Special Paper No.7

Cloud Computing – Green Giants?

"The interesting thing about cloud computing is that we've redefined cloud computing to include everything that we already do. I can't think of anything that isn't cloud computing with all of these announcements. The computer industry is the only industry that is more fashion-driven than women's fashion. Maybe I'm an idiot, but I have no idea what anyone is talking about. What is it? It's complete gibberish. It's insane. When is this idiocy going to stop?"
– Larry Ellison, CEO Oracle, 2008

The quote from Larry Ellison, CEO of one of the world's largest technology companies, demonstrates that even software experts can underestimate seismic shifts in technology. Today, cloud computing is dominated by Amazon, Microsoft and Alphabet (Google). Oracle is a laggard with a mere 2% market share[1] and Ellison's 2008 quote looks short-sighted.

This note highlights the evolution and growth of cloud computing, as well as the significant electricity usage by data centres that power the cloud and how these companies are moving towards using renewable energy. Several Troy holdings, including Microsoft and Alphabet, have data centres at the core of their business. We take an integrated approach to assessing ESG risks, alongside other business risks. It is likely that the sustainability of a company's cloud computing solution is a consideration for customers, so it is important to understand how our holdings approach the challenge. For businesses with such large electricity consumption, the environmental risk is material. Understanding how companies are transitioning to renewable energy is also an insight into the corporate culture at some of Troy's largest holdings.

Up in the Cloud

In 2001, most companies had servers in their offices. These would perform tasks such as managing employee emails, running databases and hosting a website. As the use of computers and mobile phones rose, the requirements of these on-premise servers increased and companies quickly found they were spending large amounts on servers, power, network bandwidth and IT staff.

Amazon Web Services (AWS) first launched in 2006 with the view that moving the millions of on-premise servers into centralised, shared data centres made sense from a cost, efficiency and scalability standpoint. AWS made use of Amazon's existing datacentres that were developed to support its IT platform, an opportunity missed by Oracle. These networks of centralised data centres would later be called 'the cloud'. Using cloud computing has several advantages over on-premise servers:

- Cloud computing allows multiple businesses to share servers in a secure way. The server costs are also shared, resulting in significant savings and efficiencies.
- The cloud provider makes the initial investment into hardware, to the benefit of its customers who can access the cloud at minimal upfront cost.
- The cloud enables companies to rapidly scale. Historically, adding on-premise

[1] Source: "Oracle is a distant laggard in cloud infrastructure market even after TikTok deal", CNBC, Sep 2020

server capacity would have taken weeks, limiting a company's ability to grow quickly. Cloud computing lets users scale their server capacity in seconds.

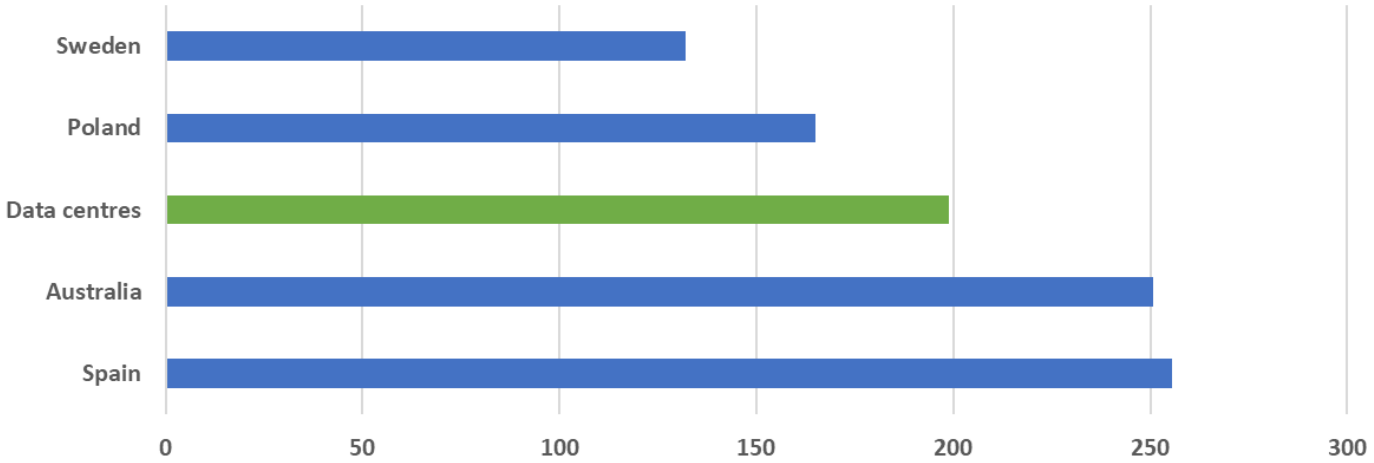
- Cloud providers manage the infrastructure for clients, reducing staff costs and improving reliability. Most cloud providers guarantee 99.99% uptime.

