Chapter 8

An Increasing Ecological Threat

> For all the mobile phones in the world today, the metal in them would have required 450 million tonnes of rock to be dug up, smashed and processed. This is equivalent to 12x the weight of all the cars on UK roads.
>
> The Great Recovery – eWaste

> We need to be more responsible about what we use the internet for … Data centres aren't the culprits – it's driven by social media and mobile phones. Its films, pornography, gambling, dating, shopping – anything that involves images. It's a great example of the Jevons paradox – the easier you make it to consume the product the greater the consumption will be.
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> Ian Bitterlin

The Ecological Fallacy of Digitalisation

Although we live in an era of unprecedented technological, scientific and financial development and resources, risks to the global community are also increasing apace and show little signs of diminishing to any great extent. Rules-based multilateralism is under threat in the face of a rise of national self-interest, nativism, protectionism and populism, making efforts at global collective action much more difficult to achieve. There is no issue more pressing at this moment in time for such global cooperation than that of the climate emergency that faces humanity. Climate change is the ongoing increase in average temperature in the earth's atmosphere and the consequences of that rise. The impacts of global warming include changes in rainfall patterns, more extreme storms and weather events, heatwave and drought intensification and rising sea levels right across the world. While there have been previous periods of climatic change in the distant past,

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most of the observed increases in global average temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas emissions.[1] According to the Intergovernmental Panel on Climate Change (IPCC), there is scientific consensus on this issue: that most of the global warming since 1950 has primarily been caused by humans.[2] Yet efforts to tackle climate change are fraught with political and regional difficulties, and many of today's world leaders and key decision-makers appear either paralysed in procrastination or unwilling to acknowledge this scientific consensus. Technology has been lauded in the past for its ability to dematerialise many features of the contemporary world – remember the paperless office – and can be a double-edged sword capable both of doing and undoing damage caused to the environment. There have been innovations in power generation, transport, food, manufacturing and construction made possible by new emerging technologies, but the reality is that digitisation is also now contributing to the climate emergency and putting additional pressure on the planet from several different directions. The consumption of electronic equipment necessary for digital information and communication technology (ICT) is growing at an immense rate while, at the same time, recycling of much of the precious and scarce minerals and materials that go into making up many of these devices is minimal. Recycling or reusing old mobile digital devices can have a positive impact on the environment by saving energy, protecting natural resources and put a stop to many of these scarce minerals and materials going to landfill. Mobiles, smartphones and tablet devices are all packed with reusable materials including precious metals, plastics and copper, and recycling these devices means these materials can be conserved while limiting the air and water pollution that is the result of the mining and production of such devices on such a vast scale. But recycling rates for such digital electronic devices is generally poor.

As digital technology becomes more routine in the workplace, in education and in the home, the need for more and more energy to run our every increasing number of gadgets and technologies must also keep pace. This electrical energy is frequently generated using fossil or nuclear fuels on a considerable scale. Previous generations did not require such levels of energy and power to be available 24/7, unlike the levels we now need to run all these gadgets, in all weathers and seasons. But it's not only about our energy consumption in the home, at work or in education; the overall carbon emissions from the digital ecosystem is significant, not least from the growing number of energy-intensive global data centres springing up all over the planet. With so many people now online with a thirst for expecting whatever, whenever and anywhere, this places even greater pressures on the physical infrastructure underlying the digital world, with consequences for the planet. Heretofore, there has been little public acknowledgement of these ecological pressures from digitisation, and most digital practices and actions are perceived to be positive for the environment. In addition, outsourcing hardware

[1]Masson-Delmotte et al. (2018).

[2]Global warming of 1.5oC | special report. (2018). *The Intergovernmental Panel on Climate Change (IPCC)*, October. Retrieved from https://www.ipcc.ch/sr15/

to the cloud further breaks our link with the truth of its actual impacts. In fact, the ecological pressures from digital ICT tends to be small in individual cases but universal in use and consumption, and widely dispersed across many people and organisations, and there is little systems thinking with regard to overall digital environmental impacts. What's more, despite their public persona as progressives, the biggest and most influential tech companies are now making deals and partnering with oil companies, the aim of which is to streamline, improve and render oil and gas extraction operations more profitable. Rather than using their cutting-edge innovation, skills and experience to mitigate the direst threat to human civilisation at this moment in time they are helping to accelerate the process of climate change. They are also allowing their platforms to be regularly used as podiums for misinformation and falsehoods against the scientific consensus of man-made climate change, abdicating their social responsibilities in this regard and washing their hands of the consequences.

