# Section II: Sites

# Ecocide isn’t Ethical: Political Ecology and Capitalist AI Ethics

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## Introduction

Emerging discourses surrounding new forms of extractivism associated with data and digital technologies are framed as ‘the new oil’;[[1]](#footnote-1) as the key raw material that drives the information economy;[[2]](#footnote-2) as a new form of circulatory capital;[[3]](#footnote-3) or as a new type of colonialism.[[4]](#footnote-4) While the framing varies, these conceptualizations of digital technoculture illuminate numerous harms that amplify existing social inequalities,[[5]](#footnote-5) discriminate against certain groups of people[[6]](#footnote-6) and enact predictive logics of control.[[7]](#footnote-7) However, these ‘new’ forms of data-driven extractivism are not distinct from ‘old’ forms of extractivism associated with procuring the materials and energy required for digital technologies and infrastructures, or the social and environmental impacts associated with the enormous increases in production, consumption and waste which results from data processing, storage, and transmission in the 21st century.

Responses to harms associated with computational systems are often framed within the field of ‘AI ethics,’[[8]](#footnote-8) where a focus on enhancing privacy, or making AI more ‘fair,’ ‘accountable,’ and ‘transparent’, elides larger ethical questions relating to the significant harms to both present and future ecosystems associated with the energy, labour, and materials required for the production, maintenance, use, and waste disposal associated with AI. The planetary assemblages of code, carbon, cobalt, copper, and numerous other materials that compose contemporary AI plays a significant role in climate change and associated ecological crises of the Capitalocene.[[9]](#footnote-9) Given the Paris Agreement targets to limit global heating to under 2 degrees Celsius above pre-industrial levels, and preferably to no more than 1.5 degrees,[[10]](#footnote-10) any meaningful discussion of AI ethics must address a much broader set of concerns than it presently does. This includes acknowedging AI’s contribution to the impacts of climate change including drought, biodiversity loss, flooding, extinctions, coastal submergence, and issues of food and water security, among many other material consequences. Omitting to address these harms when considering AI, we argue, is *unethical.* In this chapter we draw from the field of political ecology to explore what kinds of systemic and structural changes are needed for AI to be considered ‘ethical’?

We argue that the ecocidal tendencies of current global economic arrangements, where digital technologies and AI are positioned as key drivers of economic growth (*and* the solution to the climate crisis itself,[[11]](#footnote-11) requires a reframing of the ethics of AI. Technology cannot be understood as being neutral in taking us to this point of global ecological crisis and, further, its role will not be neutral as we address the crisis. It is critical, therefore, that we centre the *role of technology* in our prefiguration of future global arrangements. While political ecology focuses on making explicit the political, social, and economic dimensions of environmental crises that are often aberrantly perceived as being ‘natural’ and ‘apolitical,’ we draw on a growing body of literature which has centred this conceptual lens towards technology,[[12]](#footnote-12) data,[[13]](#footnote-13) the digital economy,[[14]](#footnote-14) and e-waste.[[15]](#footnote-15)

These recent works apply the framework of political ecology to demonstrate how the ecological and political-economic dimensions of digital technologies that are typically misidentified as being ‘dematerialized’ or ‘artificial.’ Both these terms effectively conceal the material dimensions of these artefacts, contributing to their frequent portrayal as apolitical, neutral, mathematical objects. Although ecology and technology are situated very differently with regards to an imagined nature/culture dualism, they share a tendency to be positioned as politically neutral issues that should be addressed by differing branches of the sciences rather than being understood as entangled with systems of power. This focus on power, inequalities, politics, and collective action is underpinned by political ecology’s view of ethics as normatively being concerned with social action that redistributes power towards subaltern groups,[[16]](#footnote-16) aligning the approach of political ecology with emerging arguments that discourse surrounding AI should ‘transcend the language of “ethics” and engage with power and political economy.’[[17]](#footnote-17) A key point here is that ‘AI ethics’ frequently becomes a way for powerful corporations to avoid regulation by adopting voluntary practices focused on technical fixes that fail to meaningfully address harms associated with AI.