Like all good solutions, cloud computing also brings with it further challenges to be addressed. One issue pertains to data sovereignty, as some businesses are required to physically store data in a specific country. Public cloud providers like Microsoft's Azure platform have accommodated these concerns by launching a vast network of data centres in key countries. Another concern is around the security of handing over sensitive data to be stored by a third party. Cloud providers have teams of hundreds of engineers focused on security and can easily push automatic security updates to servers on behalf of clients. Over time, these large cloud providers have earned trust and shown that in most cases their systems are more secure than those of a company managing it themselves.

The cloud is rapidly taking share from on-premise servers; however, the immense scale of the transition means that growth is likely to run for many years. Cloud computing continues to be applied to new industries, whether it is the Renault F1 Team predicting tyre temperatures using Azure Machine Learning, or ecommerce giant ASOS monitoring cyber threats using Azure Sentinel[2]. Added to this, global computing requirements increase as our economy digitises and technologies like 5G mobile telephony and Internet of Things (IoT) produce vast amounts of incremental data. Global cloud data traffic doubled between 2016 and 2018 (to 10,606 billion Gigabytes) and is forecast to double again by 2021[3]. All the data produced has to be processed and stored, leading to an increasing need for cloud-computing that will last decades.

The huge growth in required compute power is leading to increased electricity demand from data centres, despite efficiency gains. Data centres already form a significant part of global energy use; in 2020 it was estimated they use more electricity than Poland and are not far behind Australia (Figure 1). The carbon emissions attributable to a data centre vary hugely, depending on the availability of renewable electricity in the local area. Microsoft alone has over 160 physical data centres for their Azure cloud service, spread around the world.

Figure 1 – Electricity Consumption, Countries Compared to Global Datacentres – Billion kWh

