The promises and pitfalls of carbon offsetting

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Abstract

Carbon offsetting is increasingly used as a policy lever to negate greenhouse gas (GHG) emissions and mitigate climate change. This analysis attempts to unpack the advantages and disadvantages of using carbon offsets in both the environmental and social domains. The advantages of carbon offset schemes include its ability to remove 'additional' carbon emissions and can assist organisations in their route to achieving net-zero. To achieve the desired outcome, we learn that removal offsets must be prioritised over emission reduction offsets. Offset schemes also have important co-benefits for biodiversity, education, and innovation. Removal offsets such as reforestation and ecosystem restoration (e.g., peatlands) can help restore habitats, assisting in biodiversity conservation. However, there are risks of 'leakages' where reduction of carbon in one place could result in increased emissions elsewhere. The socioeconomic impacts of offsets are context specific. They provide finance for sustainable projects and encourage education and use of technology in communities. Despite these apparent benefits, there are uncertainties due to the lack of a stabilised and standardised voluntary offset market, temporal lags, lack of permanence and the potential disruptions to human systems. These pros and cons can be used to assess offsetting schemes currently used at University College London (i.e., Trees for Life, PrintReleaf and the 1.72% flight levy). According to the GHG mitigation hierarchy, carbon offsets must be a last-resort strategy and should not substitute other climate change mitigation measures. Robust guidelines and best practice principles are required to deploy carbon offsetting in a safe and effective way. Carbon offsets are effective to some extent when carried out well, but they are not a 'silver-bullet' solution that can reverse emission trajectories and it is important to be cognisant of the risks of this approach.

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1. Introduction

Anthropogenic carbon emissions are dramatically rising and exceeding levels that can be sequestered by oceans and land (Denton *et al.*, 2020; Lindsey, 2020; IPCC, 2021), making climate change a critical challenge of our time. Temperature rise should be limited to 1.5°C above pre-industrial levels, in line with the Paris Agreement, to reduce risks and adverse impacts of climate change (UNFCCC, 2015). However, to achieve this, emissions need to be reduced by more than 125 $GtCO_2e$, in addition to nationally determined contributions (NDC) pledges made at the 26th United Nations Climate Change Conference over the next 8 years (Åberg *et al.*, 2021). Many organisations across sectors have, or are in the process of, formalising commitments to decrease greenhouse gas (GHG) emissions in accordance with The Kyoto Protocol. These pledges are made either by setting internal targets, forming coalitions and signing pledges such as ‘The Climate Pledge’ which has been endorsed by 217 signatories thus far (The Climate Pledge, 2021).

Carbon offsets are perceived to tackle environmental, economic and social issues simultaneously (Herr *et al.*, 2019). A wide range of entities tend to resort to carbon offsetting as a tool to ‘neutralise’ emissions to meet net-zero commitments and reduce their carbon footprint (McLennan *et al.*, 2014). Theoretically, carbon offsets are envisaged to mitigate carbon emissions, but there are important caveats of this premise that need to be considered when evaluating its effectiveness. Barron *et al.*, (2021) argue that carbon offsets are overused with the aim of achieving carbon neutrality, and more recently, climate activist Greta Thunberg, Greenpeace and the Indigenous Climate Network heckled a carbon offsetting meeting and criticised it as “green-washing" (Shankleman and Ainger, 2021). Implementing offsets can be beneficial in theory as it allows entities to reduce emissions, supports biodiversity conservation, provides funding for nature-based solutions, and creates environmental and social co-benefits. That said, ensuring that offsets are permanent remains a challenge, and has led to offsets being viewed as a “controversial policy tool” (Barron *et al.*, 2021).

This analysis will initially provide an overview of the carbon offsetting landscape at present and in the context of higher education institutions. This serves as a segue into the advantages and disadvantages of carbon offsetting in both environmental and social domains, based on current literature. These results can be used to evaluate the current carbon offsetting approaches taken by University College London (UCL), namely Trees for Life and PrintReleaf, in light of the pros and cons identified and inform best practices for implementation. This research was commissioned by UCL Institute for Sustainable Resources in The Bartlett School of Environment, Energy and Resources, as part of its roadmap to achieving net carbon neutrality by 2030, aligning with the wider UCL target.

1.1 What is carbon offsetting?

Carbon offsets, or carbon credits, refer to the reduction or removal of atmospheric CO_2 to negate greenhouse gas emissions (van Kooten & de Vries, 2013; McLennan *et al.*, 2014). The idea of carbon as a commodity that can be tracked and traded, emerged following the Kyoto Protocol which was adopted in 1997 and ratified in 2005 as a mechanism to grapple with the rapid rise in carbon emissions (UNFCCC, 2021). The Kyoto Protocol ensured that transitioning economies and industrialised nations made commitments to reduce individual greenhouse gas emissions (United Nations, 1998). Several entities are becoming increasingly reliant on carbon offsets to meet internal or wider national and international emission reduction targets.