The Ecological Reality: (Over)Consumption and Mounting Waste

The consumption of electrical and electronic equipment (EEE), of which new digital ICT are a key part, is strongly linked to widespread global economic development over the recent decades. They have become almost indispensable in contemporary society, but their production and consumption can be extremely resource demanding. In addition, after their use, such equipment is commonly disposed in landfill rather than recycled, generating an unwanted stream which is referred to as e-waste. The electronics industry is typically divided between consumer electronics, electric utilities and general electronics, but it is consumer electronics that has driven most of the growth in the sector in the recent past. According to the *Global Electronic Components Market 2020 Research Report*, the worldwide market for electronic components is predicted to grow at a compound annual growth rate of about 4.8 per cent from 2020 to 2025.[3] The main drivers of this future consumer electronic growth includes rising demand for smartphones, artificial intelligence (AI) and voice recognition technology, and the replacement cycles and falling prices of many electronic devices serve to supercharge continued production and consumption. The Consumer Technology Association predicts that the US consumer technology retail revenue will be $422 billion in 2020, a 4 per cent increase compared to 2019 figures.[4] This includes sales from both standard consumer electronics revenue items such as smartphones, laptops and televisions, as well as revenue from new emerging technologies and

[3]Global electronic components market 2020 by manufacturers, regions, type and application, forecast to 2025. (2020). *360 Market Updates*, January 6. Retrieved from https://www.360marketupdates.com/global-electronic-components-market-14830923

[4]Cassagnol, D. (2020). Consumer tech U.S. sales to reach record $422 billion in 2020; streaming services spending soars, says CTA. *Consumer Technology Association*, January 5. Retrieved from https://www.cta.tech/Resources/Newsroom/Media-Releases/2020/January/Consumer-Tech-U-S-Sales-to-Reach-Record-$422-B-%281%29

streaming services. The global consumer electronics market is now valued at $1 trillion US dollars and is estimated to grow by over 7 per cent yearly between 2020 and 2026, again driven by the sale of smartphones, wearable technologies and digital home appliances.[5] What does not appear to be in doubt is that there will be exceptional growth in consumer electronics over the coming years, spurred by the production and sales in mobile computing, mobile communication devices and a wide range of assorted digital home technologies. But such large upscale in production of personal digital electronic items is followed by the unavoidable increase in waste, and the resultant ecological harm to the planet. The industry is linked to a rapidly increasing use of natural resources and energy and such highly developed and distributed systems cause substantial environmental and social problems along the entire value chain, from resource extraction to production, use and disposal.[6]

Rapid technological development and change, low initial cost and planned obsolescence[7] have all resulted in a fast-growing excess which greatly contributes to the ever-increasing amount of global electronic waste. E-waste is an ominously growing problem worldwide because the amount of such surplus is growing at an extremely rapid pace each year, and the necessary levels of recycling of such electronic equipment is not keeping pace. At least $10 billion worth of gold, platinum and other precious metals are dumped every year in the growing mountain of electronic waste that is polluting the planet, according to a 2020 UN report.[8] Overall, the value of selected raw materials from such e-waste was equal to approximately $57 billion in value. Declaring that the quantity of e-waste was increasing at an alarming rate, the report pointed to approximately 53.6 million metric tons (Mt) of e-waste generated annually, that is about 7.3 kg for every man, woman and child on the planet, and estimated that the amount would exceed 74 Mt by 2030. In the case of mobile devices such as tablets and smartphones, they contain several high-tech scarce minerals and although the quantity of these in each device is relatively small, billions of discarded digital devices must be recognised as an essential source of these precious materials. Like other electronic devices, mobile information and communication devices consist of a variety of substances such as plastics and ceramics, as well as several precious and rare metals. Specifically, the main such minerals that feature in mobile phones are palladium and cobalt, while the common materials found in smartphones are antimony, beryllium, cobalt, neodymium, platinum, praseodymium and palladium.[9] Many of these

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[5]Wadhwani, P., & Saha, P. (2020). Consumer electronics market size by product. *Global Market Insights*, August. Retrieved from https://www.gminsights.com/industry-analysis/consumer-electronics-market

[6]Welfens, Nordmann, and Seibt (2016).

[7]Planned obsolescence is the purposeful and artificial limiting of a product lifespan or a design of the product so that it becomes no longer functional or out of fashion or obsolete after a fixed period of time.

[8]Forti, Baldé, Kuehr, and Bel (2020).

[9]Gu, Summers, and Hall (2019).

are high-value, high-tech minerals and have limited natural deposits and cause significant environmental and social impacts when extracted from nature. With a current estimate of 5 billion smartphone in use across the world, mining these metals and minerals is a crucial activity that underpins the contemporary global economy, in particular the tech sector. Such extraction is fraught with issues of safety, social justice and ecological harm, with implications for human health such as drinking water contamination, a reduction in air quality and loss of vegetation and deforestation in these mining regions.

