Annex 1

Carbon Offsetting and Insetting in York

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Executive Summary

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1 Introduction

In March 2019, the City of York Council declared a climate emergency and committed to the ambition for York to be net zero by 2030. The council's Climate Change Strategy, published in December 2022 provides the framework and overall approach for achieving the council's 2030 net zero target. Alongside this, the council's Climate Change Action Plan sets out a comprehensive list of actions that will contribute to an estimated 77% reduction in total emissions across York by 2030 (based on a 2005 baseline).

Despite the significant steps taken to date and planned actions, the council acknowledges that it will not be able to eliminate all council and city-wide emissions before the 2030 target date due to the scale of change, technology deployment, and investment required. Even once all possible emissions reductions have been achieved across York, it is estimated that 361,000 tCO_2e of residual emissions will remain across York in 2030. The council will also likely have its own organisational residual emissions from its corporate activity that it will need to directly address by 2030.

To achieve its net zero targets, the council will need to identify actions to directly address its own corporate residual emissions and contribute towards addressing the wider 361,000 tCO_2e of estimated city-wide residual emissions by 2030. Carbon offsetting and/or carbon insetting could be used to counterbalance any remaining council- and city-wide residual emissions. The council's Climate Change Strategy includes a commitment to develop a dedicated 'Carbon Offsetting/Insetting Strategy' that defines the council's approach to using carbon offsets and insets to achieve its net zero target.

It is imperative that the council develops a strategy that aligns with existing best practice to ensure that any use of carbon offsetting and/or insetting contributes towards achieving net zero and does not result in greenwashing claims against the council. This report provides a comprehensive overview of the existing literature, guidance, and best practice around carbon offsetting and insetting. The report aims to support council decision-makers and stakeholders to better understand carbon offsetting and insetting and serves as an evidence base to inform the development of a dedicated net zero aligned Carbon Offsetting/Insetting Strategy.

2 Context

With over 300 local authorities declaring a climate emergency and many setting net zero or carbon neutrality targets, carbon offsetting has now become a major area of interest for local authorities across the UK. There is growing recognition that achieving both operational and/or area-wide net zero or carbon neutrality targets by dates earlier than 2030 is likely to be extremely difficult because of the scale of change, technology deployment and investment required[1]. Whilst avoiding and reducing emissions remains the priority, the ability to achieve net zero targets will be extremely difficult, if not impossible, without some form of offsetting and/or insetting. This has prompted many local authorities to explore offsetting and other innovative local approaches such as insetting to accelerate decarbonisation and address any hard-to-abate emissions. As with many other local authorities, the City of York Council is currently reviewing its approach to carbon offsetting and insetting and exploring how it can support the council to achieve both its organisational and city-wide net zero targets.

2.1 Scale of the challenge in York

The latest IPCC report[2] indicates that the remaining global carbon budget to remain within 1.5°C of global warming is 400 billion tCO_2e. The City of York Council has worked with Leeds University, The Tyndall Institute and the Setting City Area Targets and Trajectories for Emissions Reduction (SCATTER) project to convert this global carbon budget into a Net Zero Carbon Pathway for York, which is consistent with the city's fair contribution to the Paris Agreement[3] (see Figure X). In accordance with the Net Zero Carbon Pathway, emissions in York will need to be reduced to 196 $ktCO_2e$ by 2030; an 88% reduction on 2005 levels. The pathway will also require an average annual emissions reduction in York of 13% up to 2030.

The Net Zero Carbon Pathway describes what is necessary for York to "play its part" in meeting the Paris Agreement goals. It is focused on limiting the cumulative amount of emissions below a defined threshold based on historic emissions within the region. It should be noted that this pathway is not based in tangible actions and interventions but defines an upper ceiling for emissions based on a "carbon budget" approach.

[1] Fankhauser, S., Smith, S. M., Allen, M., Axelson, K., Hale, T., Hepburn, C., Kendall, J.M., Khosla, R., Lezaun, J., Mitchell-Larson, E., Obersteiner, M., Rajamani, L., Rickaby, R., Seddon, N., and Wetzer, T. (2022). The meaning of net zero and how to get it right. *Nature Climate Change*, 12(15-21). Available from: https://www.nature.com/articles/s41558-021-01245-w

[2] IPCC Sixth Assessment Report - https://www.ipcc.ch/assessment-report/ar6/

[3] A Net Zero Carbon Roadmap for York - https://democracy.york.gov.uk/documents/s144434/Annex%201%20-%20Zero%20Carbon%20Roadmap%20for%20York.pdf

