or Power usage effectiveness (PUE) is a metric used to determine the energy efficiency of a data centre. PUE is determined by dividing the amount of power entering a data centre by the power used to run the computer infrastructure within it. The closer the number is to 1, the more efficient the data centre infrastructure is deemed to be. PUE has pros and cons as a performance metric and customers need to ensure that their supplier is reporting PUE in a standardised way, either to ISO/IEC 30134-2, or to Green Grid 2, or the methodology required by the data centres CCA. These specify aggregated energy use. "Design" PUE or "instantaneous" PUE do not necessarily provide an accurate reflection of the working efficiency of the facility.

So, while mindful that an answer may be subject to caveats, customers can, and are, asking. We are seeing an uplift in the number of these requests especially in public sector tenders [6]: UK Government now requires prospective cloud service providers to attribute carbon to services and DEFRA reports that UKCloud is so far the only supplier that provides granular data. Others supply corporate level data but Government is very clear that the information being sought is customer specific, relating to a project or service. Corporate carbon footprints are useful in their own right as corroboration but the requirement here is more bespoke.

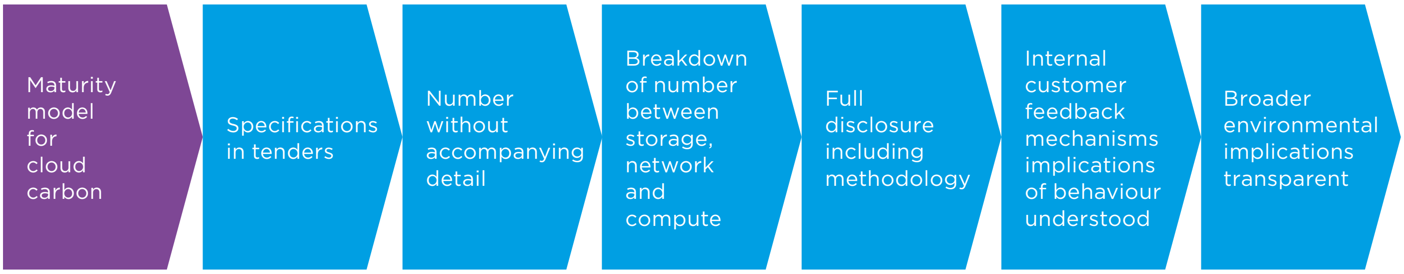
The diagram on the right provides a simple maturity model, suggesting how the level of understanding might develop with improved transparency, driven by increasingly sophisticated customer demand.

The Green Electronics Council (GEC) recently published a useful Purchasers Guide for Sustainability and Cloud Service Procurements [7]. They identify questions to ask service providers in three categories:

1) Sustainability policies and practices,
2) Facility management and equipment and,
3) Data centre power sources.

In addition, Green Public Procurement Criteria for data centres are being finalised by the European Commission and provide multiple sustainability criteria against which customers can evaluate suppliers [8].

Figure 4



b) Calculate it: DIY or GSI (Get Someone In)

Some organisations with the necessary in-house expertise can measure the carbon impact of their IT functions. There are now several peer reviewed tools to help this process, for example the ICT Sector Guidance which is available from the GHG Protocol website [9].

Many organisations, however, make use of third-party experts like The Carbon Trust to conduct carbon footprinting studies or make comparative assessments of changes in process. Such exercises are invaluable because an externally conducted carbon audit adds a level of objectivity that an internal review might struggle to achieve. The outcomes are robust and should be externally verifiable. Occasionally the results are surprising and are very useful to inform decision making.

The disadvantages are that in some cases it might seem rather like a black box exercise, where the process of calculation is not transparent or easily replicated. Studies also tend to look at a specific period in time - say a year's consumption. Therefore, the exercise will provide very useful insights but what has happened in the past may not necessarily indicate what is true in the future. Thirdly a bespoke exercise of this kind may be costly, so organisations may be unwilling to undertake it too frequently, and for smaller organisations it may prove hard to justify.

Box2: What is the ICT Sector Guidance?
The ICT Sector Guidance provides support for the calculation of life-cycle Greenhouse Gas (GHG) emissions for ICT (Information and Communication Technology) products with a focus on ICT services. It provides guidance to support the use of the GHG Protocol Product Standard, and has been developed in close collaboration with the GHG Protocol. It has been reviewed by the World Resources Institute (WRI) for conformance with the GHG Protocol Product Standard. It consists of separate chapters covering: Introduction and general principles, Telecommunications Network Services, Desktop Managed Services, Cloud and Data Center Services, Hardware, and Software.

c) Rules of (green) thumb

If the first two options (asking the supplier and getting in some experts) are not feasible or cost effective then that need not be the end of the story. In many cases the primary objective is to be confident that decisions to outsource are not leading to perverse outcomes, shifting the existing burden out of sight or adding new impacts that negate or reduce the savings. To do this, the approach need not be accurate, but it does need to be broadly robust.

Discussions with a range of stakeholders identified five criteria that, if met, can help to reassure customers that they are indeed moving in the right direction – or alert them if they are not. These are:

i. Cost
ii. Energy source
iii. Utilisation
iv. PUE
v. Refresh

These can be set up as a kind of mixing deck – so for instance cost should not be attractively low as a result of cheap energy produced by burning low quality coal. The relevance of the criteria varies depending on the service provided.