One of the more disturbing examples of the environmental cost of our remorseless desire for the smartphone and other digital mobile devices is the 'world's tech waste lake' in Baotou, China.[10] Created in 1958, this artificial lake in a remote corner of Inner Mongolia collects the toxic sludge from rare earth processing operations that go towards creating our smartphones, consumer gadgets and green tech. The area is one of the world's biggest suppliers of rare earth minerals, and it's estimated that the Bayan Obo mines, just north of Baotou, contain 70 per cent of the world's reserves of such materials. While these high-value, rare minerals have been a significant driver for the Chinese economy over the recent past, extracting them from nature has come at a very high environment cost for those living close by. The wastewater lake lacks a proper lining, and for the past 20 years, its toxic contents have been seeping into groundwater. It is trickling towards the nearby Yellow River, a major drinking water source for much of northern China, at a rate of 20–30 metres a year. Other countries too with rare earth minerals have been unmistakably exploited by those seeking to profit from the booming worldwide digital device industry. Years of violence and political conflict in the Democratic Republic of Congo (DRC) have made its vast mineral wealth an attractive and quick revenue generator, and various rebel groups have wrestled for control of its supply. The coltan mining industry in that country, and the prized metal tantalum extracted from it, is regarded as a 'conflict mineral',[11] closely linked to environmental damage and a range of human rights abuses similar to diamond mining in that country. Copper and cobalt mined in the DRC is used in a significant number of consumer digital electronics. But, it is claimed, that the human rights violations and environmental harm caused by Katanga's industrial mining industry are not only serious but also structural.[12] There are reports of extreme environmental harm being done such as the discharge of contaminated wastewater from mining operations into the Dikanga River resulting in the water being unfit for human consumption; the exposure of communities

[10]Maughan, T. (2015). The dystopian lake filled by the world's tech lust. *The BBC*, April 2. Retrieved from https://www.bbc.com/future/article/20150402-the-worst-place-on-earth

[11]The term 'conflict minerals' is defined as columbite-tantalite, also known as coltan (from which tantalum is derived); cassiterite (tin), gold, wolframite (tungsten) or their derivatives or any other mineral or its derivatives determined by the US Secretary of State to be financing conflict in the Democratic Republic of the Congo or an adjoining country: https://www.sourceintelligence.com/what-are-conflict-minerals/.

[12]Scheele, De Haan, and Kiezebrink (2016).

to fumes, dust,[13] noise and air pollution throughout the day and night; land and livelihood rights violations; and the forced relocation of entire indigenous communities. These rare, high-value minerals and chemical elements have now been included on an 'endangered list' because they are being thrown away in mobile digital devices such as smartphones at such a high rate.[14] Scientists warn that some of these materials are becoming increasingly scarce due to limited supplies, their location in conflict zones and the lack of digital device recycling.

More than 90 per cent of additional materials used in mobile digital devices such as tablets and smartphones can be recycled and reused to make other products including jewellery, plastic fencing and new batteries. But, at present, recycling rates remain extremely low with a series of factors been identified for this including regional, educational, income, personal or social norms, insufficient financial incentives, fear of privacy leakage, a lack of collection systems or knowledge of collection systems and limited information and technology availability.[15] A global build-up of discarded but not defunct digital devices was highlighted in an index of 27 countries, which analysed current levels of reuse and recycling.[16] The report painted a bleak picture with regard to reuse or recycling and found that the total number of shelved phones, for example, for the 27 countries equates to a sales value of €1.9 billion in precious metals such as gold, silver, palladium, platinum and copper. Also worryingly, e-waste is mostly managed by the informal sector in some countries and is often handled under inferior conditions, causing damaging health effects to workers as well as the children who often live, work and play near e-waste management facilities.[17] The vast bulk of such e-waste generated is mostly likely not formally collected and not managed in an environmental sound manner and in some cases shipped to developing countries for disassemble and where they are often mined for the small portions of copper wiring they contain. Copper cables are seared in fires to burn off their rubber coating, sending plumes of noxious black smoke into the already polluted air around such facilities.[18] The UN report suggests that in these middle- and low-income countries, the e-waste management infrastructure is not yet fully developed or, in some cases, is entirely

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[13]Chronic exposure to such dust can lead to potentially fatal hard-metal lung disease. It can also lead to a variety of other pulmonary problems, including asthma, decreased lung function and pneumonia. Previous research has shown that people living close to DRC's mines had 43 times the level of cobalt, five times the level of lead and four times the level of cadmium and uranium in their urine than is considered normal.