While there has been some scholarly work to broaden AI ethics to include AI’s ecological impacts,[[18]](#footnote-18) these contributions have tended to be limited to narrow technical considerations. As such, we begin by contrasting a political ecology approach that centers ecological harms and inequitable power relations, with the discourse of ‘green AI’[[19]](#footnote-19) that focuses concern on the carbon costs of training ML models. While the ecology of AI includes the data centers where ML training and inference occurs, we argue that the impacts go far beyond data centers, situating those facilities within flows of energy, labour, knowledge, and the myriad materials necessary for AI systems to operate. Nonetheless, we begin our examination of the ecopolitical impacts of AI with data centres, as this has been both the central focus of the sustainable AI literature and a key site within critical studies of digital infrastructures.[[20]](#footnote-20)

Subsequently, we critique two prominent, interconnected discourses that suggest digital technologies enable the maintenance of the socioeconomic status quo in the face of ecological crises. The first discourse argues that AI facilitates a hyper-efficient mode of production that decouples the production of wealth from material constraints, allowing the continuation of economic business as usual. We demonstrate how this line of reasoning does not hold up to scrutiny when viewed through the lens of political ecology. The second discourse we critique is premised on the erroneous contention that technological innovation will straightforwardly solve contemporary ecological crises. We challenge techno-solutionist responses which recast a crisis of capitalism as a business opportunity for innovative tech corporations. Instead, we argue that the hegemonic discourse related to AI ethics legitimates ecocide while actively inhibiting the systemic and structural social, political, and cultural transformations that are required. This includes, for example recognizing ecocide in national international criminal law.[[21]](#footnote-21)

We conclude by briefly outlining alternatives to hyper-efficient green growth and technological solutionism. We acknowledge that substantial debates exist within political ecology scholarship relating to the possible world we should strive for and how to get there. These debates extend to the role envisaged to be played by technology in both the transition and in the society being prefigured. These positions include degrowth, ecosocialism, conviviality, commoning, and public service models of digital infrastructure. It is beyond the scope of this short chapter to engage with all these perspectives in any depth. Nevertheless, highlighting these alternatives outlines postcapitalist pathways towards more ethical forms of AI. Emphasizing the structural causes of ecological harms associated with existing economic practices foregrounds how debates surrounding AI ethics function to legitimize and normalize AI’s contributions to systemic ecocide rather than meaningfully challenge them. Consequently, employing the lens of political ecology, we add our voices to accounts which critique AI ethics as ethics-washing and/or greenwashing, instead contending that the focus needs to shift towards structural issues of power.[[22]](#footnote-22)

## (not-so) Green AI

AI is resource-intensive in ways that are often overlooked.Recent debates surrounding AI, ethics and sustainability have largely focused on the carbon cost of training ML models.[[23]](#footnote-23) This partly results from a prominent paper which estimated that a single training run of a specific ML model emits 284,019 kg of CO2e.[[24]](#footnote-24) Although this estimate is staggeringly high, equivalent to the lifetime emissions of 3,422 iPhone 13s,[[25]](#footnote-25) it received little prominence in the original paper, which acknowledged that alternative hardware could reduce training time by a factor of 8.5, signaling the estimate had a substantial margin of error.[[26]](#footnote-26) Indeed, subsequent research argues that erroneous assumptions, such as using the ‘big’ 213 million parameter Transformer model for the experiment rather than the 65 million parameter base model, entailed that the training run would have resulted in 15,200 kg CO2e in an average US data centre, or 3,200 kg CO2e using the hardware in Google’s Georgia data centre where the real-world model ran.[[27]](#footnote-27)

In fact, however, more pertinent to the ecological impacts of ML systems was Strubell et al.’s finding that another model, whose development they followed from inception to deployment as a case study, required *4789 training runs*, equivalent to ‘60 GPU’s [graphics processing units]running constantly throughout the six-month duration of the project,’[[28]](#footnote-28) highlighting the fallacy of focusing on the CO2 emissions of single training runs. Furthermore, far more energy is used running ML systems (what is known as inference) than training models. Nvidia estimate 80 to 90 percent of the cost of machine learning systems is inference rather than the initial training,[[29]](#footnote-29) while Amazon Web Services state that inference accounts for up to 90 percent of the cost of machine learning.[[30]](#footnote-30)