It is important to remember that these will not provide a definitive answer: they are only indicators for comparison, not absolutes. They can be used as a sense-check and to give a feel but that is about it. We will look at these five criteria in turn.

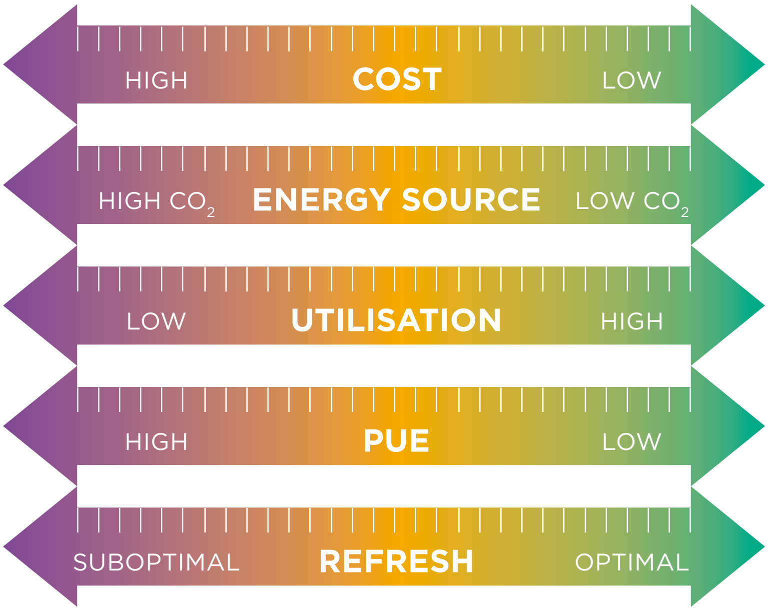


Figure 5: Mixing Deck

i) Cost

We mentioned that cost is likely to be the most important indicator. Where data centre colocation services are adopted, the energy element (plus a factor for PUE) tends to be separated out and charged transparently. So it is usually very simple to make a direct comparison between what you were paying for energy previously and what you pay for energy through the outsourced model. And to calculate carbon it is then just a case of using the appropriate conversion factors. That is the simple end of the cost factor.

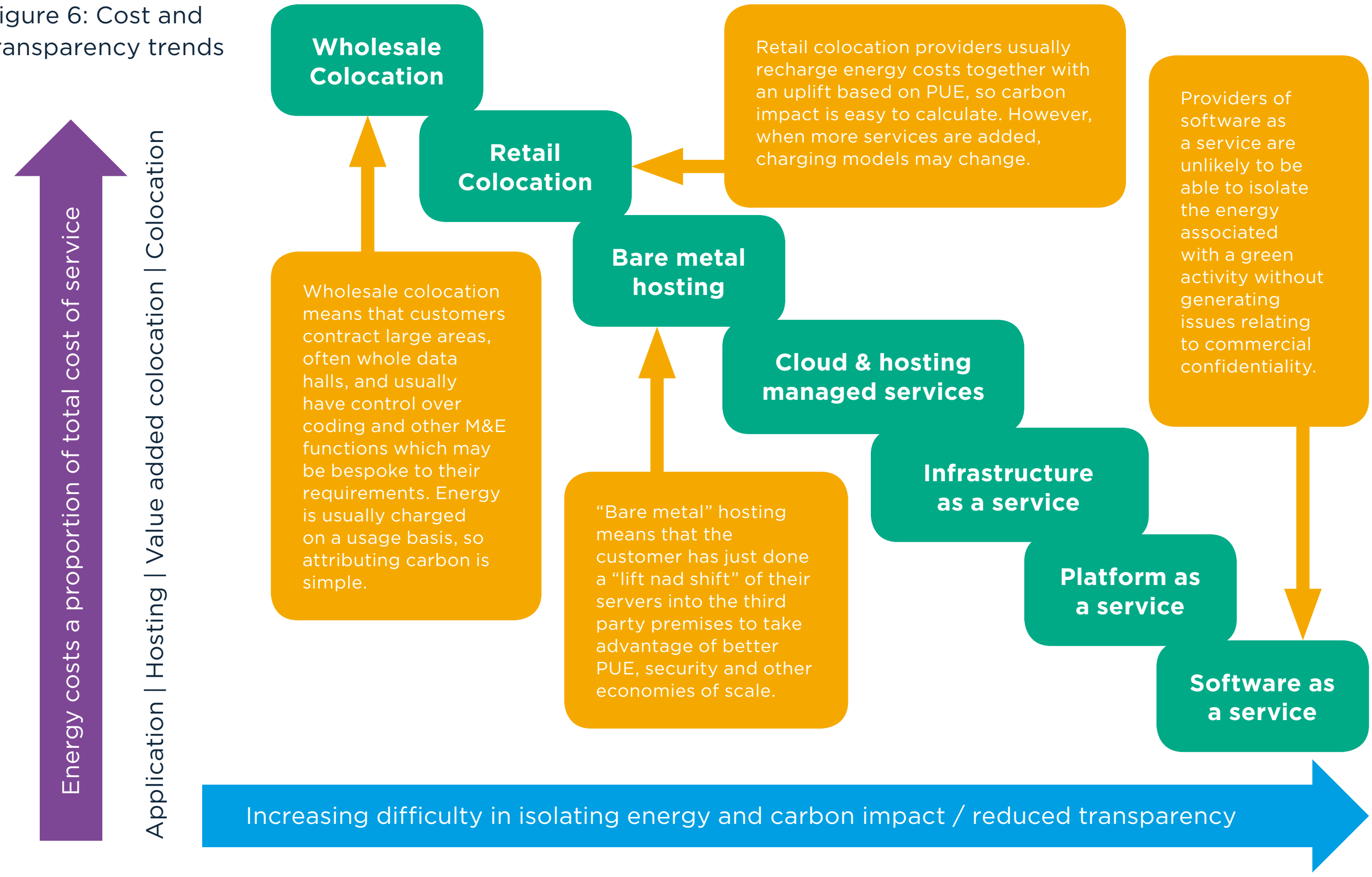
However, there is a whole spectrum of service types and levels that can be added to the basic colocation model or delivered through "as a service" cloud applications. As the level of service provision, which we sometimes call "service wrap" increases, broadly speaking the energy element of the overall cost diminishes. So at one end the customer is paying primarily for energy and at the other end, primarily for service. At the same time, transparency regarding the energy associated with a specific activity appears to decrease. The tendency is for customers to pay for an all-in service where the energy cost is not readily identifiable. See figure 6.