[14]Element scarcity - EuChemS periodic table. *The European Chemical Society*. Retrieved from https://www.euchems.eu/euchems-periodic-table/

[15]Gu et al. (2019, p. 2).

[16]2020 Mobile phone e-waste index. (2020). *rebuy*, November 12. Retrieved from https://www.rebuy.de/s/mobile-ewaste-index-en

[17]Forti et al. (2020).

[18]German photographer Kai Löffelbein spent seven years documenting how those metals are extracted, often under dangerous conditions, by some of the world's poorest people. His book, *CTRL-X: A Topography of E-Waste*, contains photographs taken in Ghana, China and India, where much of the world's e-waste ends up.

absent, and that the existing way in which we produce, consume and dispose of e-waste is unsustainable in the long run.[19]

The Insatiable Energy Demands of the Digital Age

While recycling rates for digital electronic devices used to boost the mobile communications infrastructure and services are low, leading to the loss of high-value minerals and chemicals and conflict over the remaining rare earth materials in nature, the energy needed to power digitalisation is sufficiently great to give rise to some serious concerns. The digital ICT industry has received limited attention, heretofore, for its contribution to greenhouse gas emissions and, if anything, is often praised for enabling efficiencies that help reduce other industry sector's carbon footprint. A 2018 Canadian study conducted a detailed and rigorous analysis of the digital ICT industry's global carbon footprint, including both the production and the operational energy of the devices used to power the networks, as well as the operational energy for the supporting infrastructure.[20] They found that, if unchecked, the industry's greenhouse gas emissions relative contribution could grow to exceed 14 per cent of 2016 worldwide levels by 2040, accounting for more than half of the current relative contribution of the global transportation sector. In highlighting the contribution of smartphones, they showed that by 2020, the carbon footprint of these devices alone should have surpassed the individual contribution of desktops, laptops and displays combined.

As the digital boom continues apace, there is now a growing deployment of technologies grouped under the term 'Internet of Things' (IoT),[21] a global network of interconnected objects and devices that are uniquely addressable through standard communication protocols. In the coming years, there may be as many as 30 billion objects connected to the internet, all of which require to be powered by some source of energy. These interconnected devices may, of course, yield some direct energy savings, but regulators and policy-makers must ensure that the benefits from the IoT do not come at the expense of rising and harmful energy consumption. An Australian study, focussed at the household level, examined the consumption and use of digital ICT and how technology practices change with life course transitions such as children moving through the education system.[22] They found that the use of multiple devices simultaneously, particularly when this included live streaming of high-resolution video and audio, was increasing

[19]Forti et al. (2020, p. 9).

[20]Belkhir and Elmeligi (2018).

[21]The Internet of Things (IoT) is a network of physical objects - such as home appliances, vehicles or other such devices - that use sensors and APIs to connect and exchange data over the internet. As broadband internet services become more widely available, the cost of connecting continues to decrease, more devices are developed with Wi-Fi capabilities and built-in sensors, technology costs fall and smartphone penetration continues skyrocket: all these create the perfect environment in which the IoT thrives.

[22]Lane, Follett, and Lindsay (2018).

in households with teenagers and young adults and that, if unchecked, would become a significant driver of energy demand into the future.

The expectations and hopes placed on the shoulders of digitalisation for reducing energy consumption have not yet been justified. Instead of saving energy, digitalisation has brought a number of additional and significant energy consumption needs and pressures.[23] Indeed, in many instances, increases in energy efficiency leads to the 'Jevons Paradox' – also known as the 'rebound effect' – which is the belief that increased energy efficiency often simply leads to increased energy consumption.[24] So, while the digital ICT industry is being lauded for its potential to be energy efficient and to dematerialise aspects of contemporary life that are currently energy intensive, the reality is that the industry's own carbon footprint is increasing, and this issue is not receiving the due attention it deserves. This growing problem is epitomised by the digital tech sector's growing dependence on the use of mega-data centres, which use immense quantities of energy to power its expanding digital and cloud services.

Data centres are huge computer warehouses that store massive amounts of data that meet the daily needs and service requirements of individuals and businesses alike and can be said to be the backbone of the modern digital economy. Their role in the digital ecosystem is to process, store and communicate the data behind the myriad of information services we rely upon everyday whether it be streaming video, email, social media, online collaboration or other forms of computing. They are vast factories of data, often bigger than aircraft carriers, with tens of thousands of circuit boards racked row upon row in cabinets to utilise space, stretching down long windowless halls; so long in fact that in many cases, staff ride through these halls on scooters or other mechanised mobility vehicles. They run all day and all night, all year round and so are extremely energy intensive. Such energy demand does not only derive from the storage of data alone, but it also entails extensive cooling systems and equipment, lighting, power distribution and other such requirements, making such data centres up to 100 times greater in energy consumption than a standard office accommodation. The boom in digital content, big data, e-commerce and overall internet traffic is making data centres one of the fastest-growing consumers of electricity in some developed countries, putting pressure on the energy infrastructure and raising questions about the sector's expanding carbon footprint.

