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Tech Won't Save Us: Climate Crisis, Techno-Optimism, and International Law

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Abstract

This article critiques the narrative that technological innovations can solve the climate crisis. It argues that technology is important for addressing environmental challenges, but on its own it cannot tackle the broader socioeconomic factors contributing to global ecological degradation. The article examines techno-optimism in international (environmental) law, illustrating its persistent focus on technological solutions from early treaties to contemporary policy agreements. By analysing the limitations of technology – particularly electric vehicles and bioenergy with carbon capture and storage – the article reveals how adherence to the techno-optimist narrative leads international law to undervalue the need for structural changes in our socioeconomic system. The article argues for a shift from the techno-optimist narrative to an ecological one, reflecting the urgent need to redefine development beyond economic growth and technological advancement.

Keywords: Climate change; international environmental law; techno-optimism; electric vehicles; bioenergy with carbon capture and storage (BECCS).

1. Introduction

A colleague recently told me they were not concerned about climate change because they felt they were doing their part. They invested in green funds, had recently bought an electric vehicle (EV) and had installed solar panels on their home. There is a lot to unpack here; their statement reflects a common perspective many of us share – believing that by taking individual actions and embracing technological solutions, we effectively contribute to addressing climate change. Like my colleague, many of us are adopting 'green' technologies.[1] We do not dispute the scientific consensus that human activities drive unprecedented changes in the Earth's climate.[2] We also acknowledge that, as temperatures rise, so do the risks of catastrophic events such as extreme weather, sea-level rise and loss of biodiversity.[3] But we also believe that new technological solutions will enable us to maintain the lifestyles we are accustomed to without concern about our environmental impact.[4]

It is even more troubling that this belief does not stop in our private lives: it also influences policy and environmental governance at national and global levels. International (environmental) law[5] has been shaped by this narrative, with many of

[1] On the adoption of 'green' technologies, see Marcacci, "The Vibes Lie"; Kearney, "US Solar Installations Hit Quarterly Record"; Cuthbertson, "Solar Panel World Record Broken in Huge Boost for Renewables"; Gardiner, "Green Bonds Reached New Heights in 2023."
[2] Oreskes, "The Scientific Consensus on Climate Change."
[3] Brewer, Climate Change.
[4] On how technology is driving solutions to the climate crisis, see United Nations. "Driving Innovation."
[5] In this article, any reference to 'international law' should be understood as also referring to specific the instruments of international environmental law. I treat international environmental law as a special regime within the broader field of public international law, consistent with the view set out by the International Law Commission's Fragmentation of International Law. On the relationship between general

its sources and authorities emphasising the role of technology as a key component in strategies to address climate change.[6] For instance, the Intergovernmental Panel on Climate Change (IPCC) issues reports outlining the potential of technologies such as carbon capture and storage to limit global temperature rise.[7] The Paris Agreement explicitly acknowledges the importance of technology transfer and innovation in achieving climate goals.[8] Similarly, the UN Framework Convention on Climate Change (UNFCCC) has established mechanisms to facilitate the implementation of climate technologies in developing states.[9]

Relying solely on technological developments to address climate change is insufficient, however. While technological innovations can be part of the solution to the climate crisis, believing that they can, by themselves, solve the crisis is misguided. In this article, I argue that technological advancements will fall short of resolving the climate crisis without addressing the underlying socioeconomic structures that drive environmental degradation – particularly a growth-dependent ideology. International law's adoption of the narrative of technological optimism can render it blind to the limitations of focusing solely on technology, overlooking the need for structural changes in the current economic system. Many of the existing policies aim to reduce emissions without requiring major structural changes, attempting to mask the broader problem and deferring effective action. In this respect, by prioritising technological solutions, international law risks underestimating the importance of adopting a more holistic approach to implementing regulatory measures aimed at transforming our socioeconomic system. This transformation is crucial for an effective approach to climate change and requires moving away from the current individualistic perspective towards collective action and systemic change.

To make my argument, I focus on two widely promoted technological solutions to climate change: EVs and bioenergy with carbon capture and storage (BECCS). At first glance, both appear to be preventive or even reparative measures – EVs by reducing reliance on fossil fuel-powered vehicles and BECCS by removing carbon from the atmosphere. However, as I argue, these technologies are best understood as mitigation tools that reduce emissions without demanding significant systemic change.[10] EVs maintain the current car-dependent mobility model, whereas BECCS allows high-emission industries to continue operating rather than eliminating reliance on fossil fuels. As such, these technologies show how climate policies focus on mitigating damage rather than addressing underlying causes. These two very distinctive technologies were deliberately chosen. EVs represent consumer-driven climate action, marketed to individuals as a means of contributing to sustainability. BECCS is a large-scale intervention promoted to policy-makers as a breakthrough in emissions reduction. Despite their differences, both serve as technological fixes that create the illusion of change while allowing the underlying structures that drive environmental degradation to persist. This article calls into question the idea that such mitigation-based solutions can solve the climate crisis by themselves.

In section 2, I discuss the role of technology in international (environmental) law, examining how international legal sources have consistently prioritised technological solutions in environmental governance. Section 3 dissects the allure of techno-optimism, scrutinising the belief that technology alone can lead to environmental sustainability. In section 4, I delve into two specific technological interventions – EVs and BECCS – to critique their effectiveness and implications for sustainable practices. In section 5, I explore the socioeconomics of techno-optimism, highlighting the contradictions between growth-dependent economic systems and the aims of environmental sustainability. That section calls for a shift towards alternative narratives to international law, suggesting approaches that challenge the prevailing growth-oriented paradigm and emphasise ecological strategies to address the climate crisis. I conclude the article in section 6.

2. Technology and International (Environmental) Law

Contemporary international law has evolved to address the regulatory challenges posed by new technological advancements. One of the first international organisations, the International Telegraph Union,[11] established in 1865, exemplifies an early effort to regulate cross-border communication technologies. In 1967, at the height of the Cold War, the Outer Space Treaty emerged from the optimistic assumption that humanity would soon have the potential to explore, exploit and colonise outer space –

international law and special regimes, see Marcos, "Two Kinds of Systemic Consistency in International Law" and Marcos, "From Fragmented Legal Order to Globalised Legal System."

[6] It is important to note that not all international law instruments or practices embrace a purely techno-optimist stance. In this article, references to techno-optimism within international law focus on a prevalent trend rather than a universal position and do not discount alternative approaches to the discipline (which will be discussed in sections 2 and 5).

[7] IPCC, Climate Change 2022.

[8] Paris Agreement, art 10.

[9] UNFCCC, art 4.

[10] The difference between preventive, reparative and mitigation technology is discussed in more detail in section 5.1.

[11] Now called 'International Telecommunication Union.'

activities that would need regulation.[12] Meanwhile, the 1968 Treaty on the Non-Proliferation of Nuclear Weapons highlighted the dangers of technological developments in warfare.[13]

The link between international environmental law and technological advances is even more evident, as states have realised that technological innovations could pose very real transnational risks to the environment, thus demanding unified action. The 1900 Convention for the Preservation of Wild Animals, Birds and Fish in Africa, for instance, was a response to advancements in firearms technology, which made hunting more efficient and thus could lead to the exhaustion of game on the African continent.[14] In 1959, the Antarctic Treaty designated the continent as a preserve for scientific and technological research.[15] Similarly, the 1982 UN Convention on the Law of the Sea (UNCLOS) addressed technological advances in maritime resource extraction, establishing guidelines for sovereignty and the exploitation of ocean resources.[16] In the last decades, key developments in international environmental law have continued to link environmental preservation with technological advancements. The 1985 Vienna Convention for the Protection of the Ozone Layer[17] and the subsequent 1987 Montreal Protocol[18] deal with phasing out ozone-depleting substances, encouraging technological cooperation and promoting the transfer of environmentally friendly technologies.