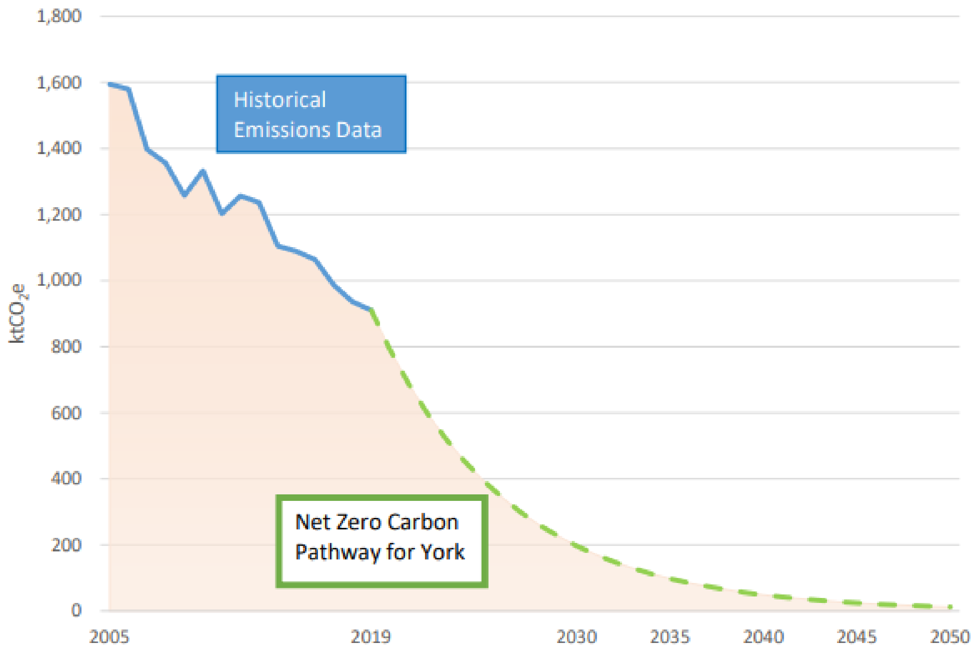

Figure 1: Net Zero Carbon Pathway for York

In March 2019, the City of York Council (CYC) declared a climate emergency and committed to the ambition for York to be net zero by 2030, a more ambitious decarbonisation goal than the Net Zero Carbon Pathway for York. The council's York Climate Change Strategy[4], published in December 2022, provides the framework, objectives, pathways, targets/benchmarks, and overall approach for achieving this ambition. This includes setting out how the council will reduce carbon emissions that are under its direct control; how the council will use its influence to reduce emissions across the wider city; and how the council can create a city that is resilient to the impacts of climate change. The council's Climate Change Action Plan[5] sets out a comprehensive list of 160 potential actions that will support in reducing emissions across York by 2030 (based on a 2005 baseline). These actions are categorised into eight 'themes', including: governance; buildings; transport; waste; commercial & industrial; natural environment; energy; and engagement & behaviour change. The council reports progress towards achieving the city-wide net zero target on an annual basis.

To assess the potential of emissions reductions in York, the council worked with SCATTER to produce a 'Projected Emissions Reduction Pathway', based on delivering actions that are currently available with existing supply chain capacity, national policy, and technological readiness. The analysis determined that the Projected Emissions Reduction Pathway will reduce our emissions to 361 ktCO_2e in 2030 (a 77% reduction on 2005 levels) and 114.8 ktCO_2e in 2050 (a 93% reduction on 2005 levels)[6] (see Figure X).

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[4] City of York Council Climate Change Strategy - https://www.york.gov.uk/downloads/file/8948/york-climate-change-strategy-2022-to-2032

[5] City of York Council Climate Change Action Plan - https://democracy.york.gov.uk/documents/s163767/Annex%20Bii%20Climate%20Change%20Action%20Plan.pdf

[6] City of York Council Climate Change Strategy - https://democracy.york.gov.uk/documents/s163766/Annex%20Bi%20Climate%20Change%20Strategy%202022-2032.pdf