The carbon market can be divided into two subgroups: compliance markets or Certified Emission Reductions (CERs), and voluntary markets or Verified Emission Reductions (VERs). Compliance carbon markets are when GHG emissions are treated under a 'cap and trade' mechanism where carbon emissions are regulated by international, regional, or national policies (Amos and Mensah, 2018). Existing government policies to mitigate carbon emissions were deemed insufficient (Fawcett *et al.*, 2015), which led to the emergence of voluntary markets, where non-state actors such as businesses, organizations and individuals purchase offsets "over the counter" (Conte and Kotchen, 2012), in an attempt to decarbonise the economy. Currently, higher education institutions (HEIs) use the latter, as they mainly engage in carbon offsetting to meet targets set internally.

There exists a range of carbon offsetting methods which can be broadly categorised into greenhouse gas reductions or removals (Fig. 1). Reduction offsets refer to projects that result in lower emissions relative to a baseline, comprising switches to renewable energy, N_2O and methane abatement and carbon capture and storage (CCS). Removal offsets refer to projects that scour residual CO_2 from the atmosphere, such as nature-based solutions (NBS) including afforestation and reforestation, and negative emission technologies (NETs) including direct air carbon capture and storage (DACCS) and bioenergy carbon capture and storage (BECCS). Offsets can also be categorised based on storage, and can be without storage, with short-lived storage or long-lived storage. Techniques that fall under short-lived storage have a higher risk of being reversed within decades, whereas long-lived storage have a lower risk of reversal. The range of carbon offsets available in the market raises important question as to which techniques are feasible and most effective. Removal offsets are favourable and analyses suggest that it is sustainable to shift away from reduction methods (Allen *et al.*, 2020; COP26 Universities Network, 2021).

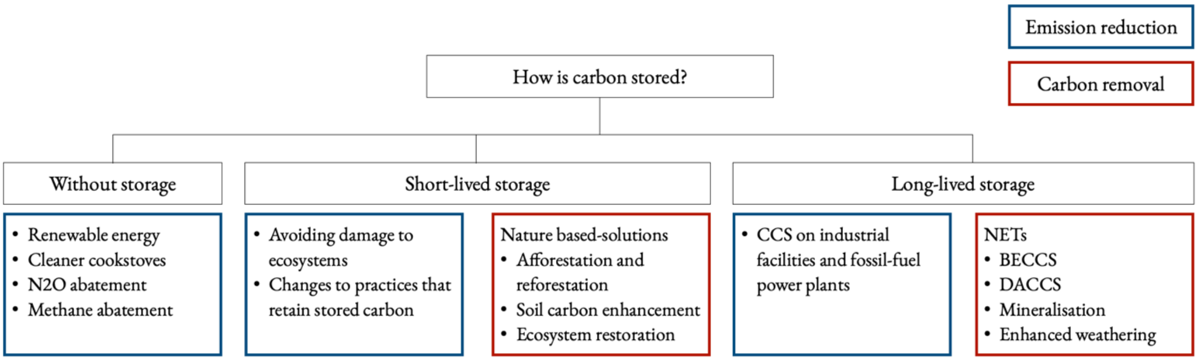

Fig. 1. Classification of carbon offsetting schemes
Source: Adapted from Allen et al. (2020). The Oxford Principles for Net Zero Aligned Carbon Offsetting, Smith School of Enterprise and he Environment, https://www.smithschool.ox.ac.uk/publications/reports/Oxford-Offsetting-Principles-2020.pdf.

1.2 The scale at which carbon offsetting is relied upon

The voluntary offset market was valued at $296 million in 2018, $320 million in 2019, and has injected $5.5 billion into emission reduction activities in the past 20 years (Donofrio *et al.*, 2020). This was supported by another source which anticipated that the voluntary market represents ~$300 million annually (Barron *et al.*, 2021). That said, voluntary offsets accounted for only 104 $MtCO_2e$ in 2019 (Donofrio *et al.*, 2020), which is less than 1% of the anticipated 125 $GtCO_2e$ that needs to be removed over the 2020s to limit global warming to 1.5°C. The uptake of offsetting schemes is reportedly low relative to the wide range of offsetting schemes available to purchase the aviation industry for example (McLennan *et al.*, 2014). The Kyoto Protocol and the subsequent establishment of market-based mechanisms such as Clean Development Mechanism (CDM) and Joint Implementation saw a parallel increasing reliance on offsets by private entities as it stimulated investment in greener technologies.

1.3 Carbon offsetting at UCL and other higher education institutions

Many HEIs have made net-zero pledges in response to the severity of climate change impacts (Rodgers, 2021). Eight hundred colleges and universities in the U.S. pledged to achieve net-zero (Barron *et al.*, 2021), 622 HEIs endorsed Race To Zero Campaign in the run up to COP26 (UNFCCC, 2021) and 566 institutions have submitted commitments in line with SDG 13 to “take urgent action to combat climate change and its impacts” (Times Higher Education, 2021). Many institutions rely on carbon offsets to help achieve these goals. For example, 77% of carbon emission reductions in the U.S. currently come from carbon offsets such as BECCS, and renewable energy certifications (Barron *et al.*, 2021) and universities are increasingly purchasing offsets to negate emissions from university-sponsored and compelled air travel (Rodgers, 2021). Carbon offset schemes are more likely to be purchased by individuals with certain values and characteristics such as those in higher education, those who fall under younger age groups and those with a greater appreciation and awareness of climate change (Heintzman, 2021). Scaling offsetting in universities appears to be a feasible solution to meet net-zero commitments; however, in practice there are risks associated with overreliance on this method, as explored in the following sections.