The 1992 UN Conference on Environment and Development (Rio 92) solidified technology's role in environmental governance. This conference produced the Rio Declaration on Environment and Development,[19] led to the signing of the UNFCCC and the Convention on Biological Diversity (CBD)[20] and laid the groundwork for the UN Convention to Combat Desertification (UNCCD).[21] The agreements from this conference underlined technology transfer as a crucial element for achieving sustainable development. The 1997 Kyoto Protocol to the UNFCCC introduced mechanisms such as the 'clean development mechanism', fostering technology transfer by allowing developed states to finance emissions-reduction projects in developing states to meet their own emissions targets.[22]

The 2015 Paris Agreement takes a step further by introducing a technology framework under Article 10, which aims to strengthen the development and transfer of technology to deal with climate change and reduce greenhouse gas emissions. The UN Sustainable Development Goals (SDGs)[23] likewise refer to technology and environmental protection, notably through SDG 9, which promotes industry, innovation and infrastructure, and SDG 13, which calls for urgent action to combat climate change and its impacts. Likewise, the 2023 Agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (BBNJ Agreement) brings attention to the role of technology in environmental impact assessments, monitoring marine biodiversity and ensuring effective management of marine protected areas.[24] It further highlights the importance of technology transfer to developing countries to enable their participation in the efforts to conserve the marine ecosystem.

Concerning transnational environmental litigation, as early as the *Trail Smelter* arbitration, there was an evident link between technological developments and environmental damage.[25] In this case, the Canadian mining and smelting company claimed its technological advancements would eliminate harmful sulphur dioxide emissions. However, this promise proved false, as sulphur dioxide levels along the Columbia River remained unchanged from the previous year, indicating no reduction in emissions. Locals, already sceptical of the International Joint Commission's strategy, grew increasingly frustrated as the toxic smoke continued to damage their crops and homes. Although there were scientific publications on the harmful effects of sulphur dioxide at the time, they were deemed insufficient to form a substantial scientific consensus. Subsequent research confirmed that sulphur dioxide emissions from the smelter were indeed responsible for the environmental damage, validating the concerns of the locals.[26]

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[12] Outer Space Treaty, preamble. See also Nucera, "International Geopolitics and Space Regulation."
[13] Treaty on the Non-Proliferation of Nuclear Weapons, preamble.
[14] IUCN, An Introduction to the African Convention, 15.
[15] Antarctic Treaty, art 2
[16] UNCLOS, arts 136, 140.
[17] Vienna Convention for the Protection of the Ozone Layer, arts 4–5.
[18] Montreal Protocol on Substances that Deplete the Ozone Layer, arts 10, 10A.
[19] Rio Declaration on Environment and Development, Principle 9.
[20] CBD, art 16.
[21] UNCCD, arts 12, 18.
[22] Kyoto Protocol to the UNFCCC, art 12.
[23] UN, Transforming our World, SDGs 9, 13.
[24] BBNJ Agreement, arts 11–12.
[25] Trail Smelter, 1905.
[26] Smith, "Anthropogenic Sulfur Dioxide Emissions," 1105.

The International Court of Justice (ICJ) has also addressed cases where technology intersects with the environment. For instance, in *Pulp Mills*, the ICJ assessed the environmental impact of Uruguay's pulp mill technology on the river shared with Argentina.[27] The Court emphasised the necessity of conducting thorough environmental impact assessments and ongoing monitoring to mitigate potential ecological damage. Similarly, in *Gabčíkovo-Nagymaros*, the ICJ examined the environmental implications of dam construction technology on the Danube River, highlighting the need for sustainable development and the precautionary principle in technological applications.[28] The World Trade Organisation (WTO) Dispute Settlement Body (DSB) cases also highlight intersections between technology, the environment and public health. The *Shrimp-Turtle* case, for example, centred on the US requirement that shrimp be harvested using turtle excluder technology.[29] *Tuna-Dolphin* similarly centres on US requirements for dolphin-safe nets to minimise dolphin fatalities during tuna fishing.[30] Moreover, the conflict in *EC-Hormones* involved the use of hormones in livestock and concerns over human health, with the European Community imposing bans on North American imports on the grounds of the environmental precautionary principle.[31]

The trend persists in the latest international decisions on environmental matters. In the 2024 *Klimaseniorinnen* case, the European Court of Human Rights (ECtHR) acknowledged the role of technological advancements in addressing climate change, highlighting that states have an obligation to implement these innovations effectively in emission reduction and renewable energy.[32] The Court examined whether Switzerland had taken adequate measures, including the use of new developing technologies, to limit its greenhouse gas emissions and meet its reduction targets, finding that Switzerland had failed to adequately assess and implement necessary measures, thus violating the European Convention on Human Rights (ECHR), particularly the right to respect for private and family life.[33] In the 2023 *La Oroya v Peru*, the Inter-American Court of Human Rights (IACtHR) also emphasised the importance of technology in dealing with environmental crises.[34] The Court ordered Peru to develop and implement a comprehensive environmental remediation plan, incorporating technology to monitor air, water, and soil quality. Additionally, the decision mandated that Peru ensure local operations comply with international environmental standards, employing technological advancements to prevent and mitigate damages to the environment and human health. The role of technology is also stressed in the 2024 Advisory Opinion on climate change issued by the International Tribunal on the Law of the Sea (ITLOS).[35] ITLOS recognised that modern technologies are crucial for accurately assessing and managing the health of marine ecosystems. The Advisory Opinion also emphasises the obligations of appropriate assistance via capacity-building, scientific expertise and technology transfer to ensure that vulnerable and developing states can access the necessary tools to effectively protect their marine environments.

Although the paragraphs above have focused on the prevalence of a technological focus in international law, it is important to recognise that such appraisal for technology is not a universally held view. Some states support alternative, non-technologically based strategies that incorporate traditional knowledge into their approach to environmental regulation. A prominent example comes from the Pacific Island states, whose diplomatic and legal stances often contradict technologically driven solutions. Several small island developing states (SIDS) – including Vanuatu, Tuvalu and Palau – have emphasised the integration of Indigenous worldviews and the cultural dimensions of environmental protection during the ongoing proceedings for the ICJ *Advisory Opinion on the Obligations of States in Respect of Climate Change*.[36] These SIDS argue that international law should encompass traditional ecological knowledge as technological innovation alone cannot protect the lives of underprivileged groups.[37] Beyond the ICJ proceedings, two examples of how SIDS approach environmental law differently are found in the 2021 Pacific Islands Forum Declaration on Preserving Maritime Zones and the 2023 Pacific Islands Forum Declaration on Statehood and Sea-Level Rise. Emphasising the need for legal stability, ecological integrity and cultural continuity in international law, the 2021 declaration asserts that marine zones should remain fixed under UNCLOS despite rising sea levels.[38] The 2023 declaration reiterates the will of these nations to maintain statehood and marine rights despite the challenges posed by climate change-induced sea-level rise.[39] These declarations clearly highlight the importance SIDS place on safeguarding legal rights and cultural heritage, thereby (at least indirectly) challenging the prevailing techno-centred perspective in

[27] *Pulp Mills*, 14.
[28] *Gabčíkovo-Nagymaros*, 7.
[29] *US-Shrimp*, 35.
[30] *US-Tuna II (Mexico)*, 13.
[31] *EC-Hormones*, 125.
[32] *KlimaSeniorinnen*, paras 192–98.
[33] European Convention on Human Rights, art 8.
[34] *La Oroya*, paras 183–90.
[35] *Advisory Opinion on the Obligations of States with Respect to the Marine Environment in Relation to Climate Change Impacts*, para 120.
[36] United Nations General Assembly, *Request for an Advisory Opinion of the International Court of Justice*.
[37] Gusman, "Pacific Island Countries Make Historic Submissions."
[38] Pacific Islands Forum, *Declaration on Preserving Maritime Zones*.
[39] Pacific Islands Forum, *Declaration on the Continuity of Statehood*.

international law. In this sense, even if techno-centrism continues to exert significant influence on contemporary international law, it is essential to acknowledge that there are also views within the international community that prioritise other perspectives over technological solutions.