But even where the energy element is not transparent in the overall price, cost is still a useful indicator. The simplest place to start is comparing the energy costs associated with previous activity to the total cost of the new service. If the former exceeds the latter then it is pretty obvious that the new service is more efficient: the service provider has to make a living and if the overall cost has dropped then the amount of energy being consumed must also have fallen: energy prices paid are consistent enough for it to be a no-brainer.

As the level of service provision increases, it is less and less likely that the total cost of outsourcing will be lower than the pure energy costs of the previous activity, but comparisons should still inform. At this point it might be necessary to introduce other existing cost elements to make the comparison with the outsourced service more realistic, like in-house overheads and facility running costs.

Sometimes offerings are very different, the service is new or organisations do not have clarity on internal costs and therefore do not have a suitable benchmark to work from. If existing costs are not known then data is now available

Figure 6: Cost and transparency trends



on server maintenance costs: the EURECA project [10] recently calculated that the average unit cost to public authorities for maintaining a single server is around €14,000 a year [11]. This includes capital depreciation, facility management, energy, staffing, etc. and was estimated from an assessment of efficiency in 350 public sector data centres across Europe. So if costs have not been adequately apportioned in the past, this could provide a ball-park estimate.

Box 3: Anecdotal comment from EURECA project
A local authority was reluctant to move activity to cloud for €30,000 a year because the cost was too high, and they "paid nothing" for their existing in-house arrangements. After some investigation it was revealed that the internal costs were actually around €150,000 a year. Lack of internal transparency had prevented them from seeing the business case.

Further complexities arise if functionality changes: Many individuals have commented that, when their organisations moved functions like email to cloud, storage limits increased by an order of magnitude on their inboxes. If you are getting ten times the functionality for the same kind of cost, then it is a pretty safe bet that efficiency has improved dramatically somewhere along the way. On top of this there may be changes in scope, in productivity, or a service may be completely new which all make comparisons hard. This is why we need more than just the single criterion of cost…

ii) Energy source: proportion of renewables

The practice of reducing carbon impacts by purchasing renewables can be rather contentious because energy markets work differently in different countries. In the UK for instance the nature of the electricity market means that renewable purchases from utility providers do not necessarily drive investment in renewable generation – they just take up existing supply. Secondly, purchasing renewable power should never be a substitute for reducing demand through energy efficiency. However, buying certified renewables definitely makes a positive statement about organisational values and also demonstrates commitment to a future market for low carbon energy. Moreover, the recent trend towards Power Purchase Agreements (PPAs) [12] is a positive development: Rather than taking up existing supply, PPAs actually drive investment in additional renewable generation by providing financial security for projects. Google is taking a leading role here and is the world's largest corporate purchaser of renewable energy with 34 agreements in place since 2010 [13]. Typically, cloud service providers are actively procuring renewable energy and Greenpeace has been monitoring this with their #ClickClean campaign [14].

Box 4: Idle running
In reality things are more complicated than this: there are different kinds of "idle" and there are cases when low utilisation could be deemed efficient but for the purposes of this rough analysis our simplistic explanation is probably sufficient. If you want to know more about how the industry optimises server efficiency at different levels of activity have a look at the SERT metric. See www.spec.org

Energy sources can also be used to validate, or at least sanity-check, claims made by service providers about carbon. Operators using renewable power should always be able to produce relevant certification.

There are standardised methodologies for assessing renewable energy sources. The Greenhouse Gas Protocol, the most widely used global standard for carbon accounting, includes a methodology for dealing with renewables. Secondly, a performance metric applicable to data centres has been developed called the Renewable Energy Factor or REF. It is now supported by the international standard ISO/IEC 3013.

iii) Utilisation

Utilisation, simplistically speaking, is a measure of how busy a computer server is. Servers need to be ready to work instantaneously, so they remain switched on all the time. A server that is waiting for work is termed to be "idling" or running "in idle mode". Even when servers are not productive they use energy. Generally speaking, servers should be busy so that the maximum possible amount of work is shared between the minimum possible number of servers. Cloud providers are in theory best able to optimise utilisation by matching workloads to capacity, moving them whenever necessary.