Like other HEIs, UCL pledged to achieve net-zero by 2030 and plans to reach this target through, but not limited to, carbon offsets. This forms part of its 2019 – 2024 Sustainability Strategy which also includes reaching net-zero for building energy use, reducing energy use by 40%, reducing waste per person by 20% and increasing the rate of recycling to 85% by 2024. However, a crucial caveat of this is the fact that staff and student travel and investments are considered beyond the scope of this target. The academic year 2021/22 saw 24,704 out of 47,884 students are from abroad and thus, and as travel is a crucial part of universities' business-model, aviation emissions are likely to be substantial. The main sources of carbon emissions, based on data from 2019, are from supply chains, electricity and heating construction, business travel and air, and food and catering. The emissions that need to be tackled are categorised into three scopes (Bhatia *et al.*, 2011). Scope 1 emissions are those directly owned and controlled by the institution, whereas Scope 2 and 3 are indirect emissions. Scope 2 emissions are associated with energy consumption and Scope 3 refers to emissions from activities that are not owned and controlled by the institution.

Carbon offsetting techniques currently deployed at UCL include: (1) Flight tax charged at 1.72% of the spend on flights, (2) a partnership with Trees for Life to offset travel emissions and (3) a partnership with PrintReleaf to offset paper consumption. According to Sustainable UCL, the levy on flights raises approximately £170,000 annually, out of which £80,000 is reinvested in campus energy efficiency and the allocation of the remainder is not yet known. Trees for Life grow native trees in the Scottish Highlands to restore the Caledonian Forest and includes a UCL grove for staff and students to offset their carbon emissions. Each tree is charged at £6 and fixes 0.25 tonnes of carbon over 100 years (University College London, 2021). Carbon emissions from print activity are not fully known, as PrintReleaf is in its early stages of being implemented. These offsetting schemes have impacts across spatial and temporal scales, in both the ecological and social domains which are explored in following sections.

2. Methods and materials

This research was conducted through a systematic literature review. Literature was sourced through electronic databases including UCL Explore, Taylor & Francis, Elsevier Science Direct and Web of Science. The main search terms used were "carbon offsets", "carbon offsetting", "Clean Development Mechanism", "Emission Trading Scheme" and these terms were combined using Boolean operators with the terms "universities" and "higher education institutions". The scope of this review was determined by inclusion and exclusion criteria. As such, academic and grey literature published in English in the past 10 years were used in the analysis. The main findings from the literature were categorised based on pros and cons, and themes were developed. Secondary data were gathered and analysed to contextualise the status quo of carbon emissions at The Bartlett and UCL, although restricted to academic travel, and student and staff census records.

3. Removal of 'additional' emissions

A main advantage of using carbon offsetting as a policy tool is its ability to remove additional carbon emissions above and beyond what would occur in its absence, which is referred to as 'additionality' (van Kooten and de Vries, 2013). For example, using renewable energy sources or avoiding damage to ecosystems is not an ideal form of offsetting when compared to nature-based solutions and Negative Emission Technologies (NETs), as outlined in Fig. 1. These removal offsets are deemed to be more sustainable in the long-term (Allen *et al.*, 2020) and is beneficial to both the environment and the economy. As the 2030 deadline to achieve carbon neutrality is fast-approaching and the urgency to mitigate climate action increases, removal offsets can potentially tackle emissions alongside development in an effective way. It provides universities, and other businesses alike with the opportunity to decrease their carbon footprint by counteracting their emissions. As such, it is recommended that carbon removal offsets are prioritised over emission reduction offsets (COP26 Universities Network, 2021; University of Bath, 2021).

Carbon offsets based on Certified Emission Reductions (CERs), which are nationally regulated, are required to be additional by the Climate Convention (Junqueira, 2005). This increases the credibility of offsetting initiatives. In contrast, there are no defined regulations in the voluntary offset market that ensures additionality. This can be particularly problematic as it could potentially allow the generation of carbon credits that do not achieve any climate benefits, such as 20 – 39 million carbon credits being generated in California (Song and Temple, 2021) and 80% of offsetting projects rich countries relied on to meet their climate targets under the Kyoto protocol according to the Institute for Applied Ecology (Morgan, 2021). Carbon credits that do not achieve any reductions, and sometimes result in leakages, are known as "ghost credits" or "phantom carbon credits" (Sandler Clarke and Barratt, 2021; Song and Temple, 2021). Leakages may occur where some offsetting initiatives that reduce carbon emissions, or increase removals, can potentially increase emissions in a different location (van Kooten and de Vries, 2013). Hence, it is important to have robust accountability measures in place to make them effective and ensure they result in additional removals from the atmosphere.