There is nothing intrinsically wrong with expecting technological advancements to contribute to environmental protection. Institutions such as the IPCC, the Climate Technology Centre and Network and the International Renewable Energy Agency, for example, are conducting essential work. The IPCC's reports are particularly relevant as they highlight the vital role of technological developments – such as renewable energy sources, transitioning from fossil fuels and coal to more efficient energy systems and carbon capture and storage – in meeting the target of capping the global temperature increase at 1.5℃ (2.7ºF) above preindustrial levels.[40] The problem arises with an overreliance on technology, where new technological developments are awaited with undue optimism. This dependence may lead policy-makers to believe they can postpone decisive action today, assuming that imminent technological advancements will resolve all environmental challenges tomorrow. Such a belief perpetuates a dangerous cycle of inaction, with major socioeconomic decisions being continually deferred in anticipation of a miraculous technological fix. This allure influences not only politicians but also those involved in technological development, who may believe their innovations alone can rectify the systemic issues driving climate change.[41] The next section delves deeper into the origins of the techno-optimist narrative.

3. A Narrative of Techno-Optimism

Techno-optimism is an ideology based on the belief that technological advances lead to a better life and can even lead to a utopian society.[42] Some might consider the link between technology and societal progress self-evident, supposing it is inconceivable to consider an alternative. However, the conviction that technological advancement guarantees a better future for subsequent generations is a modern idea.[43] In Europe, for example, the notion of progress and that each generation improves upon the previous one became evident only after the Enlightenment and the Industrial Revolution; it was notably absent during earlier periods, such as the Middle Ages.[44] The roots of techno-optimism in the West can be traced back to the Enlightenment period of the seventeenth and eighteenth centuries, which celebrated reason and science as keys to human progress.[45] This ideological groundwork set the stage for the Industrial Revolution, which began in the late eighteenth century. Technological innovations, such as the steam engine, railways, and mechanised textile manufacturing, transformed Western societies, fostering a strong belief in the power of technology to drive progress.[46] In the nineteenth century, techno-optimism grew with inventions like the telegraph and the electric light bulb.[47] This belief was further validated in the early twentieth century through the widespread adoption of electricity, automobiles and later aviation.[48]

The post-World War II period saw an upsurge of technological optimism in the West driven by rapid advancements in electronics,[49] nuclear energy[50] and space exploration.[51] The successful moon landing in 1969, in particular, was the apotheosis of Western techno-optimism, showcasing human capability to achieve what once seemed impossible.[52] The subsequent decades saw the rise of information technology and the digital revolution, embedding technology even more deeply into daily life.[53] Unsurprisingly, techno-optimism flourished in the late twentieth and early twenty-first centuries, where various sub-ideologies and movements such as accelerationism,[54] cyber-utopianism,[55] transhumanism[56] and singularitarianism[57] emerged, depicting technological utopia as a reachable goal. For instance, the 'dot.com' culture combined anti-authoritarian attitudes with

[40] IPCC, Climate Change 2023.
[41] Szeman, "System Failure."
[42] On techno-optimism, see Corn, Imagining Tomorrow; Szeman, "System Failure;" Sovacool, "Technological Utopianism." See also Luri, Kaliyamurthy, and Farmer, "Sometime in the Future."
[43] Marwah, "A Road to Nowhere."
[44] Spencer, "Progress;" Bury, The Idea of Progress; Burrow and Wei, Medieval Futures.
[45] Hankins, Science and the Enlightenment.
[46] Heaton, "Industrial Revolution."
[47] Gilmore, Aesthetic Materialism.
[48] Tobey, Technology as Freedom.
[49] Carlisle, The Relationship of Science and Technology.
[50] Mendelsohn, "Science, Scientists, and the Military."
[51] McDougall, "Technocracy and Statecraft in the Space Age."
[52] Sibley, "Utopian Thought and Technology;" Tribbe, No Requiem for the Space Age.
[53] Floridi, The Fourth Revolution; Philbeck and Davis, "The Fourth Industrial Revolution."
[54] Williams, "#Accelerate."
[55] Rushkoff, Cyberia.
[56] Bostrom, "The Transhumanist FAQ;" More and Vita-More, The Transhumanist Reader.
[57] Vinge, "The Coming Technological Singularity;" Bostrom, Superintelligence.

libertarian economic views, reflecting a belief that digital technology would revolutionise human affairs and increase personal freedom.[58] The advent of cryptocurrencies epitomises such views. Bitcoin, introduced shortly after the 2008 economic crisis by the anonymous Satoshi Nakamoto, emerged as an alleged alternative to traditional financial systems.[59] Following Bitcoin's launch, numerous other cryptocurrencies and blockchain-based tokens have been developed; many of their developers argue that a decentralised financial ecosystem free from the centralised control of banks and governments would democratise finance, bringing prosperity for all.[60]

No one personifies contemporary techno-optimism better than Elon Musk. His ventures, such as Tesla and SpaceX, epitomise the belief in technology's ability to improve humanity. Tesla's EVs are celebrated as symbols of human ingenuity, with the potential to overcome the limitations and environmental challenges associated with fossil fuels. If Earth cannot be saved, Musk's SpaceX offers an alternative solution: colonising Mars. For many of his supporters, these projects position Musk as the embodiment of hopes invested in technological innovations as solutions to humanity's most pressing problems.[61] Echoing these views, Marc Andreessen published the Techno-Optimist Manifesto in 2023.[62] Andreessen asserts that many significant problems facing humanity can be solved through the development of technology, particularly when it is allowed to advance without constraints. As such, we should do everything possible to accelerate technological development. However, beneath the promises of this narrative lie potential dangers and overlooked issues. The next section continues the analysis of techno-optimism to uncover what it might be hiding.

4. The Underside of Techno-Optimism

The techno-optimist narrative is unmistakably Western-centric.[63] This is already evident in the framing of the Enlightenment and the Industrial Revolution, which sidelines the developmental status of other regions of the globe. The discourse of post-war optimism – a period that some refer to as the 'golden age of capitalism'[64] – only serves to highlight this bias. Depicting it as a stage of technological and economic progress largely ignores several non-Western regions' socio-political realities and cultural climates. For instance, many African countries were still embroiled in political struggles and armed conflicts for independence from colonial rulers. Families in Algeria, Angola, Congo, Kenya, Nigeria, and Zanzibar faced a significantly different situation than the average middle-class reality in Western Europe or the United States.[65] In Asia, countries like Cambodia, Laos, and Vietnam were also undergoing tumultuous paths toward independence, which would soon lead to conflicts lasting for decades, severely impacting the region's socioeconomic status.[66] In Latin America – particularly Argentina, Brazil, and Chile – this was also not a period of generalised optimism but rather one marked by political struggle, violent military coups and widespread human rights violations, creating a cultural climate far removed from the optimism celebrated in the West.[67]

The West's distance from many links in the supply chain required for these technological advancements makes it easy to ignore underlying costs, both human and environmental.[68] The extraction of resources, labour conditions in developing states and the environmental degradation linked to production processes are often ignored or dismissed in the techno-optimist narrative. The pursuit of technological fixes to sustain Western lifestyles frequently results in an oversight of the negative impacts associated with these technologies. This frantic search for technological solutions blinds the West to the broader consequences of its consumption patterns and perpetuates a cycle of exploitation and environmental harm in which the cost of maintaining such lifestyles is borne disproportionately by non-Western regions, which endure the brunt of environmental degradation and human rights abuses resulting from resource extraction and technological production.[69]

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[58] Ofek, "DotCom Mania"; Cassidy, Dot.Con.
[59] Nakamoto, "Bitcoin."
[60] Antonopoulos, Mastering Bitcoin; Antonopoulos, The Internet of Money; Guerra and Marcos, "Legal Remarks on the Overarching Complexities of Crypto Anti-Money Laundering Regulation."
[61] Stephen, "Inside the Minds of Elon Musk's Fans."
[62] Andreessen, "The Techno-Optimist Manifesto."
[63] Eisenstadt, "Multiple Modernities;" Wittrock, "Modernity" Mignolo, The Darker Side of Western Modernity; Gruenwald, "The Dystopian Imagination" See also Taneja, "Speculating the City."
[64] UN, "Post-War Reconstruction and Development in the Golden Age of Capitalism."
[65] Crowder, "The Second World War."
[66] Hewison, Southeast Asia in the 1990s; Khoo, "Technocracy and Economic Decision-Making."
[67] Nef, "Demilitarization and Democratic Transition;" Pereira, "Political Justice Under Authoritarian Regimes."
[68] Shekarian, "Sustainable Supply Chain Management."
[69] Sharma, "Changing Consumption Patterns."