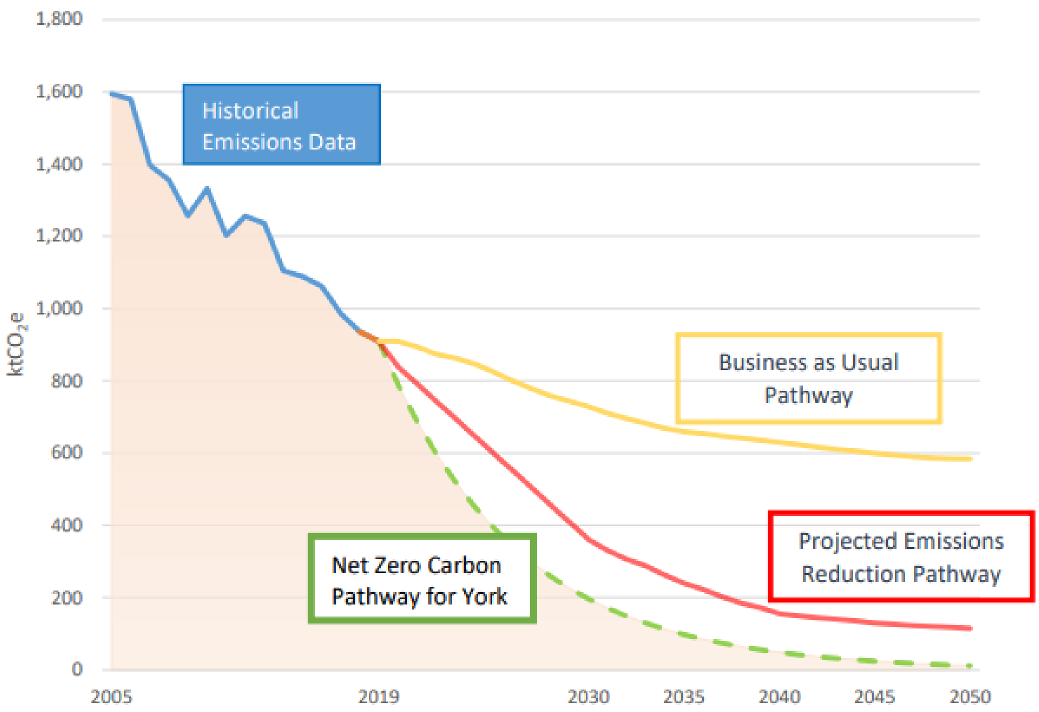

Figure 2: Projected Emission Reduction Pathway for York.

Based on this analysis, the council will not be able to reduce or eliminate all emissions at a city-wide scale by 2030 (i.e., zero carbon emissions) due to significant operational, technical, and financial constraints. The council recognises that, even once all possible emissions reductions have been achieved, it will be faced with a significant 'gap to target' in 2030 that will need addressing. The emissions remaining in 2030 after reduction projects have been achieved are termed residual emissions. Although an estimate has not yet been calculated, it is highly likely that residual emissions will also remain from the council's own corporate activity (see Section X).

2.2 The need for carbon offsetting/insetting

To achieve its net zero targets, the council will need to identify actions to address its own organisational residual emissions (see Section X) and support the wider city to address the estimated 361,000 tCO_2e of residual emissions by 2030 (see Section X). Within its Climate Change Strategy, the council recognises that carbon offsetting and/or insetting could be used as options to address residual emissions. It also sets out the council's intention to produce a dedicated offset strategy outlining its approach to addressing its residual emissions:

> *"Any remaining emissions that we are unable to decarbonise will need to be removed from the atmosphere. This can include nature-based solutions, e.g., tree planting and the restoration of other ecosystems, or other technologies such as carbon capture and storage (CCS) and negative emissions technologies (NETs). Prioritising actions within the city boundary (insetting) to remove carbon dioxide from the atmosphere can provide additional environmental, social, and financial benefit for York.*
>
> *Offsetting will only be considered as a last resort to address residual emissions after all actions have been taken to reduce and avoid direct emissions as much as possible. The cost of offsetting will be a key consideration before employing this solution and it will only be done if financially viable for the city.*

At current UK carbon prices, offsetting our residual emissions in 2030 (361,000tCO2e) would cost an estimated £5.2m/yr. We will produce a separate offset strategy outlining our approach." [7]

The council's Climate Change Action Plan also sets out the following commitment:

"Develop an offsetting/Insetting strategy to address residual emissions not tackled by direct actions in the city with a validated offsetting method" [8]

The aim of this report is to initiate the development of a dedicated 'Carbon Offsetting/Insetting Strategy' for the council. It aims to support council decision-makers and stakeholders to better understand carbon offsetting and insetting and serves as an evidence base to inform the development of a dedicated net zero aligned strategy to address council and city-wide residual emissions.

3 Defining Carbon Offsetting and Insetting

When developing a strategy for addressing council and city-wide residual emissions, it is important to first understand the differences between carbon offsetting and carbon insetting. This section provides a definition and comparison of the two terms.

3.1 Carbon Offsetting

A **carbon offset** refers to a reduction in greenhouse gas (GHG) emissions, or a removal of GHG emissions from the atmosphere, that is used to compensate for emissions that occur elsewhere[9]. Carbon offsets are usually represented by a **carbon credit** which is a tradeable certificate that represents an emission reduction or removal of one metric tonne of CO_2, or an equivalent amount of greenhouse gases (CO_2e). Purchasers of a carbon credit can 'retire' carbon credits on a **registry** to claim the underlying reduction or removal towards their own carbon reduction goals. Alternatively, credits can be acquired and retired without being used as an offset but as a form of additional beyond value chain mitigation[10].