4. Biodiversity conservation

The advantages of carbon offsets extend beyond just reducing GHG emissions, creating what is known as co-benefits (MacKerron *et al.*, 2009). Nature-based solutions (NbS) are a key constituent of removal carbon offsets which create co-benefits for biodiversity while decreasing levels of GHG in the atmosphere. The positive impacts on biodiversity result from habitat restoration through mechanisms such as afforestation, reforestation, and peatland restoration which address the climate-biodiversity nexus. Land Use, Land-Use Change and Forestry (LULUCF) has been identified as a critical climate change mitigation mechanism as trees, plants and soil can sequester atmospheric carbon and create "sinks" (UNFCCC, 2021c). This includes REDD+ assistance which refer to countries' efforts to reduce emissions from deforestation and forest degradation. LULUCF removed up to 50.7 million $MtCO_2e$ from the atmosphere in 2018, accounting for the highest volume of offsets sold that year (Forest Trends' Ecosystem Marketplace, 2019).

When designed and implemented well, REDD+ can preserve biodiversity and maintain vital ecosystem services such as pollination, seed dispersal, invasion resistance, and erosion regulation which in turn increases genetic and species diversity of forest ecosystems (Secretariat of the Convention on Biological Diversity and Deutsche Gesellschaft für Internationale Zusammenarbeit (giz) GmbH, 2011). Carbon-rich peat-swamp forests and peatlands are areas mainly targeted by REDD+ projects due to its very high sequestration potential (Harrison and Paoli, 2012). For example, peatlands in the UK currently sequester more than 3 billion tonnes of carbon, which is greater than the amount of carbon sequestered by all oceans annually (UKRI, 2021) and they store more than half of the world's soil carbon (van Noordwijk, 2014). The peatlands are a niche habitat to rare species of flora and fauna, and while carbon offsetting can assist in their conservation, these areas are typically low in species diversity (Littlewood *et al.*, 2010). Therefore, there is a growing threat of leakage, where threats to biodiversity are displaced to areas that are not protected by REDD+ or similar initiatives (Harrison and Paoli, 2012). While offsetting initiatives can conserve species in the immediate environment, the risk of unintended consequences is prevalent, and it is important to carefully consider broader impacts.

5. Financing sustainable innovation

Carbon offsets represent an effective way for economic agents to finance reductions in other countries and helps address issues that might not be covered by carbon markets otherwise. They provide an important source of funding for a range of sustainability initiatives and helps bridge the funding gap for climate change mitigation and adaptation. For example, since 2011, UCL charges a levy of 1.72% on flights which generates around £170,000 annually of which £80,000 is reinvested in campus energy efficiency. The market for voluntary carbon credits is forecasted to be worth more than $50 billion in 2030 (Blaufelder *et al.*, 2021), creating economic co-benefits. As a result of implementing sustainable initiatives, climate literacy within communities is likely to increase through technology and education, both of which play a critical role in decarbonising the economy.

The introduction of new technologies, especially to developing countries where offsetting projects are implemented, is a valuable co-benefit of offsetting. The Clean Development Mechanism, for example, has enabled "technological leapfrogging" for developing countries, allowing them to avoid technologies that negatively impact the environment and were previously adopted by the developed countries during industrialisation (Khanal, 2008). This can in turn contribute towards upskilling local communities. For example, oil producers such as Saudi Arabia aims to become a leader in solar technologies (Graciela Chichilnisky, 2010) which inherently requires a skilled workforce and increases awareness of environmental issues. This could create a positive feedback loop and further catalyse technological advances in the offsetting sector. For example, TotalEnergies, a French extractives company, allocates 10% of its research and development budget towards carbon capture and storage technologies (HSBC Centre of Sustainable Finance, 2020).

Financing projects through offsetting can play a role in climate adaptation. The requirement for adaptation was a key theme that emerged in the Working Group II contribution to the IPCC Sixth Assessment Report, which highlighted the gap between adaptation actions taken and what's needed (IPCC, 2022). Increasing education and awareness amongst local communities is one way to address this, which is a co-benefit of offsetting projects. For example, a mangrove restoration offsetting initiative in the Gazi-Kwale County of Kenya was used as a teaching mechanism (Herr *et al.*, 2019) and the Wildlife Works Kasigau Corridor REDD+ project in Kenya, which was funded by BNP Paribas, created opportunities for education (Rosales *et al.*, 2021).

6. Implications for local communities

The social and economic dimensions of offsetting on communities are important considerations when evaluating carbon offsetting projects. Social impacts can be defined as "the consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society" (Interorganizational Committee on Guidelines and Principles, 1994). Although offsetting increases financing towards projects, there are non-financial related impacts that are intricately linked to the wellbeing of societies such as food security and health-related impacts. The social impacts of offsetting have appeared to be mixture of both positive and negative in different contexts. High quality offsets should ideally not have unintended consequences that impact people negatively (Allen *et al.*, 2020).