Utilisation varies a lot. It can be low for many reasons, including:

- Legacy servers - when servers have been in place a long time and aren't doing anything but nobody can quite remember what they are there for, due to institutional amnesia, poor record keeping, staff or organisational changes, so daren't turn them off. Traditionally the "safe" thing to do with these "zombie" servers has been to treat them like sleeping dogs and leave them quietly chuntering on.
- New servers are purchased for new applications when those applications could be accommodated on existing machines.
- Failing to "right size" a procurement which means that more capacity has been acquired than is necessary and it is then inevitable that the hardware will be underutilised. This happens because the procurement team may not be familiar with efficiency improvements in ICT hardware and specify a one-for-one server replacement ratio when in reality one modern server can do the work of multiple legacy (older) machines. This is surprisingly common and has also been known to happen in outsourcing contracts. Over-provision of this kind is very inefficient.

Therefore, information on approximate utilisation levels and how server optimisation is achieved is important. Service providers may be able to demonstrate that they use automated software tools that perform real time analysis and maximise utilisation.

Typical utilisation rates vary by data centre business model. The highest utilisation rates tend to be in shared cloud environments, where activity is moved around and can make use of spare server capacity irrespective of where that server is. Lower utilisation rates are likely in dedicated environments. In-house data centres often have the lowest of all. The recent EURECA project examined 350 public sector data centres and recorded utilisation rates between 15% and 25%, averaging just over 20%. If your cloud provider can prove significantly higher utilisation then you are likely to be moving in the right direction by outsourcing.

Figure 7

Server utilisation, public sector, from a study of 350 public sector data centres, EURECA project, 2018

iv) PUE

As mentioned above, PUE or Power Usage Effectiveness is the ratio of the total energy used by the data centre to the energy used by the IT housed within it. So a PUE of 3 would mean that one third of the energy consumed by the data centre is used by the IT systems. The other two thirds are used by supporting infrastructure like cooling. The lower the PUE, the more efficient the overall operation and providers often compete on the basis of their PUE.

PUE, public sector, from a study of 350 public sector data centre, EURECA project, 2018

Average PUE in the commercial sector is around 1.7 [15], and cloud providers are reporting figures approaching 1.1. Recent figures from the EURECA project suggested that public sector PUE is around 4. However, there are many ways of measuring PUE and it is important to ensure that what is quoted is operational (actual) PUE based on aggregated energy measured and averaged over a period of time like a year. The commercial sector's PUE is measured in this way and reported publicly via the CCA. While "Design PUE" indicates a facility's potential efficiency, it may never achieve this in practice, and "Instantaneous PUE" only gives a spot reading. Ideally, PUE should be measured in accordance with international standards, ISO/IEC 31034-2/EN 50600-4-2.

Figure 8

v) Optimal refresh

"Server refresh" really just means replacing older servers with new ones. Because of the rapid evolution of processor technology, server performance and efficiency tend to double approximately every 18 months. Servers tend to use power continuously because they operate 24/7 so their life cycle carbon impacts are heavily dominated by the use phase. As a result, it is environmental good practice to replace older servers with new ones on a regular basis. This runs contrary to perceived wisdom that assets should be sweated as long as possible.

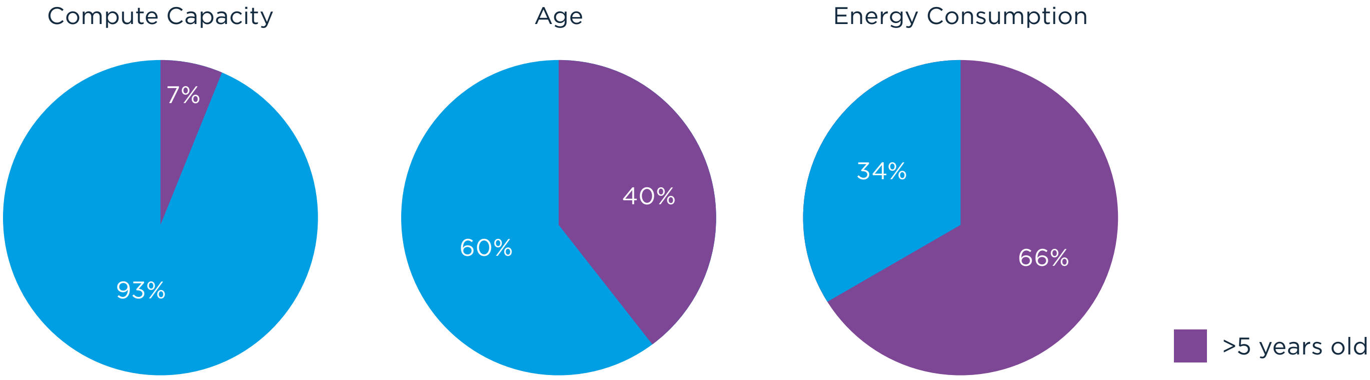


Figure 9: Server age and performance
More figures extracted from the EURECA project, 2018. 40% of servers in public sector data centres were over 5 years old. These performed 7% of compute but used 66% of power.

The large hyperscale operators may replace the central processing units as frequently as every 12 months but two to three years is more common practice. Servers over five years old are unlikely to contribute to an efficient operation. In general, third party providers are incentivised to optimise refresh rates, compared to in-house operations where the data centre is not run as a business unit.