Demand for digital services continues its exceptional growth, as does its energy consumption, and this has given rise to concerns about the ability of the sector

[23]Lange, Pohl, and Santarius (2020).

[24]William Stanley Jevons, in his 1865 book *The Coal Question*, observed that the invention in Britain of a more efficient steam engine meant that the use of coal became economically viable for many new uses. This ultimately led to increased coal demand and increased coal consumption, even as the amount of coal required for any particular use fell. Although the energy consumption at the micro-level (for the individual) goes down, overall energy consumption at the macro-level (for societies) increases due to the combined increase in use from all individuals.

to be sustainable in some locations and regions. Uptime Intelligence suggests that it is likely that some models have underestimated the energy data needs and the resulting carbon emissions, and that this issue will become more critical in the years ahead.[25] They use some examples to illustrate this point. Bitcoin mining is reliably estimated to have consumed over 73 terawatt-hour (TWh) of energy in 2019. This equates to the electricity use of 6.8 million average US households or 20 million UK households. This is just one cryptocurrency and just one application area of blockchains; there are estimated to be over 1,500 such cryptocurrencies. Online social media provides another sector of runaway energy use. For example, every time an image is posted on Instagram by the Portuguese football star Cristiano Ronaldo his more than 188 million followers consume over 24 megawatt hours (MWh) of energy just to view it. Streaming a two-and-a-half-hour high-definition (HD) movie consumes one kilowatt hour (kWh) of energy, but for 4K (Ultra HD) streaming this will be closer to 3 kWh, a threefold increase. Media streaming represents the biggest proportion of global online traffic and is steadily rising making it the real energy consuming monster of the modern internet. Such video streaming emits as much CO_2 as Spain – over 300 Mt per year – a Shift Project report has found.[26] The 2019 investigation found that the digital ICT sector, including data centres, currently generates up to 4 per cent of global CO_2 emissions with consumption growing by 9 per cent per year. Data centres alone are estimated to have the fastest-growing carbon footprint from across the entire tech sector.[27] And what of recent energy efficiency innovations?

Although the last two decades have seen major energy efficiency improvements, predictions suggest that these may be coming to an end, and this should be a source of some considerable unease. The immense growth in data centre energy use beyond 2020 is uncertain as modelled trends indicate that the efficiency measures that worked in the past may not be enough for the data centre workloads of the future.[28] Successful stabilisation of data centre energy consumption will require new innovations in efficiency to decouple electricity demand from the ever-growing demand for data centre services. No one envisages a reduction in demand for the digital services offered by data centres in the near future meaning energy demand will only increase in the coming decades, so new efficiency innovations and a commitment to decarbonise the industry are needed if the sector is to be seen as ecologically responsible in the face of the increasing climate emergency. That data centre operators are switching to renewable energy must be viewed in a positive light, but none has entirely ditched fossil fuels completely. Amazon, Google and Microsoft are the top three cloud providers and account for approximately two thirds of all rentable computing services. In an article for *Wired* magazine,

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[25]Bashroush, R. (2020). Data center energy use goes up and up and up. *Uptime Institute*, January. Retrieved from https://journal.uptimeinstitute.com/data-center-energy-use-goes-up-and-up/

[26]Efoui-Hess (2019).

[27]Avgerinou, Bertoldi, and Castellazzi (2017).

[28]Shehabi, Smith, Masanet, and Koomey (2018).

Daniel Oberhaus maintained that these companies lean heavily on a tool known as a renewable energy credit, which is basically a token representing a utility's green energy generation.[29] These energy credits are how companies like Google and Microsoft can claim their data centres are powered 100 per cent by renewables while still being connected to power grids that use fossil fuels. In reality, only a fraction of each company's energy comes directly from solar or wind installations; the rest comes from these renewable energy credits. For example, Greenpeace claimed that Amazon Web Services is only meeting 12 per cent of its renewable energy commitment as its East Coast presence and energy demand grows.[30] Greenpeace USA Senior Corporate Campaigner Elizabeth Jardim claimed:

> [D]espite Amazon's public commitment to renewable energy, the world's largest cloud computing company is hoping no one will notice that it's still powering its corner of the internet with dirty energy.[31]