The data centers where high-performance computers are used in parallel to conduct training and inference for ML systems (alongside activities including data storage, web hosting, and video transcoding) are, of course, one area of intense energy and resource use. Estimates for global energy use within data centers vary widely, from 205 terawatt-hours (TWh)[[31]](#footnote-31) to 400-500 TWh.[[32]](#footnote-32) This equates to between one and two percent of all global electricity use. Forecast increases in data storage and processing, ML dataset size, training, inference, and other computationally intensive tasks such as transcoding and streaming 8K video, mean that data centre energy use is estimated to rise to approximately 780 TWh by 2030.[[33]](#footnote-33)

The past decade has seen a significant centralisation of data accompanied towards large cloud and hyperscale data centres. By 2021 there were 659 hyperscale data centres[[34]](#footnote-34) (Synergy Research Group, 2021), a figure which has more than doubled since 2015.[[35]](#footnote-35) Half of these are owned and operated by just three companies, Amazon, Microsoft, and Google.[[36]](#footnote-36) Whereas historically, many businesses ran small, in-house centers, hyperscale data centres exemplify the logic of platform capitalism,[[37]](#footnote-37) insofar as they leverage economies of scale and network effects that centralise facilities, with a few oligopolistic technology companies leasing space and compute to smaller businesses. One purported benefit of hyperscale data centres is an increase in energy efficiency,[[38]](#footnote-38) a point we return to in the following section where we discuss efficiency and decoupling.

While carbon costs are important, the narrow focus of these studies masks the urgent necessity of meaningfully considering the ecological impacts of AI/ML that go far beyond the energy use associated with powering particular training models or inference within data centres. Instead, it requires analyzing the material and energy flows associated with the *entire* supply chain and assemblage of software, hardware and infrastructure required for ML systems to function. Political ecology here provides a useful alternative to existing ‘green’ and ‘ethical’ AI, both because of its focus on mapping the material and energy footprints of sociotechnical systems from cradle to grave, and its emphasis on ecological systems being thoroughly entangled with and affected by power, inequality and violence. Data centers also require enormous amounts of water.[[39]](#footnote-39) Within data centers, vast amounts of heat are generated, requiring active cooling.[[40]](#footnote-40) Water is central to the cooling process, with chilled water employed as a heat transfer mechanism to reduce air temperatures.[[41]](#footnote-41) In 2014, U.S.-based data centers used approximately 626 billion litres of water.[[42]](#footnote-42) While data center water consumption (1.7 billion litres/day) is a small fraction of total water consumption (1218 billion liters/day)[[43]](#footnote-43) acute and significant impacts of data centers on water availability are dependent on geographical location. For example, data centers in the western and south-western U.S. depend upon already scarce and stressed watersheds,[[44]](#footnote-44) placing technology corporations in conflict with local communities and ecosystems. When ecological disasters occur, technology corporations are often prioritised over local people.[[45]](#footnote-45)

While ‘green AI’ approaches[[46]](#footnote-46) focus on reducing the electricity needed to train and run models within data centers, they rarely engage with the human and environmental costs associated with producing or disposing of hardware or the infrastructure that houses and cools that technology. These social and environmental harms include those associated with industries that extract conflict minerals like tantalum, tungsten, and gold from the Democratic Republic of Congo (DRC),[[47]](#footnote-47) or where extraction is dependent on child labour such as cobalt from the DRC.[[48]](#footnote-48) Unbridled extraction of other materials such as lanthanides (commonly known as rare earth minerals) leave a toxic legacy of localised environmental and human health impacts such as producing ‘cancer villages’ in China.[[49]](#footnote-49)

Further to this, none of these materials come out of the ground ready for use in high-performance computing. Another set of energy-intensive extraction processes separates and purifies raw materials, resulting in significant levels of additional pollution. Processes of beneficiation remove most of the raw material that was extracted from the earth. In the case of copper, for example, as high-grade ores are increasingly depleted, the concentration within commercially viable ores has fallen from 2 percent to 0.8 percent,[[50]](#footnote-50) meaning that over 99 percent of the mass of extracted material is waste/tailings.[[51]](#footnote-51) The processes employed for purification require significant energy inputs and often require the use of toxic materials. For example, the silicon used in CPUs, GPUs and TPUs requires several stages of chemical processing to reach 99.999999999 percent purity,[[52]](#footnote-52) before it undergoes processes of thermal oxidation, photolithography, plasma etching and doping, all of which are chemically and energetically intensive, requiring precise controls over substances and temperatures, some of which reach 1100°C.[[53]](#footnote-53)