Although there are currently no formal standards for identifying the best point to replace servers, there are many studies that provide useful references. Refresh rates are not dictated purely by the point at which the efficiency gains of the new server exceed the embodied energy burden of installing new kit. A range of other sustainability factors like disposal, materials sourcing and pollutants have to be taken into account. The extract below, from the paper "A Comprehensive Reasoning Framework for Hardware Refresh in Data Centres [16] " sets out the kind of factors that should be included in calculating the optimum refresh cycle. These factors were also assessed in detail in an earlier study which attributed higher weighting to the more uncertain impacts [17].

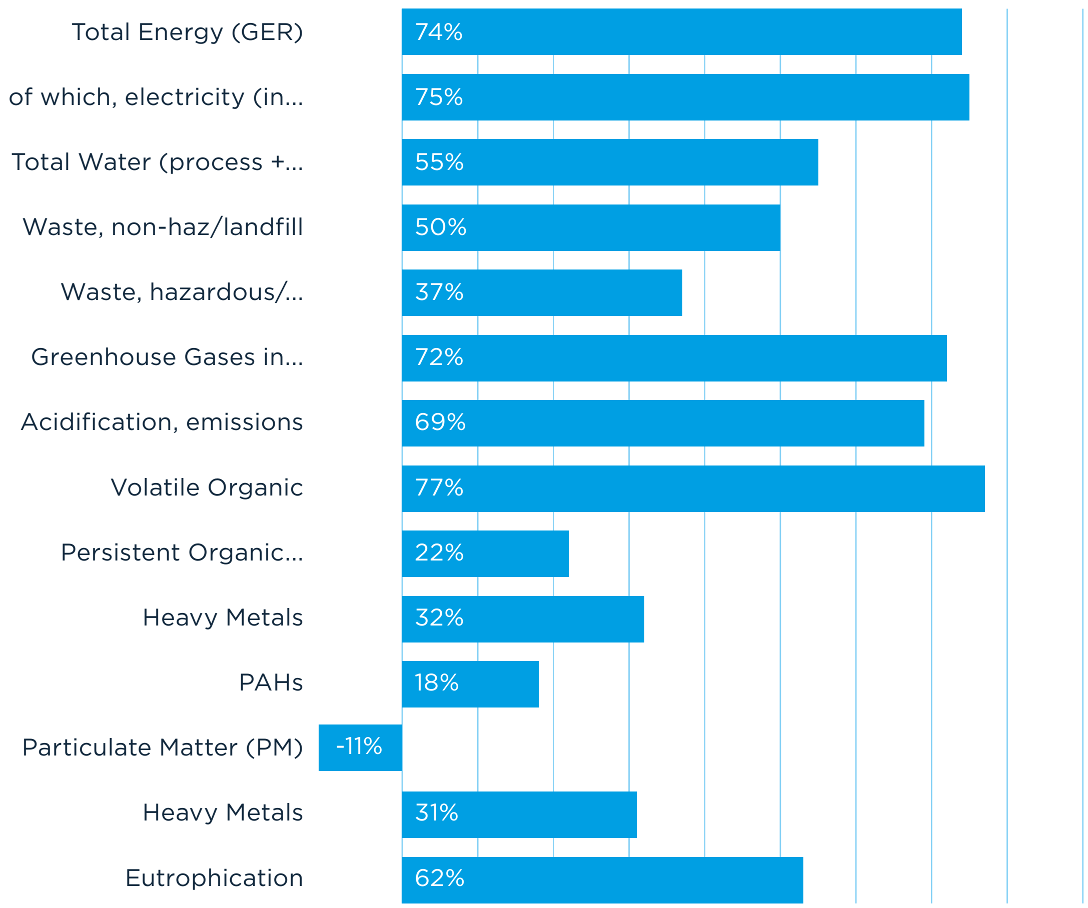


Fig 10: Percentage change in environmental impact for the given hardware refresh scenario (4.5 years) showing significant improvement in all indicators, except for Particulate Matter which is 11 percent worse off.