Big Tech's Clandestine Role in Intensifying Climate Breakdown

While digital big tech firms frequently proclaim themselves as climate change champions and pioneers and frontrunners in the use of renewable energy and clean technology, a different reality emerges when we look closer at the link between the sector and major oil exploration and production companies. Just two years ago – in 2018 – Google created an oil and gas division with the explicit aim of attracting business from the fossil fuel industry.[32] Microsoft and Amazon also offer data management services to fossil fuel companies. This is part of a growing trend that we are witnessing as the dominant tech companies team up with oil giants to use automation, AI and big data services to enhance oil exploration, extraction and production. Google specifically promises that its machine-learning tools, combined with its cloud service, can help these companies better act on

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[29]Oberhaus, D. (2019). Amazon, Google, Microsoft: Here's who has the greenest cloud. *Wired*, December 10. Retrieved from https://www.wired.com/story/amazon-google-microsoft-green-clouds-and-hyperscale-data-centers/

[30]Craighill, C. (2019). Greenpeace finds Amazon breaking commitment to power cloud with 100% renewable energy. *Greenpeace*, February 13. Retrieved from https://www.greenpeace.org/usa/news/greenpeace-finds-amazon-breaking-commitment-to-power-cloud-with-100-renewable-energy/

[31]Craighill, C. (2019). Greenpeace finds Amazon breaking commitment to power cloud with 100% renewable energy. *Greenpeace*, February 13. Retrieved from https://www.greenpeace.org/usa/news/greenpeace-finds-amazon-breaking-commitment-to-power-cloud-with-100-renewable-energy/

[32]Matthews, C. M. (2018). Silicon Valley to big oil: We can manage your data better than you. *The Wall Street Journal*, July 24. Retrieved from https://www.wsj.com/articles/silicon-valley-courts-a-wary-oil-patch-1532424600

their data. In other words, the Google service could help the fossil fuel industry extract oil and gas from existing reserves faster and more efficiently. Microsoft is also actively courting the fossil fuel industry. In 2019, the company announced a partnership with the oil and gas giants Chevron and Schlumberger to build upon the creation of innovative petrotechnical and digital technologies using the Azure platform. The partnership provoked an angry response from a coalition of Microsoft employees who accused the company of 'complicity in the climate crisis'.[33] This response led to a walkout by Microsoft employees as part of the global climate strike. Microsoft is also exploring the use of natural gas to power its data centres. While natural gas does offer some energy efficiency improvements, it is not a renewable resource and thus contributes to the company's overall carbon footprint. In an interview with *The Real News Network*, technology author and reporter Brian Merchant explored these links between big tech and big oil and framed the consequences in the following way:

> Google is assisting [sort of] old school oil and energy firms in Houston to compete with clean energy ventures, giving them access to big data services, giving them access to sophisticated, high-tech tools to compete with clean energy startups. So in some cases they're actually not only [sort of] accelerating the drive to extract and burn fossil fuels, they're actually helping the companies doing that to compete and put out of business the clean tech startups that are hoping to move us towards a cleaner, lower emissions means of energy production.[34]

So, while Google, Microsoft and Amazon are putting on a knowledgeable air with regard to climate change and eulogise their own clean energy credentials, they are in reality deep into the process of automating the climate crisis. These tech companies, the climatologist Michael Mann says, have a responsibility to use their capacity for innovation to mitigate the climate crisis, not worsen it.[35]

But at a micro-level, how is the science of climate change being presented and delivered by these tech giants on their social media platforms to individual subscribers and users of such services? While the likes of Facebook and Twitter often receive the most attention when it comes to concerns over misinformation and fake news, the majority of YouTube videos about the climate crisis oppose the scientific consensus and such posts often 'hijack' technical terms to make them

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[33]Microsoft workers for climate justice. (2019). *Microsoft Employees*, September 18. Retrieved from https://github.com/MSworkers/for.ClimateAction

[34]Lascaris, D. (an interview with Brian Merchant). (2019). How big tech helped big oil automate the climate crisis. *The Real News Network*, April 1. Retrieved from https://therealnews.com/stories/how-big-tech-has-helped-big-oil-automate-the-climate-crisis

[35]Merchant, B. (2019). How Google, Microsoft, and big tech are automating the climate crisis. *Gizmodo*, February 21. Retrieved from https://gizmodo.com/how-google-microsoft-and-big-tech-are-automating-the-1832790799

appear more credible, a recent study has found.[36] YouTube is part of the Alphabet family of subsidiaries, which includes Google. The study concluded that social media websites and video platforms without editorial control, such as YouTube, provide a very fertile ground for conspiracy theorists and opponents of mainstream science because there are no gatekeepers, and hence, no quality control is taking place on such channels. This means anybody and everybody can upload contents, no matter if it is accurate, verifiable, truthful or not. Why is this so important, you might ask?