Case studies show that offsetting projects can have positive livelihood impacts on local communities. For example, in Australia, farmers including indigenous peoples are encouraged to increase sequestration and reduce GHG emissions in return for Australian Carbon Credit Units, which provide direct socioeconomic benefits to local communities (Aboriginal Carbon Foundation, 2019). Additionally, REDD+ generally provides local communities with greater incentive to conserve forests than opportunity costs (Verra, 2019). Carbon offsets can also create multiple short-term and long-term employment opportunities for communities due to an increased demand of labour to carry out tasks such as tree planting, harvesting and monitoring, as observed in the Sundarbans Mangrove Restoration Project in India and the Mikoko Pamoja project in Gazi Bay, Kenya (Herr *et al.*, 2019).

There are inherent risks to communities that cannot be overlooked when implementing offsetting projects and it is important to carefully plan and consider the wider social impacts and unintended consequences. These impacts range from threats to food security, which in turn drive up prices and marginalise vulnerable communities. Although reforestation creates carbon sinks and contribute to the ‘additional’ removal of emissions, it can create systemic risks. For instance, monoculture threatens food security as they use up resources such as land, water and fertilisers, which may in turn increase the chances of conflict. Overreliance on reforestation as a solution to offset emissions could drive food prices up by 80% by 2050 (Sen and Dabi, 2021). Depending on offsets excessively can also mean that conventional forms of air pollutions may continue to harm vulnerable parts of society, for example, air pollution in the U.S. due to fossil fuel combustion disproportionately harm communities of colour and low-economic status (Mikati *et al.*, 2018; Hastings, Laflower and Thompson, 2019; Barron *et al.*, 2021). In this regard, it can be argued that local communities have more to lose than large corporations such as fossil fuel manufacturers (Frewer, 2021). Therefore, it is critical to remain cautious of unintended consequences and implementing frameworks for best practice.

7. Land requirements

Deploying offsetting initiatives including afforestation and reforestation, soil carbon enhancement, ecosystem restoration and BECCS requires vast areas of land to create significant carbon reductions. As mitigation scenarios become more ambitious, more land area for mitigation and/or earlier adoption of CO_2 removal strategies is required (Harper *et al.*, 2018). This can present several challenges for human settlements and existing human systems that are reliant on land. Across IPCC scenarios to create a high chance of keeping 1.5°C alive, a median of 12GtCO_2e must be removed by BECCS annually which requires 0.4 – 1.2 billion hectares of land, equivalent to 25 – 80% of agricultural land (Fajardy *et al.*, 2019).

This exceptionally high demand for land can potentially have negative impacts on biodiversity and food production (Quiggin, 2021), and this can disincentivise land-use change. For instance, a study in South Australia showed that an economically viable abatement below $38/ t$CO_2$e is not possible, which presents challenges in intensively farmed regions (Regan *et al.*, 2020). The increasing demand for carbon offsets could potentially be fulfilled by alternative technologies such as the blue carbon pool (Sapkota and White, 2020). Therefore, scaling up carbon offsetting to keep up with the current rates of emissions is not entirely feasible and it should not be considered as a silver-bullet solution.

8. Continuing business-as-usual

Carbon offsets as a policy tool can be a major deterrent to other emission reduction efforts and climate change mitigation measures taken by organisations. Many entities may continue with business-as-usual and continue to emit GHG. For example, an educational institution achieved net-zero entirely through purchasing offsets and without any other reduction measures (Barron *et al.*, 2021). Similarly, promoting NbS while engaging in fossil fuel combustion may distract the need for systemic change to decarbonise the economy, and could potentially even lead to increased combustion (Seddon *et al.*, 2021). Hence, it is possible that emitters engage in offsets to reduce costs of complying with other forms of mitigation to reach carbon neutrality.

Continuing business-as-usual is not a solution to climate change as it is important to address the root causes of emissions, and offsetting should only complement existing methods instead of substituting existing mitigation efforts. Offsetting is insufficient on its own, and it is important to take other steps according to the greenhouse gas mitigation hierarchy (Fig. 2.) such as avoiding the consumption of unsustainable forms of energy, working to reduce the impacts or convert efficiently, substitute with renewable forms of energy and turn to offsetting as a last-resort.