d) Learning from others – research, case studies and projects

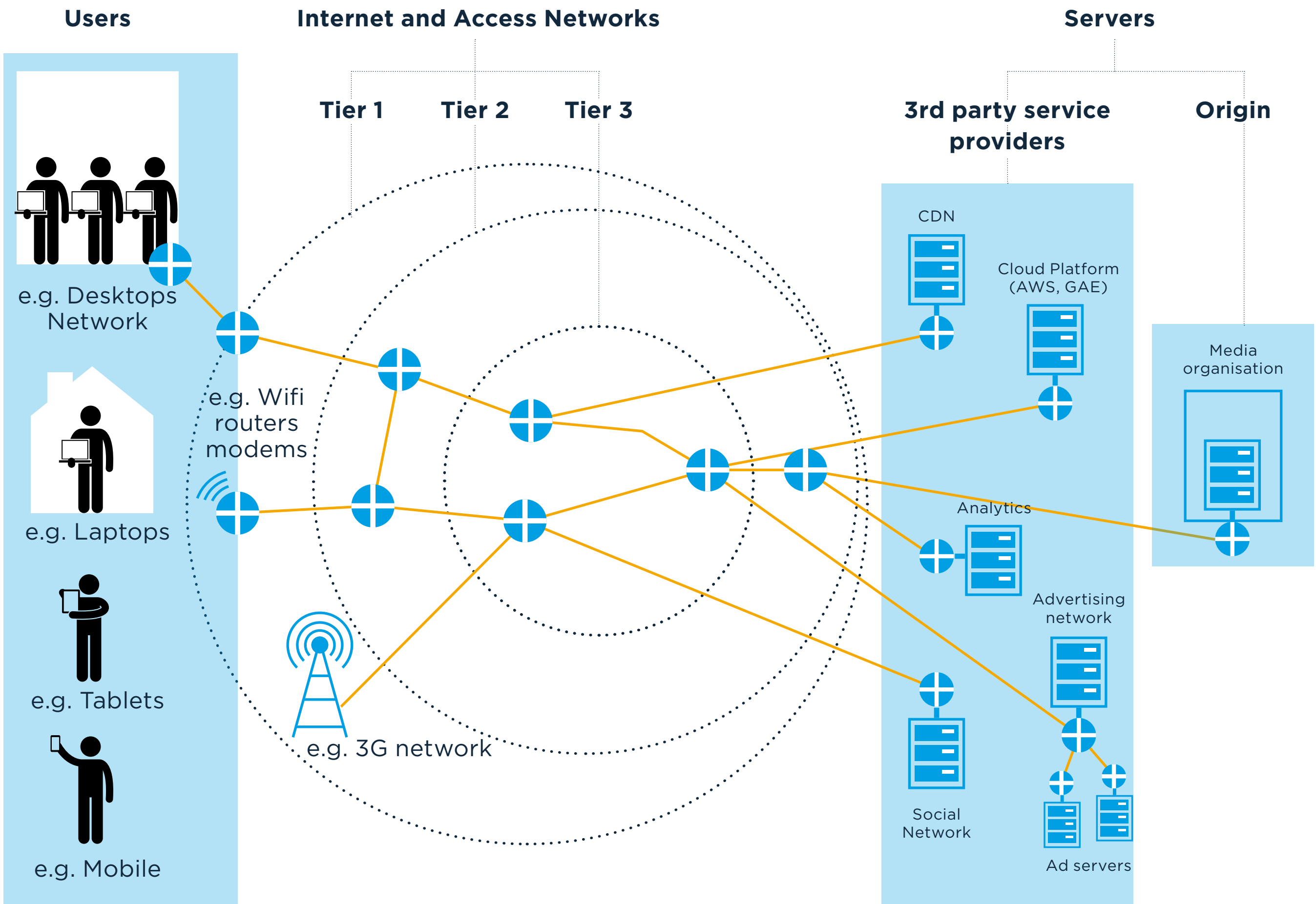
Cloud computing is a relatively recent business model but the body of relevant literature is rapidly growing. Previously, studies focused on the broader topic of the growth of digital activity and the consequential energy consumption of infrastructures and devices. On the more specific topic of the relative efficiency of cloud computing compared to conventional enterprise IT, most studies are by academic institutions, cloud providers or industry bodies. Some examples are summarised below.

i) Academic institutions

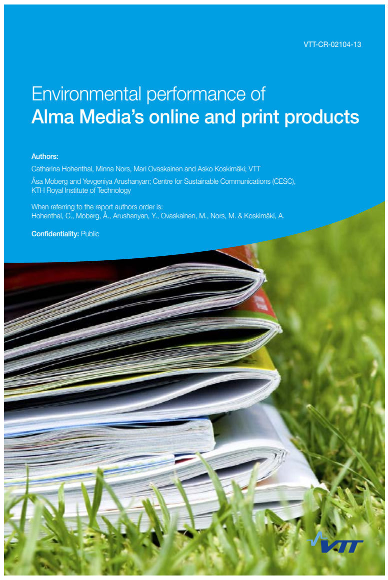
Energy use and greenhouse gas emissions in digital new media: Ethical implications for journalists and media organisations: Guardian Research 2014: S. Wood, P. Shabajee, D. Schien, C. Hodgson and C. Preist

This paper explores the impact of internet-based media products on carbon emissions in conjunction with media companies who wanted to understand how best to manage the carbon footprints of their digital services. The study finds that digital emissions are of material importance, were determined by more actors than physical products, and that reduction initiatives are more likely to conflict with commercial priorities like advertising. It concludes that digital media delivery has implications for ethical journalism.

https://www.tandfonline.com/doi/full/10.1080/21670811.2014.892759



Environmental Performance of Alma Media's online and print products: KTH Royal Institute of technology, Centre for Sustainable Communications: C. Hohenthal, A. Moberg, Y. Arushanyan, M. Ovaskainen, M. Nors, A. Kostmaki



This report concludes that the impacts of printed and digital media differ by type and distribution: physical media impacts are focused on production and distribution: digital media on distribution and consumption. The comparisons, however, are not simple and analysis is hampered by data gaps. Moreover the two forms may be consumed by customers in combination rather than as alternatives, which complicates comparisons.

