Attributing carbon to cloud

Emma Fryer, September 2019

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Organisations, whether commercial or public sector, are increasingly outsourcing their digital activity to cloud: some are adopting external providers for new applications and retaining traditional functions in-house, while others are winding down their distributed IT and divesting their data centre assets in order to move everything to third party providers. There are compelling reasons for this: the opportunity to move away from a capex-intensive business model to flexible service delivery on a pay-as-you-go basis is one: commissioning, designing, building and operating an enterprise data centre is not for the faint-hearted or the shallow-pocketed, so organisations for whom data centres are not core business are finding cloud very attractive. Cost is usually a significant factor and the choice of public, private and hybrid models addresses sensitivities about data security and control.

Cloud computing is also significantly more energy efficient than more traditional alternatives. A study by Microsoft[1] demonstrated that moving to their cloud environment would deliver a 93% reduction in carbon per user over a traditional enterprise data centre and a Copenhagen Economics study for Google[2] estimated a 98% overall energy saving based on full transition to cloud. These savings are delivered through a combination of IT hardware and operational efficiency and data centre infrastructure optimisation, plus other approaches like renewable energy purchasing.

In principle it is easy to see why cloud computing is efficient: simplistically speaking, cloud is the culmination of technical trends like virtualisation and consolidation. Workloads move to where there is capacity and this allows hardware and supporting infrastructure to be optimised, increasing utilisation and minimising resource use. Cloud services are often location agnostic which enables operators to develop facilities close to under-used renewable sources in places like Scandinavia.

Although these benefits may seem obvious, they can be hard to prove. How can a public authority demonstrate in a Select Committee hearing that their move to cloud has been a sustainable transition? How does a business report its Scope 3 carbon when significant activity is outsourced in this way? When companies run things in-house, 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 delivered by a third party the energy impact of that activity may be less transparent. Organisations need to attribute energy and carbon to these cloud services robustly enough to be confident that their outsourcing decision is indeed delivering environmental benefits. Even more importantly they need to identify occasions when it does not.

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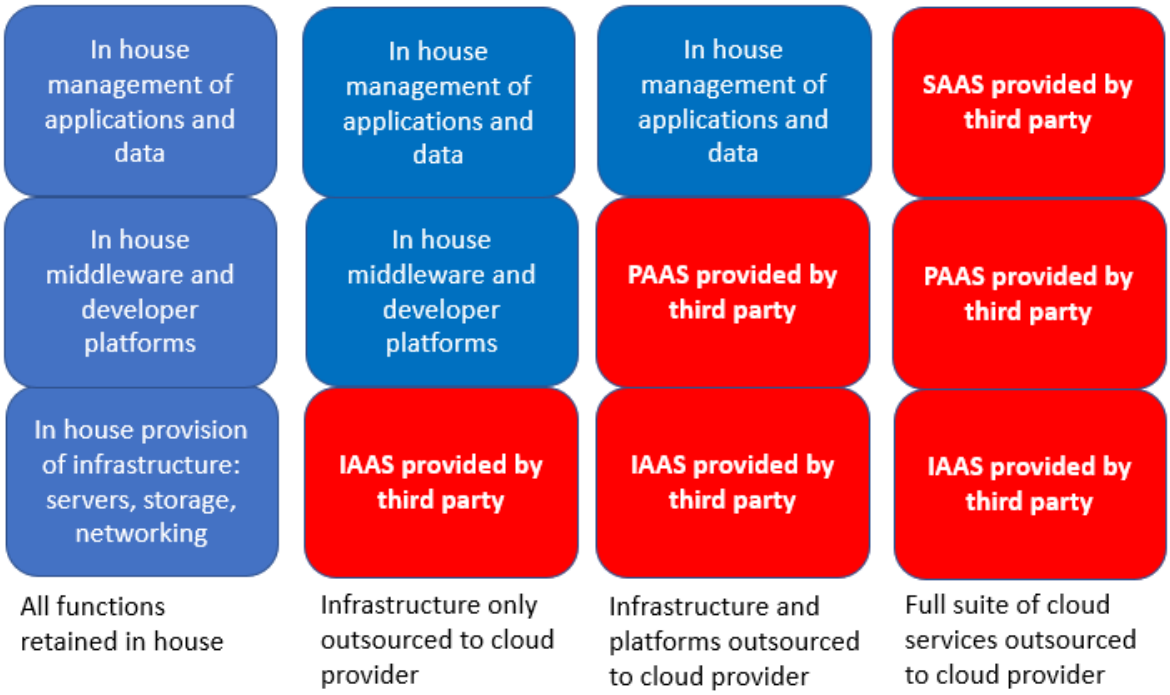
[1] See The Carbon Benefits of Cloud Computing: https://www.microsoft.com/en-us/download/confirmation.aspx?id=56950

[2] Copenhagen Economics, European Data Centres: https://www.copenhageneconomics.com/dyn/resources/Filelibrary/file/9/109/1525764693/copenhagen-economics-2018-european-data-centres-case-study-ireland.pdf

When it comes to attributing energy and carbon to a cloud service, it's trickier than you might think. The nature of cloud means that tracking the carbon associated with a particular activity or customer can become fiendishly complex very quickly. Workloads are virtualised and moved not just between servers and facilities but between regions in order to optimise hardware resources and minimise energy consumption. Different operational efficiencies apply when facilities change, and carbon conversion factors differ between countries.