The buying and selling of carbon credits takes place within **carbon markets**. There are two types of carbon markets:

1. **Compliance markets** - established by governments or multi-government bodies that control the supply of credits and regulate their trading[11]. For example, the UK Emissions Trading Scheme (UK ETS) is a system of carbon reduction and trading that applies to energy intensive industries, the power generation sector and aviation in the UK. The UK ETS operates using a 'cap and trade' system, where a cap is set on the total amount of GHGs that can be emitted by sectors covered by the scheme. Within this cap, participants receive free allowances and/or buy emission allowances

[7] City of York Council Climate Change Strategy - https://democracy.york.gov.uk/documents/s163766/Annex%20Bi%20Climate%20Change%20Strategy%202022-2032.pdf
[8] City of York Council Climate Change Action Plan - https://democracy.york.gov.uk/documents/s163767/Annex%20Bii%20Climate%20Change%20Action%20Plan.pdf
[9] Broekhoff et al (2019)
[10] Science Based Targets Initiative (2024)
[11] Investopedia (2023)

at auction or on the secondary market, which they can trade with other participants as needed[12].

2 **Voluntary Carbon Market (VCM)** - enables organisations to voluntarily purchase and sell carbon credits that represent the reduction or removal of GHGs from the atmosphere. Unlike the compliance market, the VCM operates not because of legal obligation but as a way of demonstrating corporate social responsibility and/or making voluntary climate claims such as carbon neutrality or net zero. There are a range of stakeholders that operate within the VCM[13] such as:

   a. Project Developers – organisations that design, develop, and operate carbon reduction or removal projects that generate carbon credits for sale on the market.
   b. End Buyers – organisations that purchase and retire carbon credits in order to offset their own emissions and make climate-related claims (e.g., carbon neutrality, net zero, climate positive etc.).
   c. Intermediaries – organisations such as brokers, retailers, and exchanges that support the trading of carbon credits and provide liquidity.
   d. Standards, Codes and Registries – organisations that provide the framework of rules, procedures, and methodologies for the creation, issuance, and retirement of credits. Given the voluntary nature of the VCM, standards safeguard the quality of carbon credits and projects.
   e. Validation and Verification Bodies (VVBs) – ensure that the documents submitted by project proponents to registries are an accurate representation of the project's characteristics, carbon emission reduction/removal capacity, and compliance with the standard's methodologies and other provisions.
   f. Other third parties – includes organisations such as market intelligence/data providers, insurance providers, industry bodies, technology providers, and consultants that provide products and services to other organisations operating within the VCM.

As part of their net zero strategies, many companies, organisations, governments, cities, and financial institutions are relying on carbon credit purchases to counterbalance their residual emissions. The use of carbon credits is particularly prevalent within the private sector with 42% of Forbes 2000 companies intending to use offset credits to reach their net zero targets, a figure rising to 53% for companies with targets for 2030 or earlier[14] (see Figure X). Carbon offsetting enables companies to compensate for any emissions they cannot avoid or reduce by paying for carbon credits which allows them to pay for an equivalent amount of emissions to be reduced or removed outside of their value chain.

[12] UK Government (2024)
[13] Allied Offsets (2023)
[14] https://zerotracker.net/analysis/net-zero-stocktake-2023

Aggregated data on demand for carbon offsets and/or insets from local authorities is limited, but anecdotally many are seeking to use offsets within their net zero plans[15]. However, the only council that has actually purchased carbon credits to date is Devon County Council[16]. In October 2022, Basingstoke and Deane Borough Council's Cabinet made a decision to offset its historic council emissions from 2019, but it is not clear whether the council has since purchased credits[17].