The matter and energy required for AI largely flow from the global economic periphery towards the burgeoning technomass in the economic core.[[54]](#footnote-54) Contemporaneously, theories of data colonialism outline the flow of financial value and data from the economic periphery towards the core.[[55]](#footnote-55) This ecologically unequal exchange (EUE),[[56]](#footnote-56) is not incidental to, but comprises instead a constitutive element of global capitalism which has persisted throughout past and present forms of colonialism and imperialism.[[57]](#footnote-57) Under conditions of EUE, raw materials and energy flow from periphery to core, while the periphery also functions as a ‘dump’ for much of the 50 million tons of toxic e-waste generated annually.[[58]](#footnote-58) Recent research in ecological economics indicates that high income countries’ usage of raw material exceeds domestic extraction by over 10 billion tons, while all regions except high-income countries are net providers of raw materials.[[59]](#footnote-59)As we have demonstrated, this includes the raw materials required for AI.

While hardware located inside data centres is necessary for ML systems, a holistic and ethical appraisal should also include all the network and platform infrastructure that connects data centres to end-client devices. This includes undersea and terrestrial fibre-optic cables, internet exchange points and cable landing stations and many of the desktop, laptop, tablet, smartphone and IoT devices that engage with ML systems. Furthermore, ML systems require training data, for example, the ImageNet dataset that has been commonly used for image recognition were drawn from Flickr,[[60]](#footnote-60) so the assemblage required for ML systems employing these datasets includes Flickr’s platform infrastructure and the array of digital cameras, smartphones and computers that created the dataset. The images were labelled by humans sourced through Amazon Mechanical Turk—which pays workers well below minimum wage while failing to offer the protections associated with employment.[[61]](#footnote-61) The exploitative and precarious human labour associated with such systems should also be recognised as a component of the ecology of an ML system.

Mapping the scale of the system required for contemporary ML goes far beyond a server in a data center and the energy it requires and the emissions it produces. It includes a vast array of devices, operations, facilities, and people located across the planet. Each device is itself an assemblage of materials whose extraction, processing and disposal are associated with a range of environmental, social, and labour justice issues, which remain neglected in most contemporary conceptions of ‘ethical AI.’ Acknowledging the scale of this assemblage and the range and severity of harms it inflicts on people and ecosystems unmasks any notion that AI under current extractivist capitalism arrangements of EUE is ethical, or that it could be regarded as ethical if only privacy concerns were addressed, biases were removed from training datasets so they are ‘fairer,’ or the models themselves were more ‘transparent’ and ‘accountable.’ Indeed, the current, extremely narrow framing of AI ethics largely serves to benefit technology corporations who enact minor technical modifications to ecologically calamitous technologies whilst boldly pronouncing that this proves they are acting ethically.

## Efficiency, Technology, and Capitalism

The myopic focus on the energy costs of training models results in ‘solutions’ based on improving efficiency, reducing carbon costs by limiting the computational intensity or training dataset size of machine learning models.[[62]](#footnote-62) These ‘solutions’ miss broader points around ML systems, supply chains and infrastructure; solely focusing on energy use within data centers fails to consider the upstream and downstream costs and externalities, or recognize the historical and ongoing relationships between technology, efficiency, and capitalism.

‘Green AI’[[63]](#footnote-63) advocates that increasing energy efficiency enables a decoupling of economic growth and environmental impacts, therefore reducing ecological harms from ML. Assessing this claim requires some context surrounding decoupling, technology and ‘green growth.’ Since the industrial revolution there have been strong positive correlations between economic growth (measured in GDP) and both greenhouse gas (GHG) emissions and material footprints (i.e., the overall mass of materials used by a society).[[64]](#footnote-64) The goal of decoupling is to allow economic growth to continue unabated while decreasing presently associated ecological harms. Here several key distinctions surrounding the form, scale, and rate of decoupling are required. The first distinction is between relative decoupling—which means that while rates of growth and GHG/material footprints diverge, there remain overall increases of resource use/harms—and absolute decoupling, where economic growth increases while GHG/material footprints decrease. A second important distinction involves the geographical scale of analysis. While there are numerous exemplars of OECD nations achieving absolute decoupling at a national level,[[65]](#footnote-65) that decoupling has been achieved through offshoring industry and importing goods and materials, i.e., a form of regional decoupling predicated upon EUE. To avert ecological catastrophe, absolute decoupling must take place on a global rather than national or regional scale. Finally, for green growth to be ethical *and* sustainable, the absolute decoupling of economic growth from GHG emissions must be sufficiently rapid to meet (or indeed exceed) global environmental commitments such as the Paris Agreement.