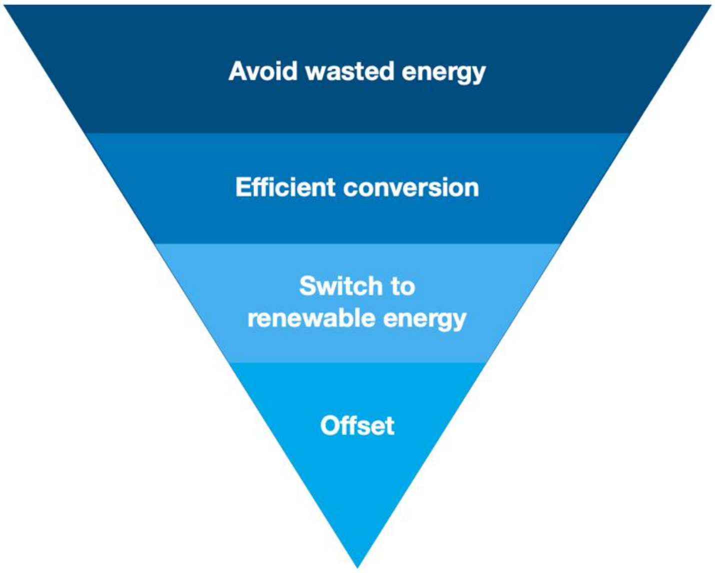

Fig. 2. Greenhouse gas emission mitigation hierarchy
Source: Adapted from Stevenson, M. (2020). First Things First: Avoid, Reduce … and only after that–Compensate. *WWF*. https://wwf.panda.org/wwf_news/?362819/First-Things-First-Avoid-Reduce--and-only-after-thatCompensate

The growing reliance on carbon offsets may also lead to ‘greenwashing’, a situation when firms make “misleading environmental, social and governance (ESG) disclosures” (Yu, Luu and Chen, 2020). Critiques of offsetting recent revealed that many top airlines such as British Airways and EasyJet who claim to use offsets verified by Verra (or The Verified Carbon Standard) lacked robust principles and generated what is known as ‘ghost credits’ or ‘phantom credits’ (Sandler Clarke and Barratt, 2021). This is extremely dangerous and poses significant threats as current business-as-usual emissions far exceed the emissions required to limit global warming to 1.5°C (Fig.3.).