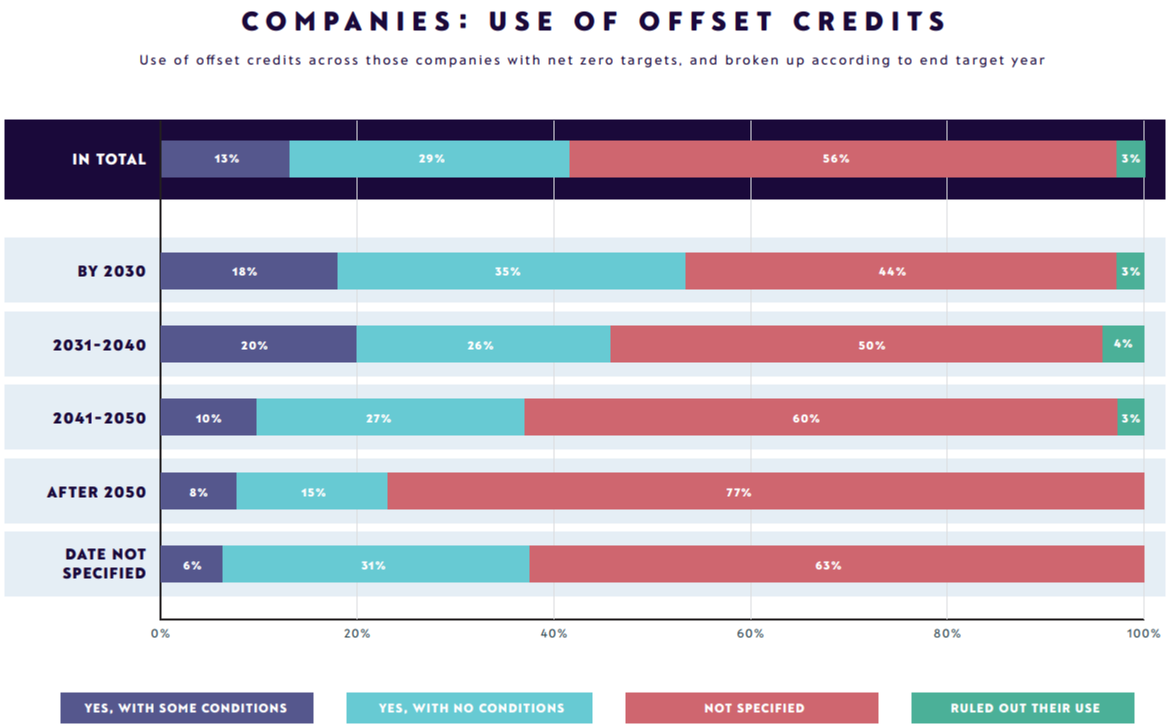

Figure 3: Use of offset credits across 929 Forbes Global 2000 companies as of 1 June 2023 and according to the net zero target year (Source: Net Zero Tracker, 2023, pg. 49).

[15] https://www.theccc.org.uk/publication/voluntary-carbon-markets-and-offsetting/
[16] https://www.contractsfinder.service.gov.uk/Notice/ce6a25dd-7ee6-4f2c-acf0-33146fb7f6e8
[17] https://democracy.basingstoke.gov.uk/documents/s29385/Carbon%20Offsetting%20report%20v1.pdf

3.2 Carbon Insetting

Carbon insetting refers to the investment in carbon reduction or removal activities *within* a business' value chain, as opposed to *outside* of the value chain, in order to compensate for residual emissions[18]. In a local authority context, the investment boundary is shifted from within the value chain to the local authority boundary[19] (see Figure X). The authority boundary could be set at an individual district or unitary council, along with counties and combined authority areas.

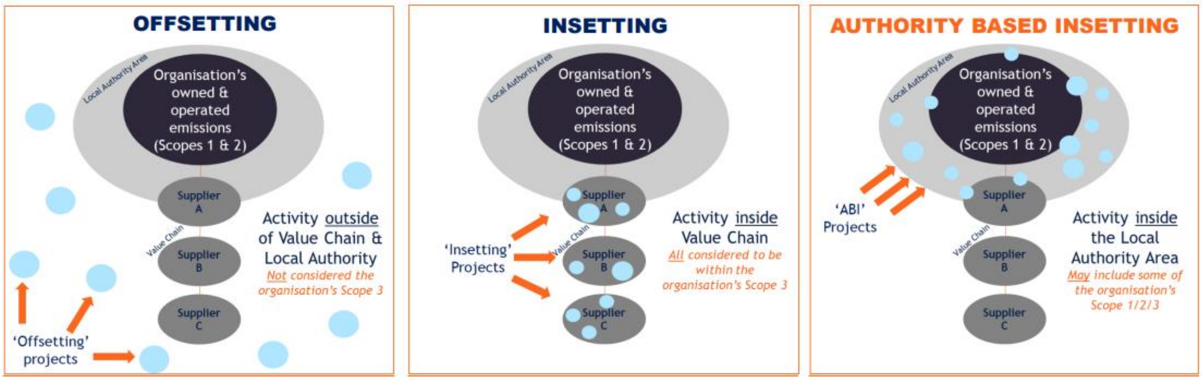

Figure 4: Diagram which illustrates the differences between traditional offsetting, insetting, and area-based insetting (Source: Anthesis, 2022).

Carbon insetting has emerged as an alternative approach to carbon offsetting that localises carbon reduction and removal projects and activities within company value chains and has been adopted by private sector organisations such as Burberry[20], Nestle[21], and PepsiCo[22]. Several local authorities are also planning to use carbon insetting or have begun developing their own carbon insetting projects in order to achieve their climate mitigation targets. Plymouth City Council, for example, has committed to developing 'local offsetting projects' (i.e., insetting) such as seagrass restoration, domestic retrofit, and woodland creation, to provide options for the council and others to meet their offsetting needs within the local area[23].

The City of York Council is also in the process of developing its own carbon insetting project through the York Community Woodland scheme which is estimated to sequester 22,587 tCO_2e over the project lifetime (see Figure X). The woodland is being established and managed by Forestry England and certified with the Woodland Carbon Code meaning that the council will be able to claim the estimated 18,070 Woodland Carbon Units (WCUs) produced by the scheme[24].