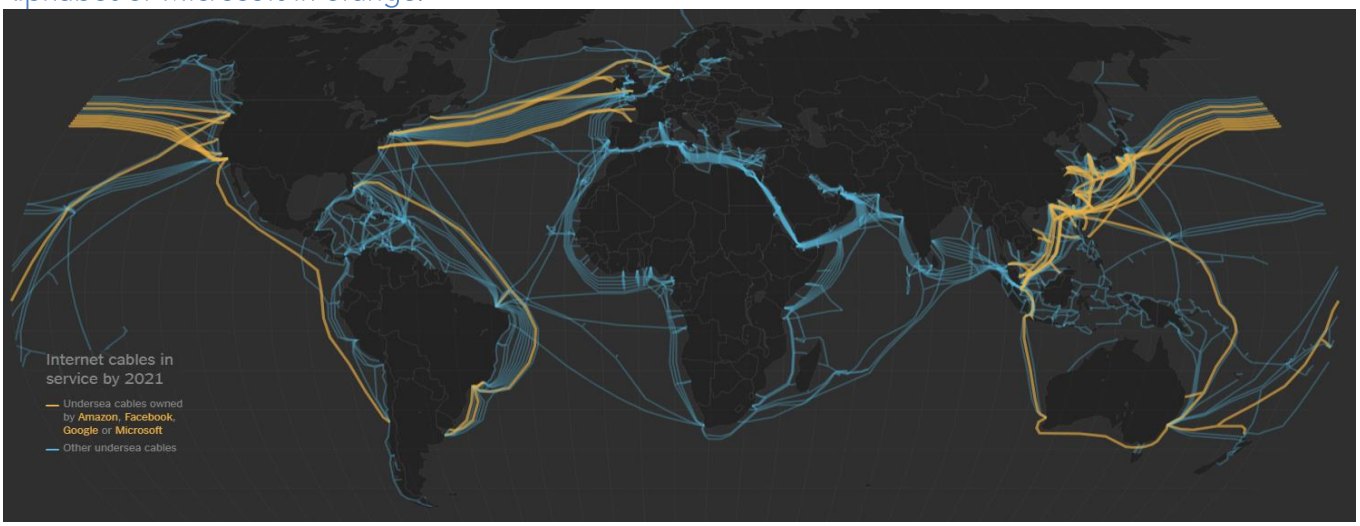


Source: International Energy Agency, 2019/2020

[2]Source: Azure customer stories

[3] Cisco Global Cloud Index Forecasts (2018)

Figure 2 – Subsea Cables Expected to be Live in 2021, With Those Owned by Amazon, Facebook, Alphabet or Microsoft in orange.



Source: New York Times

Why do we need data centres around the world?

When an internet user in London clicks on a link for amazon.com, their PC sends a request that travels through the local internet service provider's network to a subsea cable between the UK and US, eventually leading to an Amazon server (in North Virginia). The process only takes a fraction of a second, due to the high-speed fibre optic cables, but the process is not instantaneous. A few milliseconds delay can be the difference between a seamless Zoom call and the dreaded frozen video.

A key determinant of the time a page takes to load is the distance between the device and web server. Some intercontinental routes are faster than others, depending on whether a direct high-speed cable exists. If there is no direct cable, then the data must traverse whatever cables and networks exist (Figure 2 shows the subsea cables connecting the network of Azure data centres). To demonstrate the effects of server location on latency (i.e. the time from sending the request to receiving the data back), the Troy logo was hosted in five AWS data centre locations around the world. The time to load the image in London from each location can be seen in Figure 3. The Sydney location took over 10 times as long to load as Ireland, and the impact would be even more profound for complex websites, such as YouTube, with huge data requirements. To reduce the impact of latency, data centres must be spread out across the world and be close to populous areas where most users are located.

Green data centres

From an energy perspective, it would be most efficient to have all of the world's data centres in a single location with a cold climate and

Figure 3 – Troy's Data Centre World Tour

Stored File (33kb)	AWS Server Location	Average Latency Over 5 Loads
	EU (Ireland)	22ms
	US East (North Virginia)	80ms
	US West (North California	143ms
	Asia Pacific (Tokyo)	219ms
	Asia Pacific (Sydney)	291ms

Source: Troy Asset Management Limited

abundant supply of cheap, green energy (e.g. near geothermal power stations in Iceland). However, the need to minimise latency means that data centres must often be placed in warm climates, requiring cooling, or in areas with non-renewable power supplies. Due to the significant energy use in data centres, cloud computing providers have an increasingly important role in driving power grids towards renewable energy. A transition to renewable electricity can take years, so it is important to understand which businesses are leading the move towards sustainable cloud computing.

Cloud computing service providers have taken steps to tackle the root of the problem, reducing the amount of electricity required by servers to run the internet. Importantly, public cloud providers (i.e. large data centres run by AWS or Azure, with millions of customers sharing hardware) are inherently more efficient than legacy data centres (i.e. each technology company running their own data centre for their application). There are two main reasons for this:

- Utilisation rates are significantly higher in public cloud data centres. Companies like Microsoft or Amazon take advantage of the fact that the spike in one application's usage (e.g. Salesforce CRM software) is unlikely to coincide with the other's peak demand (e.g. Netflix). The average public cloud server has 65% utilisation, compared to 12-18% for an on-premise private server[4].
- Cloud computing providers are better at designing data centres. The companies are specialists and have accumulated decades of knowledge, leading to a significant reduction in electricity used in cooling, power distribution and lighting.