A 2018 survey by the Pew Research Center found that 21 per cent – that is more than one in every five people – get their news from YouTube.[37] Another survey, conducted in Germany, reported that about 50 per cent of individuals between the age of 14 and 29 years were using YouTube and other such online video sites to learn about science sometimes or very often.[38] Concerns about the role big tech is playing in the spread of misinformation on the scientific consensus around climate change continues to grow. The head of the US House Committee on Climate Change, Kathy Castor, in a letter in January 2020 to Google CEO Sundar inquired why a company that has been so outspoken in its support of policies to combat climate change outwardly continues to allow its hugely popular video platform to serve as a forum for material that casts doubt on settled science and the urgency of the problem, thus tacitly supporting such mistruth.[39] More damning is an extensive investigation by Avaaz, an online activist network, which found that YouTube is actually driving millions of people to watch climate misinformation videos and that their recommendation algorithm is giving these videos free promotion to audiences who would not have otherwise been exposed to them.[40] YouTube are further incentivising this climate misinformation content through its monetisation programme. Every time an ad is shown on a YouTube video, the advertiser pays a fee, of which 55 per cent goes to the video creator. It appears that promoting man-made climate change denial will make you money on YouTube. The platform has also made substantial contributions to some of the more notorious climate change deniers in Washington DC despite its insistence that it supports political action to tackle the ongoing crisis.[41] The list of recipients of such financial support includes

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[36]Allgaier (2019).

[37]Shearer and Matsa (2018).

[38]Science barometer 2018. *Wissenschaft im Dialog (Science in Dialogue, WiD)*. Retrieved from https://www.wissenschaft-im-dialog.de/en/our-projects/science-barometer/science-barometer-2018/

[39]Corbin, K. (2020). Lawmaker wants to know why climate misinformation is rampant on YouTube. *Forbes*, January 28. Retrieved from https://www.forbes.com/sites/kennethcorbin/2020/01/28/lawmaker-wants-to-know-why-climate-misinformation-is-rampant-on-youtube/

[40]Avaaz (2020).

[41]The updated biannually list of politically engaged trade associations, independent third-party organisations and other tax-exempt groups that receive the most substantial contributions from Google's US Government Affairs and Public Policy team at https://services.google.com/fh/files/misc/trade_association_and_third_party_groups.pdf.

the Competitive Enterprise Institute (CEI), a conservative policy group that was instrumental in convincing the Trump administration to abandon the Paris agreement. By sowing the seeds of confusion and misinformation, Google is helping to muddy the water with regard to the causes of the crisis, something that very evidently goes against the scientific consensus of anthropogenic climate change. The intrinsic danger being: people who are regularly misled to believe that scientists disagree on climate change tend to feel less certain that it is occurring and show less support for policies designed to mitigate the crisis.

But it is not only YouTube and Google that is casting doubt on the settled science of climate change. By sticking by its non-interventionist policy when it comes to misleading news content, Facebook have become a purveyor of false and dishonest news, accomplices in efforts by climate change deniers to sow confusion and misinform the general public. In one such instance, Facebook facilitated the spread of climate denial misinformation to about five million users,[42] and in another recorded instance, a misleading article linking climate change to Earth's solar orbit racked up 4.2 million views on the platform and was widely shared.[43] While tech giants have recently taken steps to remove, or label as false, potentially harmful misinformation on the Covid-19 pandemic, there has been a seeming acceptance of those who spread false theories on the climate crisis. Michael Mann of Pennsylvania State University, one of the world's best-known climate scientists, told the news website ThinkProgress; 'when it comes to efforts to avert catastrophic climate change, Facebook is no ally. They are an enemy'.[44] The relentless growth, and ongoing proliferation of social media, gives rise to irrational doubt and importantly endangers trust in climate science, and science in general, as was shown in other recent discussions about fake news.[45] Our emotions can, and often do, shape our beliefs more than logic, and as people skim through content on the internet in a state of constant distraction, they can easily get carried away with these emotions and their partisanship rather than relying on reasoning.[46]As the internet is currently organised, individuals can be easily persuaded to hurry and feel rather than stop and think, and this is compounding the

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[42]Nuccitelli, D. (2018). Facebook video spreads climate denial misinformation to 5 million users. *The Guardian*, July 25. Retrieved from https://www.theguardian.com/environment/climate-consensus-97-per-cent/2018/jul/25/facebook-video-spreads-climate-denial-misinformation-to-5-million-users

[43]Boyle, L. (2020). 'Everybody's entitled to their opinion - But not their own facts': The spread of climate denial on Facebook. *Independent*, July 23. Retrieved from https://www.independent.co.uk/environment/climate-crisis-denial-facebook-global-warming-denier-social-media-a9595546.html

[44]Romm, J. (2019). Facebook is a big obstacle to averting climate catastrophe, scientists say. *ThinkProgress*, May 29. Retrieved from https://thinkprogress.org/facebook-misinformation-pelosi-climate-science-8bc80493ac7c/

[45]Weingart and Guenther (2016).