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18 https://www.insettingplatform.com/insetting-explained/
19 https://www.anthesisgroup.com/solutions/carbon-projects-offsetting/area-based-insetting/
20 https://www.burberryplc.com/news/corporate/2020/burberry-introduces-carbon-insetting-and-autumn-winter-2020-runw
21 https://www.nestle.com/sites/default/files/2023-10/nestle-scope-3-removals-framework.pdf
22 https://www.pepsico.com/docs/default-source/sustainability-and-esg-topics/pepsico's-climate-action-strategy.pdf
23 https://democracy.plymouth.gov.uk/documents/s144938/240318%20Appendix%20A%20NZAP%202024-27%20FC%20FINAL.pdf
24 Carbon sequestration calculated using the Woodland Carbon Code Carbon Calculation Spreadsheet: https://woodlandcarboncode.org.uk/standard-and-guidance/3-carbon-sequestration/3-3-project-carbon-sequestration

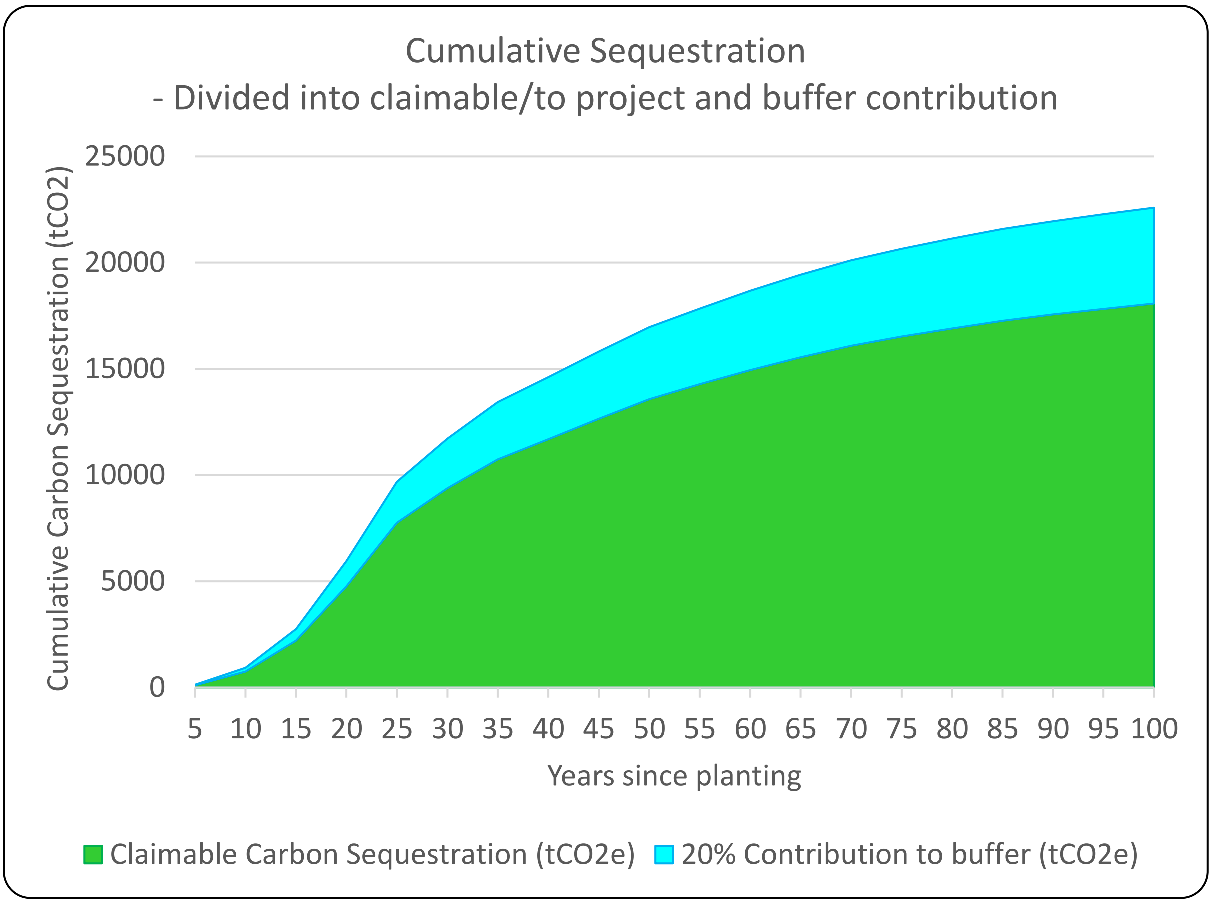

Figure 5: Cumulative carbon sequestration from the York Community Woodland project measured using the Woodland Carbon Code Carbon Calculation Spreadsheet.