Assuming continued economic growth of around 2 percent a year, this decoupling would require OECD nations to reduce emissions at a rate of 15 percent per annum until they reach zero.[[66]](#footnote-66) While moving from fossil fuels to renewable energy does decouple GHG emissions from energy use, there is no empirical evidence to support this rate of absolute decoupling of GHG emissions from economic growth. Additionally, since 1990 global growth in material use has *outpaced* growth in GDP.[[67]](#footnote-67) There is no contemporary evidence for any trend towards decoupling of economic growth and resource use; in fact for every unit of economic growth over this time, *more* resources have been required. While the current global material footprint is approaching 100 billion tons per annum—having more than doubled since 1990—a sustainable level is estimated to be 25–50 billion tons per annum.[[68]](#footnote-68) Further, the vast majority of material footprint growth since 1990—81 percent at a per capita level—is attributable to high income nations, further demonstrating that the responsibility for current ecological crises is deeply inequitable.[[69]](#footnote-69)

Moving from global aggregate figures to focus on efficiency and AI, digital technology has long involved a relative decoupling between metrics of performance and energy use.[[70]](#footnote-70) Exemplifying these changes, data centres have become more energy efficient over time, particularly with the move towards hyperscale and cloud data centres.[[71]](#footnote-71) The metric for measuring data center energy efficiency is power use effectiveness (PUE), a ratio demarcating the proportion of a data centers’ energy use required for operating the IT equipment in comparison with the total energy required by the facility (which includes energy for cooling, lighting, etc.). An ideal PUE would be 1, signaling that total energy usage equals that used by the IT equipment. As of 2020, the US average PUE was 1.59, while certain data centers have achieved a ratio of 1.11.[[72]](#footnote-72) However, PUE only measures efficiency, not the overall energy use of the facility,[[73]](#footnote-73) or the total number of facilities. Accordingly, while facilities become more efficient, total data center energy use has grown.[[74]](#footnote-74)

Efficiency gains are essential in shoring up capitalist economic growth and have been present throughout the history of computational development.[[75]](#footnote-75) The problem is that efficiency gains are typically negated by rebound effects such as Jevons’s paradox:[[76]](#footnote-76) more efficiently using resources leads to overall increases in resource use. Nonetheless, it is in the economic interests of data centre owners to increase efficiency, which reduces costs, therefore enhancing profits. This is not to suggest that efficiency is ‘bad’, but within a growth-based capitalist economy, efficiency savings do not typically lead to absolute reductions of emissions or materials usage—they increase material input overall. As Foster and colleagues argue, ‘An economic system devoted to profits, accumulation, and economic expansion without end will tend to use any efficiency gains or cost reductions to expand the overall scale of production.’[[77]](#footnote-77) What is required, then, is a shift away from the conflation of exchange value (i.e., GDP) with social progress and abandoning the fairy-tale of endless economic growth. Our conclusion outlines strategies for achieving this, but we first turn to a second model for resolving ecological crises under ‘green capitalism’ via technological solutionism.[[78]](#footnote-78)

## The Fallacy of Technological Solutionism

New and emerging technologies are positioned as a panacea to ecological crises, enabling current forms of overconsumption to continue unabated. This is exemplified by former Australian prime minister Scott Morrison’s statement that we will resolve climate change through ‘technology not taxes.’[[79]](#footnote-79) This approach is far from novel. In 2007, six years after withdrawing from the Kyoto Protocol, which mandated industrialized nations to reduce greenhouse gas emissions, then U.S. President George W. Bush and then Australian prime minister John Howard released a joint statement arguing that ‘the development and deployment of low emission technologies will be a key element in addressing the climate challenge,’[[80]](#footnote-80) citing clean coal and carbon capture and storage (CCS) as technological solutions. Fifteen years on, clean coal and CCS have repeatedly failed to demonstrate technical and economic viability.[[81]](#footnote-81) As Kuch illustrates, CCS is framed by a worldview derived from the fossil fuel industries, for whom climate change is a technical issue to resolve technologically rather than by phasing out fossil fuels.[[82]](#footnote-82)