In this section, I examine two technologies often hailed as promising solutions to climate change, offering the possibility of continuing our lifestyles without significant changes to our behaviour or consumption patterns. The first is the EV, widely adopted to reduce greenhouse gas emissions from transportation (section 4.1). The second is BECCS, endorsed by various official sources as essential for mitigating climate change and achieving net-zero emissions (section 4.2).

4.1 Electric Vehicles

One of the most emblematic technologies in combating climate change is the EV, which provides a consumer-friendly approach to addressing the environmental crisis. EVs promise to reduce greenhouse gas emissions while letting people indulge in the comfort and luxury to which they are accustomed: owning one or more vehicles per household. From the consumer's perspective, it is a win–win: save the planet while preserving their lifestyle. Official environmental initiatives also seem to subscribe to the hopes placed in EVs. For instance, the 'European Green Deal' explicitly mentions EVs as a part of a sustainable mobility strategy for the EU to become climate neutral by 2050.[70] The IPCC's 2023 Climate Change Report also addresses EVs as a means of mitigating climate change in the transport sector.[71] Likewise, the IPCC's Climate Change 2022 Report discusses integrating EVs within the renewable energy sources framework as a way to reduce transport-related emissions.[72]

EVs are regarded as a sustainable alternative to traditional internal combustion engine vehicles. Their primary advantage lies in their potential to reduce greenhouse gas emissions, which are a major contributor to global warming and climate change. EVs can operate with zero tailpipe emissions by using electric power from batteries.[73] As such, the adoption of EVs can significantly decrease the reliance on fossil fuels. Traditional internal combustion engine vehicles run primarily on gasoline or diesel, both of which contribute to air pollution and pose risks related to their extraction, such as oil spills and habitat destruction.[74] In contrast, EVs can be powered by electricity generated from various sources, including renewable energy options such as solar, wind and hydroelectric power.[75]

Such an optimistic view of EVs overlooks several downsides, however.[76] The extraction and processing of raw materials necessary for the batteries used in EVs pose significant ecological and human rights concerns.[77] These mining activities are frequently linked to severe environmental degradation and exploitative labour practices, particularly in Africa and South America.[78] The extraction of lithium has caused substantial environmental harm in the "Lithium Triangle," which spans Chile, Bolivia, and Argentina.[79] For example, in the Atacama salt flats of northern Chile, approximately 2.2 million litres of water are needed to produce one ton of lithium. Such immense water consumption in an arid region diverts scarce water resources away from local communities.[80]

The disposal and recycling of the batteries of EVs also pose additional environmental concerns.[81] The limited lifespan of lithium-ion batteries needs effective recycling methods to prevent the accumulation of hazardous waste.[82] With the rapid growth in the number of EVs and the substantial size of their batteries, significant amounts of lithium-ion battery waste are being generated annually.[83] If this waste is not effectively recycled and reused, it could lead to severe environmental impacts. Unfortunately, current recycling technologies are still developing and are not keeping pace with the rapid increase in the production of EVs.[84] The energy source for charging EVs is another factor to consider in their overall environmental impact. In regions such as Europe,[85] where electricity is generated predominantly from fossil fuels, the emissions associated with EV charging would partially offset the benefits of reduced tailpipe emissions.[86] As such, the shift to EVs might be insufficient

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[70] European Commission, "The European Green Deal."
[71] IPCC, Climate Change 2023.
[72] IPCC, Climate Change 2022, Chs 6, 10.
[73] Chen and Khattak, "The Future of Green Transportation."
[74] Reşitoğlu, "The Pollutant Emissions from Diesel-Engine Vehicles and Exhaust Aftertreatment Systems."
[75] Bastida-Molina, "Multicriteria Design and Experimental Verification of Hybrid Renewable Energy Systems. Application to Electric Vehicle Charging Stations."
[76] Ankathi, "Beyond Tailpipe Emissions."
[77] Das, "The Cobalt Supply Chain and Environmental Life Cycle Impacts of Lithium-Ion Battery Energy Storage Systems."
[78] "Lithium-Ion Batteries Need to Be Greener and More Ethical."
[79] Maeve Campbell, "South America's 'Lithium Fields'."
[80] Roche, "S-LCA of Lithium Mining in Chile."
[81] Weidenkaff, "A World Without Electronic Waste."
[82] Gaines, "The Future of Automotive Lithium-Ion Battery Recycling."
[83] Baum, "Lithium-Ion Battery Recycling."
[84] Yu, "Current Challenges."
[85] Eurostat, Shedding Light on Energy in Europe.
[86] Hawkins, "Comparative Environmental Life Cycle Assessment."

without a systemic transition to renewable energy sources, which would involve substantial investment in renewable energy infrastructure, policy support for clean energy initiatives and advancements in energy storage technologies to manage the intermittent nature of renewable power sources.[87]

4.2 Bioenergy with Carbon Capture and Storage

Another technology lauded as promising in the fight against climate change is BECCS, which promises to reduce carbon dioxide emissions in the atmosphere.[88] A BECCS system starts by producing energy from burning biomass (crop residues, forest residues, or dedicated energy crops). During this process, carbon dioxide is produced, but in a BECCS system, the carbon is captured before it can escape into the atmosphere through special technologies designed to trap the carbon dioxide gas. Once captured, carbon dioxide is transported and stored underground in geological formations or old oil and gas fields, thus preventing carbon dioxide from entering the atmosphere.

Article 4 of the Paris Agreement encourages the development and deployment of carbon removal technologies (which include BECCS) as part of a suite of strategies to achieve the goal of capping the global temperature increase. The Agreement also requires states to submit their nationally determined contributions, outlining their plans for reducing greenhouse gas emissions. Many states include BECCS in their plans as mitigation strategies, with the Energy Futures Initiative (EFI) dedicating a large portion of its 2022 report to analysing the BECCS industrial landscape in the United States.[89] BECCS is also extensively mentioned in IPCC reports as a critical component of climate change mitigation. In the Special Report on Global Warming of 1.5°C, the IPCC mentions BECCS in the context of the carbon dioxide-removal technologies that are needed to achieve net negative emissions.[90] Similarly, the IPCC Special Report on Climate Change and Land discusses the implications of large-scale BECCS deployment as an instrument to mitigate climate change and addresses the potential need to change land-use policies.[91] In the recent 2023 Climate Change Sixth Assessment Report, the IPCC includes BECCS within various strategies to mitigate climate change, underscoring its role alongside other negative emission technologies as a possible instrument to meet the more stringent climate targets.[92]

A significant criticism that can be made against BECCS concerns its scalability and the sustainability of biomass production.[93] Delivering BECCS at the scale required to meet global climate targets involves substantial land use.[94] Estimates suggest that an additional 300–600 million hectares of land would be needed for energy crop production (for comparison, the total land area of the EU is around 400 million hectares). This represents a considerable shift in land use, equivalent to about 40 per cent of current global arable land. Such a large-scale conversion would necessarily lead to deforestation, loss of biodiversity and competition with food production, raising concerns about land rights.[95] Moreover, the logistics of transporting and processing vast amounts of biomass, along with the construction of the necessary infrastructure for carbon capture and storage, present further challenges.[96] Existing infrastructure does not support widespread carbon dioxide transport and storage, and building this infrastructure would require massive investment and international cooperation. These economic and technical barriers make the large-scale deployment of BECCS highly uncertain and potentially unfeasible within the time limits necessary to meet climate goals.[97]