The upshot is that, according to Microsoft, an Azure compute server uses 79% less power than a company's on-premise server.[5]

Energy also represents a significant portion of the cost to run a data centre, therefore the improved efficiency has enabled savings for cloud users. This has, however, contributed to rapid growth in the number of applications and amount of data traffic, engendering a circularity whereby energy efficiencies are partially offset by the increase in data traffic. While most applications have little environmental benefit, there are some specifically aimed at carbon reduction. These include Google running machine-learning algorithms to control the cooling in their data centres, or a factory optimising their production to reduce wasteful energy use.

Greenwashing

Companies including Facebook, Apple, Alphabet, Microsoft, Amazon and Adobe have committed to using 100% renewable energy within a specified timeframe. The effect of these policies should be to replace carbon-intensive electricity production with renewable energy. There is, however, devil in the detail. Some other companies use the term 'clean energy' in their commitments but, in the past, included nuclear or even natural gas in this definition. 'Renewable energy' in this report refers to solar, wind, hydropower and geothermal. Most new installations are wind or solar with these typically being installed together to reduce the need for expensive energy storage equipment.

'Net zero' targets often involve buying local, carbon-intensive electricity and attempting to offset it. The offsetting method is often unclear and may involve planting trees (which does not increase renewable energy construction) or involves other greenhouse gases, such as methane. The most robust commitments are for '100% renewable energy'.

Once electricity has been generated, it is impossible to tell 'renewable' electricity from

[4] 'Cloud Computing, Server Utilization, & the Environment' AWS blog post (2015)

[5] 'The carbon benefits of cloud computing' – Azure (2015)

that generated in a coal power plant; therefore, a system of renewable energy credits is used. These are awarded as renewable electricity is generated and can be sold to consumers as proof that their electricity is renewable.

Renewable energy credits can also be bought and sold by corporates. States such as Texas have excess supply of renewable energy credits because tax incentives have encouraged the building of renewable energy plants. As a result, the price of a renewable credit here can be many times lower than in other states. Some companies have form in building a data centre in one state and buying renewable credits from another, where credits are cheaper. A company with a data centre in Virginia, buying renewable credits in Texas, is not helping incentivise green energy investment even though this allows them to claim they use '100% renewable electricity'. In our analysis, the first and most important step for a company in addressing problems of any kind is full transparency in their disclosure.

Three Kings

Both Microsoft and Alphabet are held in Troy's multi-asset portfolios and have taken steps to ensure their growing cloud businesses minimise carbon emissions. Alphabet was one of the first technology companies to announce a 100% renewable energy target in 2012, when only 34% of their electricity was from renewable sources. In 2018 the target was met. Alphabet is also unusual in explicitly stating that all the renewable energy credits they retire are from the same electricity grid as their operations. In 2020 Microsoft provided an update on their progress. The company is targeting 100% renewable energy across the business by 2025 and already reached 60% in 2018. They also went further and said that by 2050 Microsoft will have removed all CO_2 emitted directly or indirectly through electricity usage since the group was founded in 1975, using negative emission technologies.

AWS has generally been less transparent than peers and for a long time did not commit to a date to reach 100% renewable electricity. The company recently announced a pledge to reach 100% renewable energy by 2025. The target compares to 17% renewable energy in 2016 and "above 50%" in 2018. It is not yet clear by which means this will be achieved.

Due to the aforementioned benefits of scale, it is logical that AWS, Azure (Microsoft) and Google Cloud (Alphabet) enjoy a combined market share of 61% in a cloud infrastructure market worth $129bn[6]. We expect these businesses to power the digital world in the decades ahead and think the market continues to underestimate how big public cloud can become.

We view Microsoft and Alphabet as leaders in sustainability and expect this to be a competitive advantage as awareness grows. Both Microsoft and Alphabet have younger cloud businesses than AWS but they are rapidly gaining share and scale. Despite the three businesses generating ~$75bn of revenue, the cloud market is still relatively immature and represents only 10% of total IT spend. With tech spend as a percentage of GDP expected to double over the next decade, these companies look set to share a larger slice of a growing pie. With financial strength comes responsibility, and it is critical that we continue to monitor their progress in contributing towards a greener future.

Both Microsoft and Alphabet remain core holdings in Troy funds.

Marc de Vos April 2021

[6] Source: Statista, 2021

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