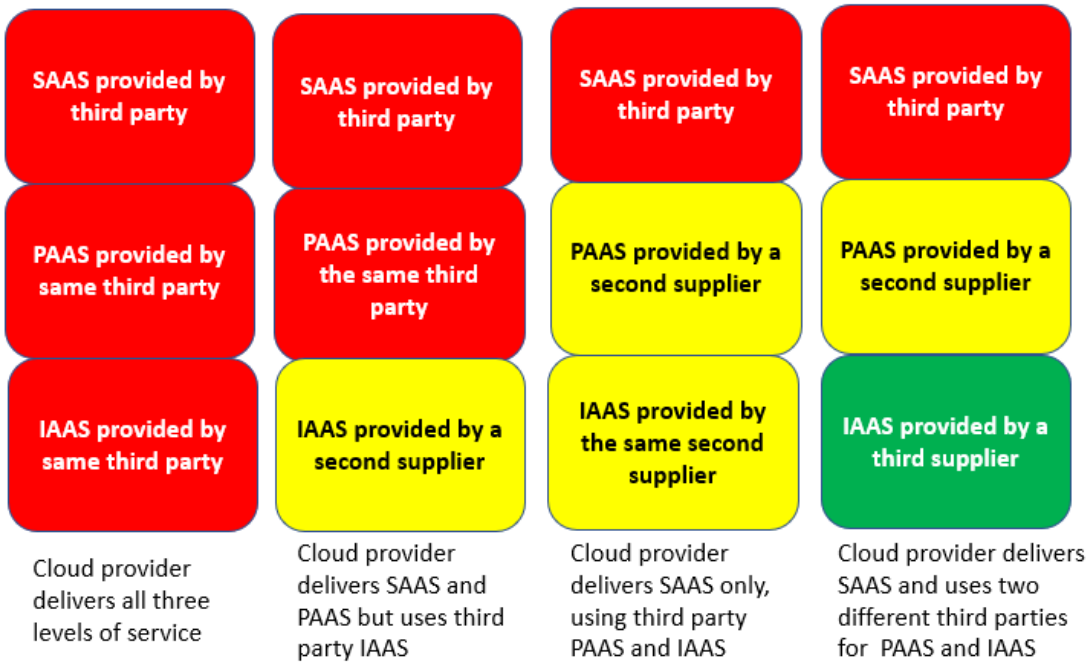
The cloud business model also adds layers of complexity because it is not a single service but a combination of application, platform and infrastructure. SAAS, or Software as a Service, provides the customer with remotely managed software applications usually delivered via the internet, as well as the 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. Customer can opt for application, platform or the whole suite, as shown below.

Figure 1: Simplified Cloud business model



But it gets more complicated still, because a single cloud application may be underpinned by several different providers, as shown in the diagram below, so there could be multiple sets of energy data to report and attribute:

Figure 2: Cloud outsourcing options



So, with these challenges in mind, how do customers establish the energy associated with the cloud services they buy? Firstly, they should ask their supplier, ideally at the pre-procurement stage, where they can use criteria like those developed by the Green Electronics Council[3] for sustainable cloud procurement. Public sector bodies in particular are already doing this and report that only UKCloud[4] provides the granular data they need, but that the indicative figures provided by others go part of the way. The more these requests are made, the more likely that information will be provided.

If the supplier cannot help, another route is to calculate carbon using a tool like the GHG Protocol, or to commission a third party study. Large media organisations have conducted or commissioned footprinting exercises to inform their cloud procurements, but these are costly and may be unappealing for smaller organisations.

The next option is to establish how the supplier performs. Currently, many customers 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 they may be able to apply simple rules of thumb, using a combination of factors like cost, energy source, PUE[5], utilisation and server refresh. Metrics like these are increasingly supported by international, peer reviewed standards to ensure they are robust and applied consistently.

Alternatively, customers can make use of academic or commercial research or case studies where they can compare what they are doing with a worked example where outcomes are measured.