The effectiveness of BECCS in achieving genuine net negative emissions is still uncertain due to the complexities of the entire supply chain, from biomass production to carbon storage.[98] For instance, the type of biomass used can significantly impact the overall emissions balance. Life-cycle assessment studies show significant variability in emissions reductions depending on the specific supply chain configurations and assumptions made.[99] There are questions about the long-term monitoring and verification of carbon storage and the potential risks of leakage, which would undermine the benefits of BECCS. If leakage occurs, it could release significant amounts of carbon dioxide back into the atmosphere, negating carbon capture efforts.[100] An

87 Zsiborács, "Intermittent Renewable Energy Sources."
88 Tanzer, "Decarbonising Industry via BECCS."
89 EFI, "Surveying the BECCS Landscape."
90 IPCC, Global Warming of 1.5°C.
91 IPCC, Climate Change and Land.
92 IPCC, Climate Change 2023, 27.
93 Günther, "Human Rights and Large-Scale Carbon Dioxide Removal."
94 Gough, "Challenges to the Use of BECCS."
95 Kreuter, "The Geopolitics of Negative Emissions Technologies;" Stoy, "Opportunities and Trade-Offs."
96 Heffron, "Three Layers of Energy Law."
97 Yang, "The Global Mismatch."
98 Talus, "Carbon Capture and Utilization."
99 Duval-Dachary, "Life Cycle Assessment of BECCS Systems."
100 Deng, "Leakage Risks of Geologic CO_2 Storage."

example of this risk is the In Salah carbon dioxide storage project in Algeria, where concerns about carbon dioxide leakage due to pressure build-up led to a temporary halt in operations.[101] Finally, political hazards are also associated with relying on BECCS, as it might reduce the urgency for immediate emission reductions and mitigation efforts in other sectors. If policy-makers perceive BECCS as a solution to climate change, they might delay necessary regulatory actions to cut emissions in industries such as transportation and manufacturing, leading to a prolonged period of high emissions.[102]

5. From 'Innovate or Die' to 'Coexist or Collapse'

In the previous section, I discussed technologies that have been presented as solutions to climate change, highlighting their limitations. While EVs and BECCS are marketed as sustainable technologies, they come with environmental trade-offs that complicate their real effectiveness. These technologies do not fully address the structural problems driving climate change, and in some cases may even create new problems. However, beyond these imperfect solutions there are also technologies that, despite their growing popularity, are actively detrimental to climate efforts. These technologies attract enormous investment and enthusiasm, yet their environmental impact is often overlooked, as they are developed and deployed without sufficient regard for their planetary footprint.

As noted in section 3, blockchain-based cryptocurrencies epitomise certain contemporary techno-libertarian ideals, promising a decentralised financial ecosystem beyond the reach of traditional banks and governments. Despite this rhetoric, the mining process for cryptocurrencies such as Bitcoin (and until recently Ethereum)[103] is highly energy-intensive.[104] These networks commonly rely on a 'proof-of-work' consensus mechanism, which requires powerful computers to solve complex cryptographic puzzles to validate transactions and mint new coins.[105] This process, known as 'mining', demands enormous computational power and, in turn, vast amounts of electricity – much of which still comes from fossil fuel sources.[106] Mining operations often cluster in regions with cheaper electricity,[107] including some developing countries whose energy grids remain heavily reliant on coal or natural gas.[108] Consequently, the net effect is to shift the environmental burden to areas already grappling with pollution and resource scarcity. Some estimate that Bitcoin's annual energy consumption rivals that of entire mid-sized nations,[109] contributing significantly to global carbon emissions when fossil fuels are burned to power these mining facilities.

Artificial Intelligence (AI) is another high-profile technology that has attracted significant investment and public enthusiasm, yet it is also highly energy intensive. While popular media outlets often speak of the electricity or water usage per individual user query (such as when we ask questions to ChatGPT),[110] the actual bulk of AI's carbon footprint originates in the training phase for large language models (LLMs).[111] Unlike everyday computers, LLMs rely on training that depends on massive clusters of specialised hardware (such as GPUs and TPUs) running continuously for days or even weeks,[112] generating substantial heat that must be countered by equally energy-intensive cooling in data centres.[113] One study found that training a single deep-learning model for natural language processing produced over 280 metric tons of carbon dioxide – roughly five times the lifetime emissions of an average car.[114] Even though AI can aid climate-related data-driven research,[115] such as improving climate modelling and risk assessment, its high power consumption and intensive cooling requirements could potentially undermine its potential for helping sustainability projects.[116] As such, even incremental hardware and software

[101] Oldenburg, "Leakage Risk Assessment."
[102] Quiggin, "BECCS Deployment"; Greenpeace UK, "Written Evidence Submitted by Greenpeace UK."
[103] In 2022, Ethereum transitioned from a 'proof-of-work' to a 'proof-of-stake' consensus mechanism through 'The Merge,' which seems to have reduced its energy consumption. See European Blockchain Observatory and Forum, Ethereum Merge: Trend Report.
[104] De Vries, "Bitcoin's Growing Energy Problem."
[105] Sriman, "Blockchain Technology"
[106] Jones, "Economic Estimation of Bitcoin Mining's Climate Damages."
[107] Roberts, "This is What Happens."
[108] Chamanara, "The Environmental Footprint of Bitcoin Mining."
[109] Kohli, "An Analysis of Energy Consumption and Carbon Footprints."
[110] Business Today, "Every Time You Talk to ChatGPT."
[111] Cao, "Making AI Less 'Thirsty'"; Liu and Yin, "Green AI."
[112] Fernandez, "Hardware Scaling Trends and Diminishing Returns in Large-Scale Distributed Training."
[113] Stackpole, "AI Has High Data Center Energy Costs — but There Are Solutions."
[114] Strubell, "Energy and Policy Considerations"; see also Hao, "Training a Single AI Model."
[115] For example, see Jones, "AI for Climate Impacts."
[116] Ligozat, "Unraveling the Hidden Environmental Impacts."

improvements on efficiency may fail to keep pace with the rapid expansion of large-scale AI projects and their energy expenditure.[117]

Regardless of whether we are discussing EVs, BECCS, blockchain or AI, the tendency to overlook the environmental impact of these technologies highlights a broader trend in technological development—one that prioritises innovation and market adoption over true sustainability. These micro-level examples of technological developments have illustrated how techno-enthusiasm can sideline deeper ecological concerns. In what follows (section 5.1), I shift to a macro perspective, arguing that the hopes vested in new technologies to tackle climate change result from our present socioeconomic system and its connection to growth and innovation. I then proceed (section 5.2) to explore an alternative ecological narrative, challenging the dominant assumption that continued economic growth and environmental protection can coexist.

5.1 The Socioeconomics of Techno-Optimism

Our current socioeconomic system is growth-dependent, a notion that can be summarised by the 'innovate or die' mentality.[118] This dependency is not a by-product but a fundamental prerequisite for the stability and continuation of the system. Capitalism thrives on the continual expansion of production, consumption and profit. Without consistent growth, capitalist economies risk severe crises and instability.[119] This growth imperative drives resource exploitation, technological innovation and mass consumption, creating a cycle that demands ever-increasing levels of economic activity.[120] Schumpeter's ideas, particularly his concept of 'creative destruction', are critical to this growth-centric model.[121] Schumpeter argued that technological change is the engine of capitalist expansion, incessantly revolutionising the production and delivery of goods and services.[122] This process introduces volatility within competitive markets as new technologies render old ones obsolete, compelling firms to innovate continuously to survive. Schumpeter identified the 'visionary entrepreneur' as the central figure in this process, constantly seeking competitive advantages to outpace rivals.[123]

The 'innovate or die' mentality has become deeply embedded in our contemporary ideology, underpinned by the belief that technological progress is synonymous with economic prosperity. Schumpeter's theories were later expanded to emphasise the systemic nature of innovation, highlighting the importance of creating environments conducive to technological advancement through interactions between public and private institutions.[124] In this perspective, innovation drives economic growth and stretches the limits imposed by resource scarcity.[125] However, the relentless pursuit of innovation and growth often overlooks the nature of technological development and its broader implications. The focus on techno-optimist beliefs that technological progress is inevitable, and that increased productivity is inherently beneficial has normalised the notion that continuous economic expansion is natural.