With the support of 13 councils, Anthesis has developed a practical guide for local authority representatives seeking to establish their own **"Area Based Insetting" (ABI)** mechanism[25]. ABI aims to enable local authorities to identify potential insetting projects within their boundaries, attract finance for projects, and effectively measure and report project impacts. ABI can support councils to retain the socio-economic benefit of carbon reduction and removal projects locally and support the achievement of corporate and area-wide net zero targets.

ABI applies relevant principles and learnings from offsetting, including the use of carbon credits to raise finance. It also seeks to retain insetting's potential to connect local stakeholders and generate mutual benefits. There are several local authorities currently involved in developing their own ABI mechanisms in order to direct business and developer investment towards local carbon reduction or removal schemes as an alternative to traditional offsetting. For example, Oxford City Council recently secured £157,243 of grant funding from Innovate UK to launch its FutureFit Area Based Insetting (FABI) project which aims to explore how localised insetting can be used to help fund retrofit projects across the city and support their net zero goals[26].

[25] https://www.anthesisgroup.com/solutions/carbon-projects-offsetting/area-based-insetting/
[26] https://www.lowcarbonhub.org/p/programmes/futurefit-area-based-insetting-fabi/

4 Offsetting/Insetting Projects

Carbon offsets/insets can be generated by activities that reduce or remove GHGs from atmosphere. In most cases, these activities are undertaken as discrete projects ranging in scale from very small (i.e., tens to hundreds of tCO_2e per year) to very large (i.e., millions of tCO_2e per year).

Carbon offset/inset projects can be categorised into two main types: carbon reduction (see section 4.1) and carbon removal (see section 4.2). Figure X provides a visual taxonomy showing five different project classifications which distinguish between carbon reductions and carbon removals and distinguish between where carbon is removed from the atmosphere, how it is stored (in the biosphere or geosphere) and the risks and benefits associated with these different approaches[27]. For the purpose of this report, the classification system set out in Figure X will be used to denote the various offset/inset options that could be used to counterbalance any residual emissions in York.

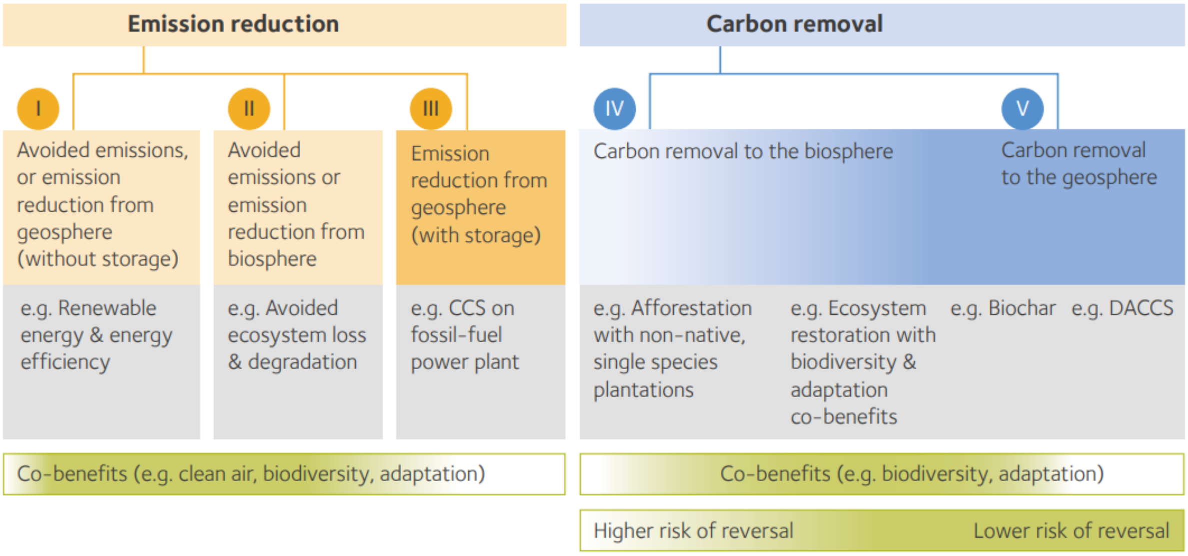

Figure 6: Simplified taxonomy showing five different classifications of carbon offset/inset projects (Source: Axelsson et al, 2024, pg. 12)

4.1 Carbon Reduction

Carbon reduction projects are a type of project that prevents or reduces greenhouse gas emissions from being released into the atmosphere. There are three broad categories of options for reducing emissions:

I. **Avoid or reduce emissions from the geosphere** – emissions can be avoided by deploying renewable energy to replace fossil fuel use, or by improving efficiency.

II. **Avoid or reduce emissions from the biosphere** – by protecting ecosystems and their soils and vegetation from damage or degradation.

[27] Axelson et al (2024).

III. **Reduce emissions from the geosphere by capturing and storing fossil carbon –** from industrial point sources or fossil-fuelled power stations.