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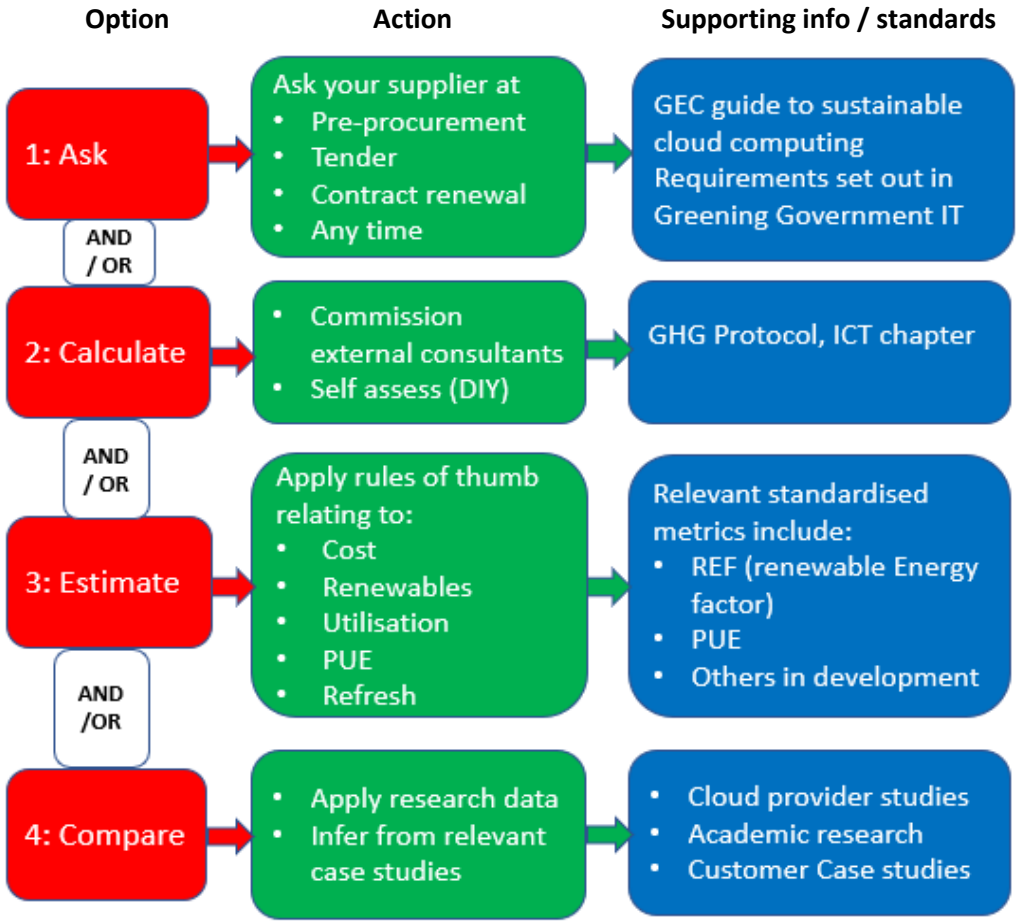
[3] GEC Purchasers' Guide for Sustainability and Cloud-Service Procurements: https://greenelectronicscouncil.org/resources-guidance/

[4] DEFRA reported in June 2019 that UKCloud was the only provider to furnish them with full details of carbon associated with a specific customer service. See also https://ukcloud.com/governance/green-credentials/

[5] PUE: power usage effectiveness, the ratio of the energy entering the facility to that consumed by the IT within it

Cloud computing is a relatively recent business model but the body of relevant literature is rapidly growing. Most studies are by academic institutions, cloud providers or industry bodies. For instance, the University of Bristol has run a long term programme of research into ICT energy consumption[6] and the way that technology trends are changing the pattern of energy use. Large cloud operators like Google and Microsoft have both published major studies of cloud energy use (see above).

Figure 3. Customer options in a nutshell



There are broader issues to consider relating to the carbon impacts of cloud. ICT is increasingly becoming a utility like electricity or water, and highly price-elastic. We flush our toilets and wash our cars with drinking-quality water because it is cheap. Similarly, the more efficient cloud is, the more we use it, and this can encourage profligacy[7]. The widely adopted freemium and advertorial business models are very effective in driving innovation, but do not give consumers any indication of the carbon impact of their digital activity. That said, the same price-elasticity that fuels uptake also

[6] E.g. Analyzing End to End Energy Consumption for Digital Services: https://research-information.bristol.ac.uk/en/publications/analyzing-endtoend-energy-consumption-for-digital-services(6a2efdbc-32cd-4e18-8065-c4da6a73437e).html and Evaluating Sustainable Interaction Design of Digital Services: the Case of YouTube: https://research-information.bristol.ac.uk/en/persons/paul-shabajee(bc16a29c-86c1-436a-a343-83eba3d5b012)/publications.html

[7] See Jevons Paradox. Jevons was a 19th Century economist who predicted that increases in production efficiency lead to greater overall consumption.

acts as a controlling valve on energy consumption: if it does escalate, the market will apply financial signals. Imagine the impact of a small charge for each picture uploaded on Facebook.

So where does that leave us? It's clear that the energy we use when accessing cloud services needs to be more transparent. While by its nature, cloud computing is far more efficient than alternative approaches, customers cannot simply assume this. Businesses and public sector bodies increasingly wish to account for their Scope 3 carbon emissions 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.

We anticipate that over time, transparency will improve for all types of cloud customer, and in doing so, other net gains from cloud computing, such as lighter mobile devices, truly mobile working through online collaboration tools may also become more transparent. Assessing these impacts, getting the system boundaries right and keeping pace with ever-changing technology will continue to present challenges well into the future.

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