While at first glance, CCS appears to be a sleight of hand employed by the fossil fuel industries and right-wing political leaders to inhibit actions that address ecological crises, it has been embraced by the Intergovernmental Panel on Climate Change Fifth Assessment Report,[[83]](#footnote-83) which centers CCS in conjunction with bioenergy (abbreviated to BECCS) in socio-economic models designed to avert catastrophic climate change. BECCS features in over 100 of the 116 scenarios for avoiding dangerous warming.[[84]](#footnote-84) BECCS theoretically allows significant overshoot of the carbon budget for remaining under 2°C of warming as it produces negative emissions, capturing carbon dioxide from the air in trees, turning these trees into pellets that are then burnt, and capturing the carbon emissions and storing them underground, thereby reducing atmospheric CO2 levels. Relying on problematic (and probably inaccurate) forecasts for significant negative emissions in the second half of the 21st-century allows governments to delay reducing emissions now based on a speculative panacea of unrealized future technological innovations.[[85]](#footnote-85) While CCS technology has so far failed to realize efficacy claims, the bioenergy component of BECCS is also problematic, with the land required for biomass in IPCC models typically being one to two times the size of India.[[86]](#footnote-86) In conjunction with the reduction of crop yields in a warming world, this likely compounds the catastrophic food shortages and reductions in biodiversity already being experienced in parts of the global economic periphery.[[87]](#footnote-87)

The issue is not just that technological solutionism (such as BECCS) is unlikely to resolve ecological crises, but also that they are adistractionthat actively inhibits the collective social, political, and cultural change that is urgently required by suggesting that technology (including technologies that do not yet exist) will comprehensively ‘fix’ the ecological crises, so there is little to be gained by citizens demanding action now.[[88]](#footnote-88) In the case of AI, the alleged solutionist silver bullet involves using renewable energy to power data centres. Big Tech companies have embraced this extremely limited definition of sustainability, foregrounding it within promotional materials such as annual environmental reports that publicly portray themselves as leading society towards a sustainable future.[[89]](#footnote-89)

For example, Google’s 2020 environmental report declares ‘sustainability is one of our core values at Google and we’ve been a leader on climate change since the company’s founding over 20 years ago.’[[90]](#footnote-90) Google claims that they became the first major company to become carbon neutral in 2007 and that by 2020 they had ‘neutralized our legacy carbon footprint since our founding, making Google the first major company to be carbon neutral for its entire operating history.’ However, the environmental data located at the end of Google’s environmental report shows otherwise. Unpacking this data requires a basic grasp of the ways corporations measure and audit emissions. Distinctions are drawn between Scope 1, 2 and 3 emissions;[[91]](#footnote-91) Scope 1 refers to emissions produced by directly owned sources, such as onsite furnaces, while Scope 2 covers the GHG emissions associated with purchased electricity and other utilities. Scope 3 emissions are usually the most significant in terms of overall volume, they include all the emissions associated with those that the company is indirectly responsible for, all the way up and down its supply chain.

Whereas Google’s total reported emissions for 2019 were 17,646,902 tCO2e—the majority of which are Scope 3 emissions, whose sources are of indeterminate origin within the document, but which almost certainly arise from the production of hardware and infrastructure[[92]](#footnote-92)—Google’s emissions reductions arising from onsite renewable installations, power purchase agreements with third-party providers and carbon offset projects totalled 5,725,635 tCO2e.[[93]](#footnote-93) Basic arithmetic demonstrates that net emissions far exceed mitigation, Google was not carbon neutral in 2019, let alone counteracting the corporation’s historical carbon footprint as the Environmental Report claims. Google’s declaration of carbon neutrality only includes their negligible direct emissions and more substantial electricity usage (Scope 1 and 2 emissions), and simply ignore the vast carbon footprint associated with producing hardware and infrastructure. Ergo Google’s claims surrounding carbon neutrality are a straightforward case of greenwashing through a strategy of selective disclosure,[[94]](#footnote-94) whereby a company selectively highlights positive elements of their environmental performance in order to misleadingly portray themselves.