Growth dependency is a hallmark of capitalist economies and a driving force that shapes policies, organisational strategies and societal norms. It perpetuates a cycle that prioritises economic expansion at the expense of all other considerations.[126] The dependency on growth couples with techno-optimism in expecting that any problem – including climate change – can and should be solved by technological innovation.[127] Such expectations are unequivocally evident in the OECD's publications. In the 2011 report on promoting technological innovation to address climate change, the organisation states that 'Technological change is undoubtedly one of the keys to ensuring that climate change can be addressed without compromising economic growth.'[128] In its 2023 outlook on science, technology and innovation, the OECD states that 'Without a major acceleration in low-carbon innovation, reaching net-zero emissions by 2050 will be unachievable.'[129] The same spirit inhabits the OECD's 2024 report on anticipatory governance for emerging technology: 'Emerging technologies can contribute to unprecedented gains in health, energy, climate, food systems, and biodiversity.'[130]

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117 Wright, "Efficiency is Not Enough"; Chakraborty, "Towards A Comprehensive Assessment." See also Marcos, "Can Large Language Models Apply the Law?"
118 Pansera, "Innovation Without Growth."
119 Harvey, The Enigma of Capital.
120 Foster, The Ecological Rift.
121 Schumpeter, Capitalism, Socialism, and Democracy.
122 Aghion, "A Model of Growth."
123 Śledzik, "Schumpeter's View on Innovation."
124 Ziemnowicz, "Joseph A. Schumpeter and Innovation."
125 Barbier, "Endogenous Growth and Natural Resource Scarcity."
126 Koch, "Social Policy Without Growth."
127 Barry, "Bio-Fuelling the Hummer?"
128 OECD, Promoting Technological Innovation.
129 OECD, Science, Technology and Innovation Outlook 2023.
130 OECD, "Framework for Anticipatory Governance."

The major issue is that these techno-optimist narratives fail to address the deep-rooted values and the politics of unsustainability that shape contemporary societies. As Blühdorn argues, modern eco-political practices are more about managing the implications of 'sustained unsustainability' than genuinely transforming societal values and behaviours.[131] The emphasis on technology as a solution enables societies to avoid confronting uncomfortable truths about our behaviour. This faith in technological fixes perpetuates the idea that we can maintain our current lifestyles and economic models without significant changes to our consumption patterns or societal values.[132] It suggests that the crisis can be managed without addressing the systemic drivers of ecological destruction. The OECD's publications clearly reflect the secondary position given to behavioural change: 'Reaching this [net-zero emissions] target requires rapid large-scale deployment of available technologies … as well as the development and widespread use of technologies that are far from mature today … It also requires behavioural change.'[133] Note how the need for behavioural change is acknowledged, but presented almost as an afterthought, a secondary consideration to be addressed besides ongoing technological development.

In this respect, an important distinction must be made between different technological approaches to environmental governance: prevention, reparation and mitigation.[134] Prevention is grounded in an anticipatory rationale, requiring due diligence and the implementation of proactive measures with a broad ecological scope to safeguard the environment in its entirety.[135] Prevention requires systemic changes that eliminate environmental harm before it occurs – such as shifting away from car-dependent urban planning.[136] Reparation deals with harm that has already been inflicted. It includes legal mechanisms such as environmental liability laws, financial compensation for affected communities and large-scale ecological restoration projects.[137] Reparation can take the form of funding for climate adaptation in vulnerable regions, land restoration or even reparative action for communities displaced by environmental changes.[138] While reparation acknowledges past harm, it does not necessarily prevent its recurrence, and in some cases it can lead to scenarios where damage is compensated for but the underlying causes remain intact.[139]

Mitigation seeks to reduce the damage caused by ongoing activities without fundamentally altering them. This is where the vast majority of policies have been concentrated.[140] EVs are a clear example: rather than questioning our dependency on cars, they offer a cleaner alternative that still enables mass car ownership, transport infrastructure expansion and resource-intensive production. BECCS is another clear example of mitigation. While at first glance it might seem to align with reparation, as it removes carbon from the atmosphere, its primary function is not to address past emissions but rather to enable the continuation of high-emission industries with minimal disruption. So, rather than transforming the energy system, BECCS attempts to justify the persistence of our reliance on fossil fuels. The same logic applies to the financial sector, as financiers promote 'green' financial products while continuing to finance harmful industries, maintaining the very economic structures that drive environmental degradation.[141] Almost all climate policies that have been implemented – and remain in force – have shared this same core objective: mitigate emissions without requiring major systemic change.[142] They seek to make activities less harmful, but they do not challenge the underlying logic of endless economic growth and consumption. As a result, they allow the crisis to be masked rather than solved, continually deferring responsibility to future generations while ensuring the status quo remains untouched.

The mainstream eco-political discourse focuses more on mitigating the visible symptoms of unsustainability than addressing its root causes. In other words, contemporary environmental practices tend to perpetuate the politics of unsustainability, prioritising short-term stability over the profound sociocultural transformation needed for true ecological sustainability.[143] As

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131 Blühdorn, "Sustaining the Unsustainable."
132 Blühdorn, "Post-Capitalism, Post-Growth, Post-Consumerism?"
133 OECD, Science, Technology and Innovation Outlook 2023.
134 Sources often use varying terminology or group these three approaches to environmental governance together. For example, the US Federal Council on Environmental Quality (CEQ) provides a broad definition of mitigation, which can encompass elements of prevention and even reparation. So, I am not using these terms as universally adopted categories, but as analytical distinctions to differentiate between clearly distinct strategies of environmental governance. CEQ, Definition of Mitigation.
135 Duvic-Paoli, The Prevention Principle.
136 See, for example, Winkler, "The Effect of Sustainable Mobility Transition Policies."
137 Pérez-León-Acevedo, "Reparations in Environmental Cases."
138 Mayer, "Climate Change Reparations."
139 Kindji, "Assessing Reparation of Environmental Damage."
140 Biesbroek, "On the Nature of Barriers to Climate Change Adaptation"; Meadowcroft, "What About the Politics?"
141 Dempere, "Unveiling the Truth." Hassani and Bahini introduce the concept of 'crosswashing,' where companies strategically invest in sustainable activities to boost environmental, social and governance (ESG) scores while preserving non-sustainable core operations, effectively masking ongoing environmental degradation. Hassani, "Crosswashing in Sustainable Investing."
142 For an overview of the effectiveness of climate policies, see Stechemesser, "Climate Policies That Achieved Major Emission Reductions."
143 Blühdorn, Sustainability–Post-Sustainability–Unsustainability.

such, the current mainstream discourse on sustainability has become a means to perpetuate the socioeconomic *status quo* without substantial structural transformation. Sustainable development policies often focus on technological solutions and market-based mechanisms that allow for continued economic growth under the guise of environmental responsibility.[144] This approach avoids confronting the fundamental paradox of a growth-dependent system operating within finite ecological limits. Techno-optimism is a clear symptom of this paradox.

While techno-optimist narratives provide hope for a seamless transition to sustainability through innovation, they ultimately fail to challenge the underlying problems causing the climate crisis. In the same way, by neglecting to consider the root causes of the crisis, such as capitalism's growth imperative, international law risks perpetuating the very structures that drive climate change. Technological advancements undoubtedly offer tools that can mitigate some of the adverse effects of climate change; however, these innovations are insufficient on their own to address the full scope of the environmental challenges we face. Technological solutions focus on improving efficiency within the current economic system rather than transforming the system itself. This approach leads to the continuation of the politics of sustained unsustainability, where the underlying drivers of environmental degradation remain unchallenged.