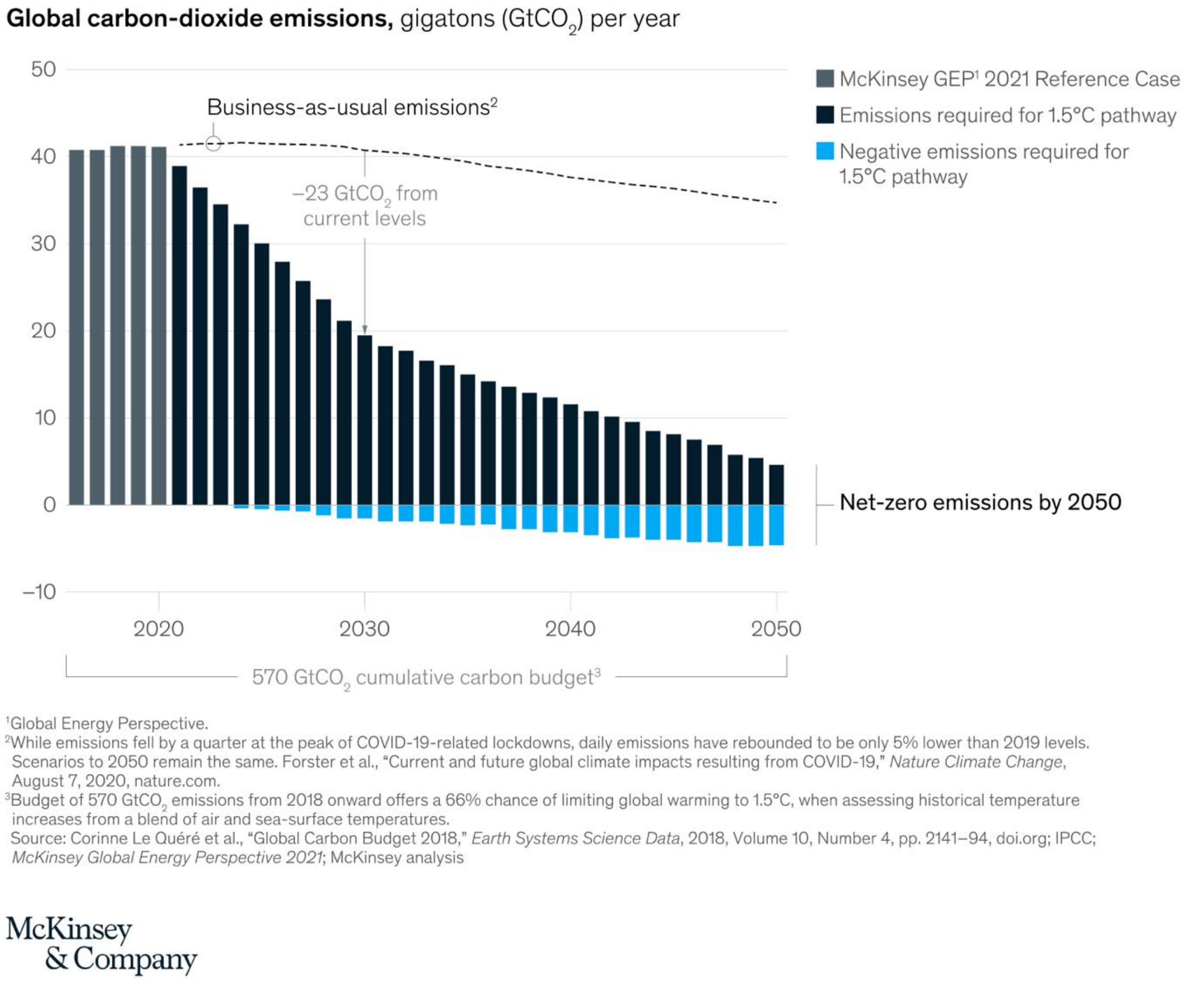

Fig. 3. The reduction in emissions required to reach the 1.5°C target.
Source: Blaufelder, C., Levy, C., Mannion, P., Pinner, D. (2021). A blueprint for scaling voluntary carbon markets to meet the climate challenge. McKinsey & Company. https://www.mckinsey.com/business-functions/sustainability/our-insights/a-blueprint-for-scaling-voluntary-carbon-markets-to-meet-the-climate-challenge

9. Temporal lags and the need for long-term monitoring

While emissions occur almost instantaneously, the time over which trees grow may take many years. This could mean that carbon remains in the atmosphere over a relatively longer period before it is completely offset. Therefore, it might not be valid to use offsets and claim to have reached a net-zero target by 2030, for instance, without fully knowing if the emissions have been sequestered. Furthermore, a project in southeast Brazil unveiled that the survival of trees planted in a mixed-carbon offset plantation was low and required replanting and carbon removal was often overestimated (de Morais Junior *et al.*, 2020). Another issue associated with existing offsetting methods is its permanence of the project. There is a risk that the impacts can be reversed (Environment Agency and Flood and Coastal Erosion Risk Management Research and Development Programme, 2021). It is complex to ensure that trees are not cut down a few years after reforestation resulting in sequestered carbon being released into the atmosphere (Barron *et al.*, 2021). Therefore, monitoring offsets in the long-term and ensuring that carbon credits account for the temporal costs is critical to ensure that it is an effective solution. However, there still are not any methods that can accurately measure the amount of carbon sequestered and it is not always feasible to monitor projects over many decades.

10. Carbon pricing and the lack of universal standards

As voluntary carbon offset markets exist outside a regulatory regime, it is complex to maintain consistent standards. This could potentially compromise its transparency and quality. Voluntary markets are usually certified by different bodies such as the Verified Carbon Standard (Verra) and Gold Standard Verified Emission Reductions, and Climate, Community and Biodiversity Standards to name a few (Fig. 4). These standards have varying levels of rigor (Scholes and Smart, 2013) when evaluated against different indicators. According to Barron *et al.* (2021), high quality offsets should fulfil the PAVER criteria (Permanent, Additional, Verifiable, Enforceable, and Real). Similarly, UCL has set the principles for offsetting providers which include Additionality, Social impact, Verifiability, Communicability and Cost (Table 1).

Criteria	**Explanation**
Additionality	The initiative needs to result in a carbon reduction that would not otherwise have happened, either naturally or without this funding
Social impact	The social impacts of the project including co-benefits such as creating employment opportunities, increasing education and alleviating poverty, and risks such as threats to agricultural systems
Verifiability	The extent to which carbon reductions delivered and if the project results in real impact, as opposed to ‘ghost credits’
Communicability	The extent to which the benefits of the project can be clearly communicated
Cost	The relationship between carbon pricing to social costs (or opportunity costs)

Table 1. The criteria for offsetting projects set by UCL

Main Supporters	Market Share	Additionality Tests (relative to CDM)	Third-party Verification Required	Separation of Verification and Approval Process	Registry	Project Types	Excludes Project Types with high chance of adverse impacts	Co-Benefits (relative to CDM)	Price of Offsets
Clean Development Mechanism									
UNFCCC Parties	large	=	yes	yes	yes	All minus REDD, new HFC, nuclear	no	=	€14–30
Authors' Comments:	The CDM is part of the Kyoto protocol and aims to create economic efficiency while also delivering development co-benefits for poorer nations. It has been successfull in generating large numbers of offsets. Whether it also has delivered the promised development co-benefits is questionable.								
Gold Standard									
Environmental NGOs (e.g. WWF)	small but growing	=/+[1]	yes	yes	Planned	EE, RE only	yes	+	VERs: €10–20 CERs: up to €10 premium
Authors' Comments:	The GS aims to enhance the quality of carbon offsets and increase their co-benefits by improving and expanding on the CDM processes. [1] For large scale projects the GS requirements are the same as for CDM. Yet unlike CDM, the GS also requires the CDM additionality tool also for small-scale projects.								
Voluntary Carbon Standard 2007 (VCS 2007)									
Carbon Market Actors (e.g. IETA)	new; likely to be large	=[2]	yes	no	Planned	All minus new HFC	no	-	€5–15 [3]
Authors' Comments:	The VCS aims to be a universal, base-quality standard with reduced administrative burden and costs. [2] The VCS plans to develop performance based additionality tests. These tools have not yet been developed and are thus not included in this rating. [3] Prices are for projects implemented under VCS ver. 1.								
VER+									
Carbon Market Actors (e.g. TÜV SÜD)	small but growing	=	yes	no	yes	CDM minus large hydro	yes	-	€5–15
Authors' Comments:	VER+ offers a similar approach to CDM for project developers already familiar with CDM procedures for projects types that fall outside of the scope of CDM.								
Chicago Climate Exchange (CCX)									
CCX Members and Carbon Market Actors	large in the US	-	yes	yes	yes	All (mostly soil carbon)	no	-	€1–2
Authors' Comments:	CCX was a pioneer in establishing a US carbon market. Its offset standard is part of its cap-and-trade programme.								
Voluntary Offset Standard (VOS)									
Financial Industry and Carbon Market Actors	N/A	=	yes	no	Planned	CDM minus large hydro	yes	=	N/A
Authors' Comments:	VOS closely follows CDM requirements and aims to decrease risks for offset buyers in the voluntary market.								
Climate, Community and Biodiversity Standards (CCBS)									
Environmental NGOs (e.g. Nature Conservancy) and large corporations	large for LULUCF	=	yes	no [4]	N/A	LULUCF	yes	+	€5–10
Authors' Comments:	The CCBS aims to support sustainable development and conserve biodiversity. [4]The CCBS is a Project Design Standard only and does not verify quantified emissions reductions.								
Plan Vivo									
Environmental and social NGOs	very small	=	no	no	yes [5]	LULUCF	yes	+	€2.5–9.5
Authors' Comments:	Plan Vivo aims to provide sustainable rural livelihoods through carbon finance. [5] It verifies and sells ex-ante credits only. Third party verification is not required but recommended.								