In comparison to Google, Apple deserves praise for including their supply chain (Scope 3 emissions) within their carbon footprint, and for moving to make their entire business carbon neutral within a decade. However, despite first appearances, Apple still falls short of genuinely sustainable action. Between 2016 and 2020 electricity use at Apple’s corporate facilities (primarily data centers) almost doubled, rising from 1,420,000 MWh to 2,580,000 MWh.[[95]](#footnote-95) Although during this period Apple increased renewable electricity usage to cover this increase, there are two reasons why this cannot reasonably be considered sustainable. Firstly, in the USA, where approximately 80 percent of Apple’s corporate electricity usage occurs, over 60 percent of electricity generation was from fossil fuels in 2021.[[96]](#footnote-96) While decarbonization urgently requires replacing fossil fuels with renewable energy, in Apple’s case, instead of replacing existing fossil fuel generation, vast amounts of renewable energy are required to cover the rapid growth in electricity usage associated with data centres.[[97]](#footnote-97)

The history of energy is often narrativized as the successive dominance of coal, then oil, then gas. What this periodization obscures is the fact that these sources have supplemented, rather than replaced, one another. Since the first IPCC report in 1990, coal use has increased slightly, oil and gas use has nearly doubled, and by 2019 solar and wind combined provided just 2.6 percent of global energy.[[98]](#footnote-98) Transitioning away from fossil fuels within the time required to avoid global warming above 2 degrees is a monumental task, one that means the additive logic of the energy mix since the industrial revolution must be supplanted by one whereby the energy currently provided by fossil fuels is rapidly replaced by renewables. In this context, alongside the need for growth in energy use among non-OECD nations in the global periphery and semi-periphery where electricity blackouts are common and billions lack internet access, rapid growth in electricity demand within affluent nations in the economic core cannot be considered just nor ‘ethical.’

The second issue is that alongside GHG emissions, material footprint is a pressing ecological issue and solar panels and wind turbines require many of the materials also required for digital hardware such as highly-purified silicon, rare earth minerals, lithium, and cobalt. Accepting the finitude of these resources, and the inequitably experienced social and environmental harms associated with their extraction, entails realizing that while energy sources such as the sun and the wind are renewable, the technological means of converting them into electricity is not. Solutionists contend that further speculative technologies, such as deep-sea[[99]](#footnote-99) or comet mining[[100]](#footnote-100) will resolve the scarcity of terrestrial materials required for green capitalism. However, given both the multi-decadal timescales involved and the fact that ventures such as deep-sea mining will cause significant environmental harms, these claims should not distract us from the urgent task of reducing emissions, material usage and ultimately consumption.

Far from genuinely resolving problems, technological solutionism provides an extremely narrow focus that ignores the broader context of EUE and serves, instead to greenwash corporate communications. The neoliberal technical fix is designed to preserve existing systems of power and privilege by positing technical fixes that maintain a growth-orientated capitalist model which is fundamentally unethical and at odds with ecological justice.

## Conclusion

This chapter forms a damning critique that ‘ethical’ and ‘green’ AI can render current AI systems ethical and just, especially where ethical interventions are largely limited to mathematically addressable technical fixes to make AI systems more ‘fair’, ‘accountable’ and ‘transparent.’[[101]](#footnote-101) Instead, we must take action to remedy ecological harms associated with AI that address the deeply unjust, unsustainable and inequitable socio-economic system in which AI is entangled.[[102]](#footnote-102) Fundamentally, according to the normative model of social ethics present within political ecology, AI cannot be deemed ethical while it is complicit in ecocide. We therefore conclude by outlining emerging postcapitalist approaches that re-envision and prefigure less ecologically destructive and more ‘ethical’ sociotechnical systems.

The structure of capitalist economies requires compound growth of at least 2 to 3 percent GDP per annum.[[103]](#footnote-103) Economic growth strongly correlates with material footprint and greenhouse gas emissions. While widespread adoption of renewable energy enables the decoupling of greenhouse gas emissions from GDP, the underlying correlation between energy and GDP remains, and ‘renewable’ energy still requires significant unrenewable materials. This means that the inevitable quest for infinite growth under a capitalist mode of production is impossible on a materially finite planet. Consequently, postcapitalist positions broadly concur on the necessity of supplanting and replacing GDP as a measure of socioeconomic wellbeing.[[104]](#footnote-104) GDP is a measure of economic exchange value—the sum of monetary transactions within nation states—and has been widely criticized for valuing things that are destructive, including coal burning power stations, producing nuclear weapons and increased hospital admissions. At the same time GDP fails to value things that do not generate incorporate exchange value, including clean air, biodiversity, unpaid domestic labour, and commons-based digital ventures such as Wikipedia. Equally, GDP fails to account for spectacular levels of inequality within nation states, so employing GDP as an indicator of social progress fails to recognize that since the 1970s, within developed economies, growth has almost exclusively accrued among the wealthiest while poverty levels have steadily risen.[[105]](#footnote-105) Postcapitalist arguments are thus clear that GDP, with its focus on exchange value, is an inadequate measure for evaluating what matters in life.