5.2 Towards an Ecological Narrative

Without challenging these socioeconomic drivers, efforts to mitigate climate change will remain insufficient. While detailed solutions lie beyond the scope of this article, it is essential to highlight alternative approaches within international law, such as post-growth approaches, which call for rethinking economic systems.[145] These approaches advocate shifting away from relentless growth to tackle root causes of the crisis rather than relying exclusively on technological solutions. An ecological narrative within post-growth offers a different perspective on our relationship with the environment, challenging individualistic notions that separate us from our surroundings.[146] An ecological narrative invites us to consider how our actions resonate within the larger context of the biosphere[147] and to understand that our individual stories are part of a much larger ecological tale.[148] Being ecological is not just being 'green'; it means moving beyond self-centred views to embrace a holistic understanding of our place in the world. Shifting from an individualistic, technology-reliant view to an ecological narrative means recognising humans as integral parts of the ecological web, deeply intertwined with the non-human world. So, instead of 'innovate or die', we might consider 'coexist or collapse'.

There is a critical distinction between superficial engagement with nature in individualistic narratives and the deeper engagement an ecological narrative demands. Individualistic narratives focus on personal experiences or achievements, centring on the individual's perspective. In contrast, ecological thought recognises the multiple voices and experiences within the ecological narrative.[149]A personal commitment to 'green' technologies is commendable but it invites deeper reflection, as it may reflect an underlying belief that individual efforts and technological solutions alone are sufficient. A notion that ' I am doing my part, so I need not be concerned with anything else' encapsulates a tendency to address global issues individualistically, neglecting the necessity of collective action. In this context, an ecological narrative challenges the assumption that we can buy our way out of environmental crises through 'green' technologies. Instead, it emphasises the importance of fundamentally rethinking our relationship with the planet. This narrative calls on us to acknowledge our intrinsic interconnectedness, recognising that we cannot separate ourselves from the environment – there is no 'nature' independent of us.[150] As participants in a shared world, addressing climate change requires collective responsibility alongside individual efforts.

In international law, an ecological narrative would emphasise the limitations of relying solely on individual actions and technological solutions, while also uncovering deeper issues, such as the dependence on perpetual economic growth. The prevailing focus on individual responsibility reinforces an outlook that obscures the structural and systemic dimensions of environmental crises.[151] In this context, a continued reliance on techno-optimism avoids addressing the growth-driven ideology that underpins environmental harm. The institutional promotion of 'green' technologies often serves as a distraction from more fundamental issues, such as the structural incentives that drive over-consumption, resource exploitation and environmental

[144] Eisenmenger, "The Sustainable Development Goals Prioritise Economic Growth."
[145] Jackson, Post Growth.
[146] An ecological narrative is consistent with a post-growth approach, recognising the irrationality of seeking unlimited growth on a finite planet. For an overview of post-growth theories, see Fioramonti, "Post-Growth Theories in a Global World."
[147] In this sense, the ecological view is consistent with an ecosystem approach. On the latter, see De Lucia, The 'Ecosystem Approach.'
[148] Morton, Being Ecological.
[149] Morton, The Ecological Thought.
[150] Morton, Ecology Without Nature.
[151] Maniates, "Individualization."

deregulation. By placing the burden of environmental responsibility on individuals, governments and corporations deflect attention from the systemic forces that enable environmental degradation – such as fossil fuel subsidies, unsustainable industrial practices and weak enforcement of environmental norms in place.[152] Consequently, current approaches risk overlooking the socioeconomic drivers of environmental harm and undervaluing the importance of regulatory measures that enforce emission reductions and encourage systemic behavioural changes. Without structural changes, the emphasis on individual action remains insufficient, and in many cases counterproductive.[153] A genuine ecological approach would move beyond consumer-based solutions and challenge the institutional frameworks that perpetuate environmental harm, ensuring that international law prioritises legally binding commitments leading to systemic transformations for true sustainability.[154]

International law would need to move beyond an emphasis on economic growth and sustainable development to pursue true sustainability that prioritises ecological integrity and collective well-being. Achieving this shift entails adopting alternative economic metrics that mirror ecological health and social equity, rather than merely reflecting gross economic output.[155] For instance, the Genuine Progress Indicator (GPI)[156] or Gross National Happiness (GNH)[157] go beyond Gross Domestic Product's (GDP) narrow scope by incorporating broader measures of societal welfare.[158] Bhutan's GNH framework explicitly treats environmental conservation as a cornerstone, steering national policies away from unchecked growth.[159] Aotearoa New Zealand's Wellbeing Budget,[160] launched in 2019, similarly foregrounds mental health, child poverty, and environmental quality in shaping fiscal decisions.[161] The European Green Deal's 'Beyond GDP'[162] initiative likewise complements conventional economic assessments through programs such as the EU Taxonomy for Sustainable Activities,[163] which classifies economic activities according to their environmental impact. These alternative measures offer a deeper and more ecologically attuned lens through which to view development.[164] Including such metrics in international law could assist practitioners in steering the law towards truly sustainable goals, ensuring that 'progress' no longer prioritises financial expansion for a few but rather reflects the collective interests of the many.

Moving away from a top-down approach, international law should address fundamental socioeconomic issues by enacting policies that emphasise local empowerment and participation. Community-based resource management exemplifies this approach, as it permits local actors to exercise greater authority over their natural resources.[165] Indigenous-led conservation in the Amazon rainforest shows that when Indigenous communities gain legal recognition of their lands, deforestation rates substantially diminish.[166] A World Resources Institute study showed that deforestation in legally recognised Indigenous territories within the Amazon is two to three times lower than in adjacent areas.[167] The Joint Forest Management program in India further supports this claim, enabling local villages to co-manage forest resources sustainably while benefiting from their use.[168] Likewise, the Haida Nation's stewardship of Gwaii Haanas National Park Reserve in Canada shows how Indigenous oversight can complement domestic environmental legislation, resulting in more robust protections for biodiversity.[169] New Zealand's decision to grant the Whanganui River legal personhood and co-manage it with the local Māori community is another illustration of how ecological governance can be reshaped to incorporate community stewardship and values.[170] Such approaches challenge regulatory models imposed from above that often neglect local knowledge and cultural priorities. Instead, by incorporating community governance into international legal frameworks, law-makers could promote more resilience in environmental stewardship, resulting in outcomes that are both ecologically sustainable and culturally responsive.

152 Klein, This Changes Everything.
153 Shove, "Beyond the ABC."
154 Kim, "International Environmental Law." On ecological economics, see Daly, Ecological Economics. On an ecological approach to constitutional law, see Collins, The Ecological Constitution.
155 Jackson, Prosperity Without Growth.
156 Garcia, "Economics of the Genuine Progress Indicator."
157 Thinley, "National Progress, Sustainability and Higher Goals."
158 Stiglitz, Report by the Commission. See also Kubiszewski, "Beyond GDP."
159 Ura, A Short Guide to Gross National Happiness Index.
160 The Treasury New Zealand, The Wellbeing Budget 2019.
161 Mintrom, "New Zealand's Wellbeing Budget Invests in Population Health."
162 Joint Research Centre, Beyond GDP.
163 European Commission, EU Taxonomy for Sustainable Activities.
164 Schütze, "The EU Sustainable Finance Taxonomy and Its Contribution to Climate Neutrality."
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166 Silva-Junior, "Brazilian Amazon Indigenous Territories."
167 Ding, Climate Benefits, Tenure Costs.
168 Tewari, "Joint Forest Management."
169 Swerdfager, "Co-Management at a Crossroads in Canada."
170 Cribb, "Beyond Legal Personhood for the Whanganui River."