Fig. 4. Comparison of the different offsetting standards.
Source: Kollmuss, A., Zink, H., & Polycarp, C. (2008). Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards. WWF Germany, https://www.globalcarbonproject.org/global/pdf/WWF_2008_A%20comparison%20of%20C%20offset%20Standards.pdf

Another caveat of voluntary offsets is the pricing. With Certified Emission Reductions (CERs), there has been progress made to address shortcomings such as double counting by tightening the system with the adoption of Article 6 at COP26 (UNFCCC, 2021a). However, as the voluntary market or VERs is not regulated to this extent which may lead to organisations using less stringent credits and could potentially lead to the risk of corruption. For instance, REDD+ already takes place in a sector that is prone to corruption in the form of state looting, elite capture, theft and fraud, and this can be exacerbated by poorly regulated offsets and may lead to double counting, fraudulent trade of carbon credits, and inappropriate verification (Anti-Corruption Resource Centre, 2010). Furthermore, forest carbon credits are generally cheaper when compared to technical solutions such as NETs (Principles for Responsible Investment, 2020). This may lead to overreliance on reforestation as a carbon offsetting initiative. For example, UCL planted 188 trees in the Scottish Highlands as part of the Trees for Life scheme (Sustainable UCL, 2021), but there are issues of permanence associated with this approach. This is also an important aspect that needs to be accounted for as UCL has longer term plans to explore similar partnerships e.g., with Woodland Trust.

Carbon pricing in the voluntary market is also influenced by individuals’ willingness to pay (WTP) (Heintzman, 2021). Young people and those within the higher education sector fall within the demographic of groups who are more likely to engage in offsetting due to high climate literacy (Barron *et al.*, 2021; Heintzman, 2021). The way in which offsets are marketed play a key role in ensuring its effectiveness. Conveying gain-framed messaging has shown to increase engagement with carbon offsetting and increase WTP, as opposed to loss-framed messaging (Chi, Denton and Gursoy, 2021). Therefore, when deploying an offsetting scheme and aiming to convince people to partake in them, it is critical to consider ensuring effective implementation.

11. Conclusion

Carbon offsetting is not a panacea and has clear pitfalls, but we cannot rule out offsetting in the context of HEIs as they can potentially mitigate climate change used correctly. The main promises of this approach include its ability to remove additional carbon emissions, and co-benefits for biodiversity and communities. As climate change impacts are mounting, it is critical for all economic agents to play a role in decarbonising the economy as emissions need to be reduced by a staggering 45% from 2010 levels by 2030 to limit global warming to 1.5°C. Hence, it is important to take every effort to decarbonise the economy and voluntary offsets used by the private sector is essential to achieve this. There are caveats and the credibility of offsets continues to be an issue. The disadvantages of offsets include leakages, issues of permanence, threats to agricultural land, temporal lags and businesses taking it for granted. A worst-case scenario of overreliance on offsets could exacerbate these risks, hence it is important to ensure the long-term viability of offsetting initiatives and think beyond immediate short-term impacts in both the environmental and social domain.

Acknowledgments

This work was generously supported by The Bartlett, University College London. I specially thank Dr. Nick Hughes, Senior Research Fellow and Faculty Lead for Climate Action at The Bartlett, for supervising this research and guiding me towards relevant literature and data sources. I also thank Dr. Isabela Butnar, Senior Research Fellow at The Bartlett School of Environment, Energy and Resources, for her guidance and valuable insights on the topic.

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