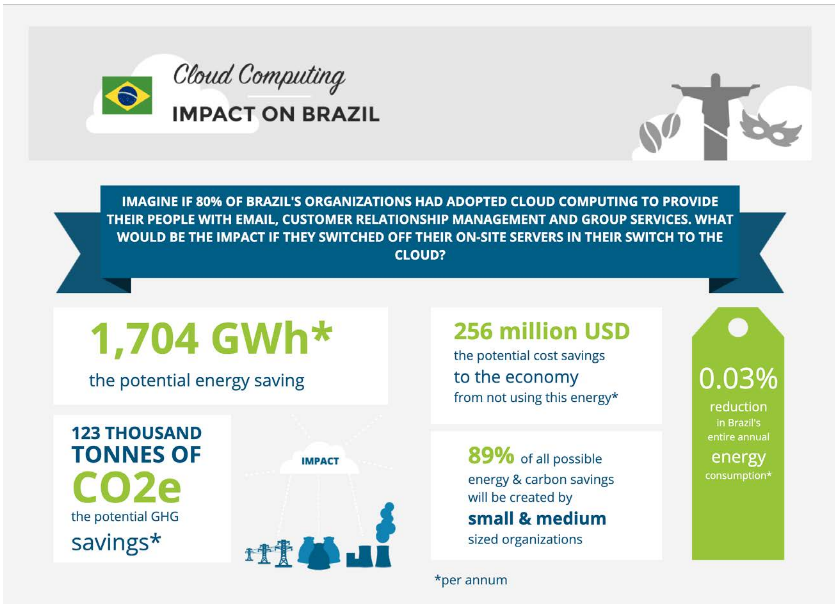
https://www.vtt.fi/inf/julkaisut/muut/2013/VTT-CR-02104-13.pdf

ii) Industry associations

GESI Cloud Impact Calculator:

GeSI, the Global eSustainability Initiative, has developed a calculator showing the savings attributable to a migration to cloud computing at national level. It is based on a number of variables. There is scope to adjust the degree of outsourcing and to explore the impacts for different nation states.

http://www.gesicloudimpact.org/emission-calculator?ar=80&cc=br&cs=small&tt=all



iii) SMEs

UKCloud White Paper: Greening Government ICT: How cloud can help.

UKCloud already provides detailed data on the carbon associated with their cloud services for government customers, which is offset. The company has produced a guide explaining how government departments and other public sector bodies can use cloud to help them meet the objectives of the digital strategy and greening ICT strategy. The report also includes several worked examples and case studies.

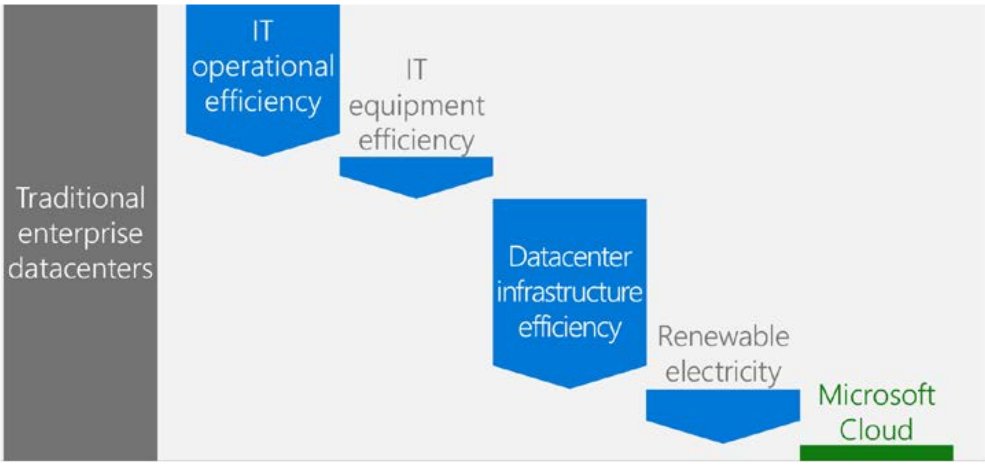
https://ukcloud.com/wp-content/uploads/2019/05/greening-ict.pdf

iv) Hyperscale cloud providers

Microsoft: the carbon benefits of cloud computing.

This report explains how Microsoft cloud delivers between 72% and 93% reduction in carbon compared to conventional computing. It also sets out Microsoft's carbon policies, processes and achievements.

https://www.microsoft.com/en-us/download/confirmation.aspx?id=56950

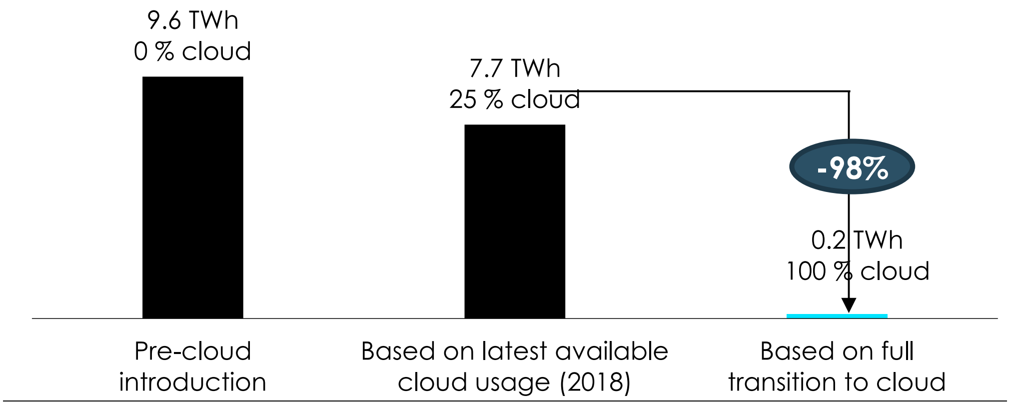


Google: European Data Centres.