International law should likewise incorporate Indigenous and traditional knowledge systems rooted in relational frameworks,[171] recognising that humans and non-humans co-inhabit a shared ecological system.[172] Legal mechanisms that validate these perspectives could strengthen environmental governance by integrating practices such as rotational farming, 'cultural burning' for ecosystem management and sustainable hunting and fishing methods shaped by Indigenous traditions. For example, Aboriginal communities in Australia employ carefully managed burns to foster biodiversity, encouraging new plant growth and reducing hazardous underbrush.[173] In North America, the Coast Salish peoples rely on selective fishing systems such as weirs and reef nets, ensuring stable fish stocks.[174] Similarly, Andean communities in Peru practise rotational agriculture that conserves soil fertility and biodiversity without resorting to industrial fertilisers.[175] Initiatives such as Ecuador's recognition of the Rights of Nature in its 2008 Constitution,[176] granting ecosystems legal personhood (similar to the abovementioned legal recognition of the Whanganui River in New Zealand), illustrate how international law could evolve to accommodate Indigenous worldviews. Bolivia's Law of Mother Earth (*Pachamama*), which endows nature with rights akin to human rights, further demonstrates the feasibility of integrating Indigenous worldviews into formal legal frameworks.[177] Such worldviews offer a corrective lens to dominant perspectives that prioritise economic goals over ecological integrity.

Another key aspect of proposed international law reforms concerns the strengthening of legal powers to hold businesses accountable for environmental damage. At present, many international mechanisms depend on voluntary codes of conduct or weak enforcement, effectively enabling businesses to pass on ecological costs.[178] An ecological perspective on international law would therefore need a shift towards binding obligations that compel corporations to fully account for the environmental repercussions of their operations. For instance, the EU's Corporate Sustainability Due Diligence Directive[179] could illustrate this approach by requiring companies to identify and mitigate environmental and human rights risks throughout their supply chains. Likewise, France's Duty of Vigilance Law (2017)[180] places legal responsibilities on large corporations to prevent environmental and social harm, with potential liability in case of inaction. Germany's Supply Chain Due Diligence Act (2021)[181] similarly mandates corporate accountability for environmental and human rights violations in supply chains, prompting firms to adopt more sustainable practices.

Broadening legal liability for environmental damage – exemplified by the concept of ecocide, currently under discussion as a potential international crime – could intensify corporate accountability. The Stop Ecocide Foundation, together with the Pacific Island nations of Vanuatu, Fiji and Samoa, have been advocating for the possibility of recognising ecocide as a fifth core crime under the Rome Statute,[182] signalling a growing commitment to criminalising large-scale environmental destruction.[183] Notably, Belgium has incorporated ecocide into its penal code, making it one of the first states to impose criminal penalties for grave ecological harm,[184] while Brazil contemplates new legislation aimed at holding corporations criminally accountable for deforestation and environmental degradation.[185] Strengthening laws on environmental liability and expanding judicial mechanisms – such as through the prospective UN Binding Treaty on Business and Human Rights[186] – could equip international law with the necessary tools to foster a genuinely ecological model of corporate responsibility, prompting businesses to safeguard the environment rather than simply pay for damage after the fact.

In essence, an ecological approach to international law calls for a fundamental reorientation of the international legal framework. Moving beyond growth-centred perspectives, engaging local communities, integrating traditional ecological knowledge, and imposing meaningful liability on corporations for environmental harms would enable international law to more effectively address the climate crisis. In the absence of these structural changes, international law risks enabling the very socioeconomic systems that perpetuate environmental degradation, rather than steering us towards any real solutions.

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[171] Nunes Chaib, "Multinaturalism in International Environmental Law."
[172] Dorji, "Understanding How Indigenous Knowledge Contributes."
[173] McKemey, "Indigenous Cultural Burning."
[174] Morin, "Indigenous Sex-Selective Salmon Harvesting."
[175] Halloy, "Traditional Andean Cultivation Systems."
[176] Akchurin, "Constructing the Rights of Nature."
[177] Villavicencio Calzadilla, "Living in Harmony with Nature?"
[178] Morgera, Corporate Environmental Accountability.
[179] European Commission, *Directive (EU) 2024/1760 of the European Parliament* and *Regulation (EU) 2023/2859*.
[180] French Republic, *Law No. 2017-399 of 27 March 2017 on the Duty of Vigilance of Parent Companies and Ordering Companies*.
[181] Germany, *Act on Corporate Due Diligence Obligations.*
[182] *Rome Statute of the International Criminal Court*.
[183] Stop Ecocide International, "Mass Destruction of Nature."
[184] Belgian Chamber of Representatives, *Bill Amending the Criminal Code to Criminalize Ecocide.*
[185] Brazilian Chamber of Deputies, *Bill No. 2787, of 2019.*
[186] Office of the United Nations High Commissioner for Human Rights, Business and Human Rights Treaty Process.

6. Final Remarks

Rachel Carson's *Silent Spring*, one of the most influential environmentalist books ever written, serves not only as a manifesto for an ecological approach to addressing the impact of human activities on our planet but also as a cautionary tale about the unintended consequences of new technologies. She focuses on the harmful effects of pesticides used in agriculture – technologies that were designed to enhance productivity but that carry substantial risks to both the environment and human health. Carson argues that these innovations, though promising immediate benefits, threaten the delicate balance of ecosystems. In this context, in the last chapter of her book, she remarks:

> We stand now where two roads diverge. But unlike the roads in Robert Frost's familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road – the one "less traveled by" – offers our last, our only chance to reach a destination that assures the preservation of the earth.[187]

Carson's poignant observation remains as relevant today as it was in 1962. We stand at a crossroads, faced with a choice between the deceptive ease of technological solutions and the more challenging path of systemic socioeconomic change. The road of techno-optimism is alluring because it promises that we can maintain our current lifestyles without making substantial sacrifices. However, this path leads to a future where the root causes of environmental degradation remain unaddressed, and the consequences of climate change become increasingly severe. The narrative that technological advancements alone can solve the climate crisis is a dangerous one. As highlighted throughout this article, while technology can mitigate environmental degradation, it is not a panacea. The reliance on technology as a primary solution to climate change overlooks the systemic issues inherent in our socioeconomic structures, particularly the growth-dependent nature of capitalism.

International law has persisted in prioritising technological innovation. From early regulatory efforts to contemporary sources, there is a clear emphasis on technology transfer, investment and development. While these measures are essential, they must be complemented by strong regulatory frameworks, changes to consumption and production patterns and a structural transformation of our economic systems. In this respect, this article does not oppose technological innovation; instead, it critiques the reliance on technology alone to solve the climate crisis. A modest form of techno-optimism, guided by a post-growth approach and an ecological narrative may indeed be acceptable.[188] Unfortunately, the mainstream eco-political discourse in international law often falls into the trap of strong techno-optimism, thus perpetuating the politics of sustained unsustainability, where systemic issues are managed rather than resolved.

I must also acknowledge my own tendency towards an individualistic perspective. By referring to international law in the third person, I have removed myself from the equation, failing to recognise that international law results from the actions of international actors, including international law academics like me. We are responsible for changing international law; it will not change on its own – that will only occur if we start with ourselves. While the degree of influence varies, international legal practitioners, educators and researchers are responsible for critically approaching their own practice. We must question whether our staunch support of new technologies can solve the world's problems. If we conclude – as I have – that it cannot, we must ask what steps we need to take to effect meaningful change.

We must move beyond a narrow focus on technological solutions and embrace a different strategy. We must evolve the law to prioritise changes in our socioeconomic system, ensuring a sustainable future for generations to come. As legal practitioners, educators, and researchers, it is incumbent upon us to adopt a self-reflective practice.[189] We need to be more critical of technology, wary of its promises, and recognise our responsibility in shaping legal frameworks that address the structural complexities of the climate crisis. By doing so, we can move beyond individualistic perspectives and work collectively toward systemic changes that genuinely contribute to solving these pressing global issues. The road less travelled, though challenging, offers our last and only chance to avoid mass extinction.

187 Carson, Silent Spring, 277.
188 See Danaher, "Techno-Optimism."
189 On how lawyers can train their awareness of the narratives imbued in legal language, see Phoa, "Narratives in Flux."

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