[46]Harford, T. (2020). Facts v Feelings: how to stop our emotions misleading us. *The Guardian*, September 10. Retrieved from https://www.theguardian.com/science/2020/sep/10/facts-v-feelings-how-to-stop-emotions-misleading-us

spread of misinformation and falsehoods with regard to climate science. More worryingly, this rush to adopt a position on the cause of the climate crisis is pushing some to openly doubt the mounting available evidence purely and only in the service of political partisanship.

The scientific evidence of anthropogenic climate change is overwhelming, and our views on this should not be a case of left or right ideology. But worryingly, it appears it is. What people profess about the climate crisis does not reflect what they know; it expresses who they are. These were the findings from an independent US study designed to disentangle what people know from who they are in assessing their comprehension of climate science.[47] The study found that Democrats become more likely, and Republicans less likely, to say they believe in human-caused global warming. Yet a large percentage of Republican voters who told pollsters they do not believe in man-made climate change do, in fact, know the most important thing there is to understand about the crisis: that adding carbon to the atmosphere causes the temperature of the earth to increase. Thus, articulating your views on climate change does not convey what you know about the science, but it expresses who you are, particularly in the ideological battle for the soul of America. This is a tragedy of the 'science communications commons', and if we want to overcome it, then we must disentangle competing positions on climate change from opposing cultural identities so that informed pluralistic citizens are not put in the position of having to choose between knowing about the science and being who they are.[48] Individuals should be allowed to think and reason for themselves, free of the distorting impact of the partisanship that individuals view as protecting their own political meaning and self of identify. But the shift from a minimal choice to an extensive choice new digital media and news landscape has led to a strengthening of the emotional and psychological wedge between opposing cultural groups. Yet another reason why, despite the rhetoric and 'for the common good' narrative propagated by the digital oligopoly, these megacorporations should not be allowed free reign to continue to spread misinformation and untruths and should be held to a much higher standard than heretofore, while been compelled to honour their corporate social responsibilities and public utterances.

Digital Technology Alone Cannot Save Us?

Digital ICT has developed extraordinarily over the past two decades and have become almost a near universal subject of faith for some; a faith that proposes that new technologies will solve all the problems facing societies across the world. Not least in this line of problems facing humanity is the urgent issue of climate change. But few of us seem to appreciate that technology may have, in fact,

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[47]Kahan (2015).

[48]Kahan, D. (2014). What you 'believe' about climate change doesn't reflect what you know; it expresses *who you are*. *The Cultural Cognition Project*, April 23. Retrieved from http://www.culturalcognition.net/blog/2014/4/23/what-you-believe-about-climate-change-doesnt-reflect-what-yo.html

exacerbated many of our current environmental and social problems and hastened the climate emergency. In *Techno-Fix*, Michael and Joyce Huesemann carefully outline the reasons why many technological solutions to social and environment problems are ineffective and the inherent limitations of modern technology can create unintended and unavoidable consequences, some of them irreversible.[49] While not simply focussed on digital technology, they explore in depth some of the many unintentional environmental and social consequences of modern technologies ranging from environmental pollution, global warming, species extinction, topsoil loss and ecological disruptions by genetically engineered organisms to social alienation, high-tech weaponry, human overpopulation and the decline in biological fitness. They persuasively argue that it will require a near complete revision of attitudes towards technologies and towards the puerile notion that science and technology are 'value free' and call for a re-evaluation of our assumptions about technology systems and their relationship to power structures and equity. Their call is a powerful one: one that asks us to be much more critical about the assumptions and blind techno-optimism that is prevalent in society. If digital technologies are to play a role in alleviating the extremes of the climate crisis, then the present crop of digital platforms and megacorporations must be forced to be much more responsible and accountable in their intent, and for their actions. But big tech does not appear to have the imagination nor the will to tackle the most pressing concern facing humanity rather; they are content to embrace an (over)consumption mindset that has led us to the edge of this abyss. They are happy, as corporations, to fiscally bloat beyond recognition, all the while delivering platitudes of the virtues of their social and ecological responsibilities that do not match their actual actions.

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[49]Huesemann and Huesemann (2011).

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