While there has been significant debate within political ecology surrounding the merits and potential shortcomings of degrowth, ecomodernist and ecosocialist approaches,[[106]](#footnote-106) both eco-socialists[[107]](#footnote-107) and proponents of degrowth[[108]](#footnote-108) argue for a decommodification of the relationships between humans and ecosystems and emphasize that the need for an economy based on use value. Nevertheless, when discussing technology there are tensions between eco-socialist positions which advocate for democratic centralizations such as state-funded national digital public services and infrastructures[[109]](#footnote-109) or platform socialism,[[110]](#footnote-110) and degrowth approaches that emphasize conviviality as a means of creating non-alienated technologies that draw upon forms of communing,[[111]](#footnote-111) including the free/open source software and peer-to-peer movements.[[112]](#footnote-112) Rather than advocating for any specific ‘solution’ we briefly highlight this diversity of postcapitalist approaches in order to advance dialogue and solidarity between those involved in promoting a range of ecosystem-centred alternatives to technological solutionism and hyper-efficient ‘green’ capitalism.

As it stands, AI and data centers exhibit network effects and economies of scale that lead towards the immense centralization associated with hyperscale data centers and this in turn produces oligopolistic corporate control over these systems and infrastructures.[[113]](#footnote-113) Although AI, the internet and computers were all developed within capitalist economies, the current, corporate-dominated model of AI infrastructure is not inevitable. Indeed, a key contention of postcapitalist approaches is that altering the governance of technologies can transform their functioning in ways that markedly reduce ecosystem harms and social inequalities. Platform socialists argue that current asymmetries of power between corporations, and ecosystems (including humans) can be meaningfully addressed by centralized public service models, such as those used in many nations for healthcare, telecommunication, sewage systems and other forms of infrastructure. Where a ‘natural monopoly’[[114]](#footnote-114) occurs, a use-value led approach suggests managing infrastructure as a socialised public good, rather than as private commodities. Elsewhere, cooperatives, federated, and distributed peer-to-peer systems, and other forms of digital commons suggest decentralized alternatives. Further, moving away from exchange value as a measure of wealth would entail that numerous harmful forms of AI would no longer be deemed useful or valuable.

Eliminating harmful models of capitalist surveillance designed to nudge citizens to engage in acts of unsustainable consumption, and corporate hoarding of as much data as possible in the hope that there will eventually be a way to monetize it,[[115]](#footnote-115) would enable significant reductions in data storage and computational processing. This would go some way toward reducing the current social and environmental harms AI incurs, while affording growth in those areas where AI can support the healing of ecosystems and communities rather than benefit the private interests of those who control technology and associated infrastructure. Within the context of data/digital colonialism,[[116]](#footnote-116) a key component of this change must involve the decolonization of data[[117]](#footnote-117) and enhanced technological sovereignty,[[118]](#footnote-118) enabling individuals and communities to utilize their data for their own benefit. However, decolonization must also go beyond data to address EUE.

It is critical to highlight the role of AI in the current extractivist, capitalist system, a system that is causing a global ecological collapse through rapacious overconsumption predicated upon spectacular levels of social inequality within and between regions of the globe, and which can be considered neither just nor ethical. Alongside addressing climate and ecological debt, what is urgently required is a rapid decommodification of the economic system in the economic core. This will enable those living outside the core to reinstitute sovereignty over their resources, technology, energy, and land. While there are contentious debates about the appropriate ways to move beyond capitalism, a starting point is acknowledging that we can. A political ecology perspective requires us to strengthen our understanding of the possible roles of AI in the process of postcapitalist transition and to develop a praxis around ‘AI ethics’ and justice that incorporates these broad aims. We need much more than an ethical plaster to cover the flawed structures and systemic failures we face on a global scale.

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