Google's 2019 Environmental Report covers its credentials, policies, processes and achievements, especially renewable energy purchasing:

Google has also produced an economic report on European hyperscale data centres. This includes an assessment of energy savings attributable to the movement of activity from enterprise to cloud, which they estimate to be 98%.

Figure 25 Electricity savings by moving to cloud-based e-mail services
TWh



Note: The Eurostat survey data provides binary yes/no information on cloud use, without capturing the type of setup chosen by businesses that report not to use cloud. Since some of those may be using off-site servers, the 7.7 TWh figure may be overestimated insofar as some of those Eurostat respondents rely on more energy efficient solutions for their servers than the standard in-house server.

Source: Copenhagen Economics based on Eurostat(isoc_ci_eu_en2, sbs_sc_sca_r2, nrg_pc_205) and Google(2011), Google's Green Data Centers

IV. Conclusion

Customers are seeking more transparency regarding the energy associated with the cloud services they procure. While by its nature, cloud computing is far more efficient than alternative approaches, customers cannot simply assume this. Businesses and public sector bodies increasingly require scope 3 accounting and need robust energy data to inform decision making regarding their digital assets and activities. Consumers too need to understand the energy impacts of their online activity. Whether at work or at home we all need to be responsible digital citizens, but without insight into our impacts we will struggle to make the right decisions.

Cloud computing workloads are virtualised and moved not just between servers and facilities but between regions in order to optimise hardware resources and minimise energy consumption. Cloud business models are also complex with applications underpinned by several different providers. This makes the accurate attribution of energy to individual customers extremely complex and calculating detailed and accurate data for every cloud service could be very technically challenging.

Nevertheless, customers do have options and should not be afraid to ask their supplier. An increasing number of organisations are doing this, which is driving a higher level of expectation that information will be provided. Large media organisations have conducted or commissioned footprinting studies to inform their cloud procurements, but these are costly and may be unappealing for smaller organisations. The reality is that while customers would welcome more granular data, many only need to know whether outsourcing to cloud will be a positive or negative environmental move in order to inform their decision making. For this purpose, applying some simple rules of thumb like cost, energy source, utilisation, PUE and server refresh may help.

We anticipate that over time, transparency will improve for all types of cloud customer, and in doing so, other net carbon gains from cloud computing, such as lighter mobile devices and truly mobile working through online collaboration tools will also become clearer. Assessing these impacts, getting the system boundaries right and keeping pace with ever-changing technology will continue to present challenges in future. This paper is an attempt to start the discussion, which looks set to continue for some time.

IV. Further information and contacts

Our publications

Cloud 2020 and Beyond

Cloud Business Guide for Business Leaders

techUK Cloud week review

Technology Delivering CO2 Reductions

Data centres and power: fact and fiction

High tech: Low Carbon

Ten Myths About Data Centres

Author: Emma Fryer

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Special thanks to members of HMG Sustainable Technology Advice and Reporting Team whose insights and support have been invaluable to this discussion paper.

End notes

1 Emissions are classified by the Greenhouse Gas Protocol into three scopes:

Scope 1: These are emissions that arise directly from sources that are owned or controlled by the company, for example fuels
Scope 2: These are the emissions generated by purchased electricity consumed by the company
Scope 3: These emissions are a consequence of the activities of an organisation but occur from sources not owned or controlled by the organisation. For example, waste, water, business travel, commuting and procurement.

2 A colocation data centre (also spelled co-location, or colo) or “carrier hotel” leases space to customers who “co-locate” their servers. Customers may take halls, cages, racks or part racks.

3 For example, Crown Hosting provides full disclosure of customer energy

4 See https://www.gov.uk/government/collections/ict-strategy-resources#greening-government-ict

5 Government now includes requests for information on carbon impacts in pre tendering for cloud services and responses are monitored by HMG Sustainable Technology Advice and Reporting Team (STAR).

6 See HMG Sustainable Technology Strategy 2018-2020: https://www.gov.uk/government/publications/greening-government-sustainable-technology-strategy-2020

7 https://greenelectronicscouncil.org/wp-content/uploads/2019/03/GEC-Sustainable-Cloud-Services_Purchasers-Guide_FINAL-March-2019.pdf

8 see https://susproc.jrc.ec.europa.eu/Data_Centres/index.html

9 http://www.ghgprotocol.org/guidance-built-ghg-protocol

10 See www.dceureca.eu

11 Figures from the EURECA project: www.dceureca.eu

12 commercial PPAs are fixed term contracts directly with the generator. This approach facilitates the financing of new, utility-scale, renewable energy generation projects.

13 See page 26, https://services.google.com/fh/files/misc/google_2019-environmental-report.pdf

14 http://www.clickclean.org/uk/en/

15 Based on audited, measured data from the Climate Change Agreement, 2018 the commercial sector’s PUE was 1.7. The scheme applies very strict reporting criteria so caution should be applied when comparing these results with PUE measured under other conditions.

16 Author: Dr Rabih Bashroush, Published by IEEE: see: https://ieeexplore.ieee.org/document/8263130#full-text-header

17 The life cycle assessment of a UK data centre: Dr Beth Whitehead, International Journal of Life Cycle Assessment, 2015: https://link.springer.com/article/10.1007/s11367-014-0838-7

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