Whilst these activities help to reduce the rate of new GHG emissions entering the atmosphere, they do not remove GHGs that are already in the atmosphere. An appraisal of the potential carbon reduction projects that could be used for carbon offsetting/insetting purposes can be found in Appendix X.

4.2 Carbon Removal

Carbon removal projects, also known as negative emissions technologies (NETs) sequester carbon from the atmosphere and store it in biological or geological reservoirs. There are two categories of options for removing carbon from the atmosphere:

IV. **Carbon removal to the biosphere –** involves enhancing the carbon stored in the biosphere, such as by restoring healthy ecosystems (e.g., woodlands, grasslands, wetlands, and marine habitats) or enhancing soil carbon on agricultural land. Often referred to as nature-based carbon removal technologies (see Appendix X).

V. **Carbon removal to the geosphere –** involves extracting CO_2 from the atmosphere and storing it in the geosphere, such as through direct air capture with geological storage (DACCS) or converting atmospheric carbon into rock through remineralisation. Often referred to as technology-based or engineered carbon removal technologies (see Appendix X).

Type IV offsets are more mature and accessible whereas Type V are less developed and more expensive.

5 Best Practice

It is imperative that the council develops a strategy that aligns with existing best practice to ensure that any use of carbon offsetting and/or insetting contributes towards achieving net zero. The aim of this section of the report is to provide an overview of existing literature, guidance, and best practice around carbon offsetting and insetting to inform the development of a council strategy.

5.1 Net Zero vs Carbon Neutral

Ahead of developing a net zero aligned offsetting strategy, it is important to first define the term 'net zero' and distinguish this from the term 'carbon neutral' that has been set by other local authorities.

Net Zero

Net zero refers to the condition in which human-caused residual GHG emissions are balanced by human-led removals over a specific period and within specified boundaries [28]. Several organisations including local authorities have set net zero targets and strategies.

International guidance has emerged to support organisations in developing credible net zero strategies including: the International Standards Organisation's Net Zero Guidelines [29]; the Science Based Targets Initiative's Corporate Net Zero Standard [30]; and the UN Secretary General's Integrity Matters Report [31].

Consensus has emerged that to achieve and maintain net zero, organisations should reduce emissions as far as possible following science-based pathways, with any residual GHG emissions attributable to that actor being fully compensated by removals with low risk of reversal, exclusively claimed by that actor, either within their own value chain (i.e., insetting) or through the purchase of high-integrity credits (i.e., offsetting) [32].

As the council has set a target to be net zero by 2030, this report outlines the best practice guidance around using offsets/insets to make net zero claims as opposed to other potential claims such as carbon neutrality (see below).

Carbon Neutral

While carbon neutrality and net zero are terms that should be functionally equivalent concepts, practitioners, standards, and regulators alike (particularly referring to claims of non-state actors) have come to interpret and apply 'carbon neutral' as a less rigorous, interim claim in which an organisation purchases credits (reductions or removals) to compensate for the total amount of remaining emissions, often ahead of the net zero target [33].

[28] https://www.iso.org/obp/ui/en/#iso:std:iso:iwa:42:ed-1:v1:en:term:3.1.1
[29] https://www.iso.org/obp/ui/en/#iso:std:iso:iwa:42:ed-1:v1:en
[30] https://sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf
[31] https://www.un.org/sites/un2.un.org/files/high-level_expert_group_n7b.pdf
[32] https://www.smithschool.ox.ac.uk/sites/default/files/2024-02/Oxford-Principles-for-Net-Zero-Aligned-Carbon-Offsetting-revised-2024.pdf
[33] https://www.smithschool.ox.ac.uk/sites/default/files/2024-02/Oxford-Principles-for-Net-Zero-Aligned-Carbon-Offsetting-revised-2024.pdf

The International Standards Organisation's Carbon Neutrality Standard, for example, defines carbon neutral as the "condition in which during a specific period there has been no net emission of GHGs to the atmosphere as the carbon footprint of the subject has been counterbalanced by offsetting". It further states that "achievement of this condition is not limited to the GHG emissions and GHG removals within the boundary of the subject and can include counterbalancing measures such as the use of carbon offsets, as long as these meet certain criteria" [34].

This understanding of carbon neutrality demonstrates a departure from the definition of net zero, which is achieved through deep emissions reductions, with any residual GHG emissions attributable to that actor being fully compensated by removals with low risk of reversal.

5.2 Carbon Mitigation Hierarchy

Emissions reductions are the core component of any credible net zero strategy and voluntary initiatives and standards on net zero commonly advocate using the mitigation hierarchy (see Section 5.3). The carbon mitigation hierarchy emphasises the need for actors to reduce emissions from within their value chain as much as possible before using offsets and/or insets to reduce carbon emissions (see Figure X [35]). The introduction of carbon offsets and/or insets should not replace, nor detract from, the rollout of carbon reduction measures across York; offsets must only be used to remove residual emissions that remain in the net zero target year.

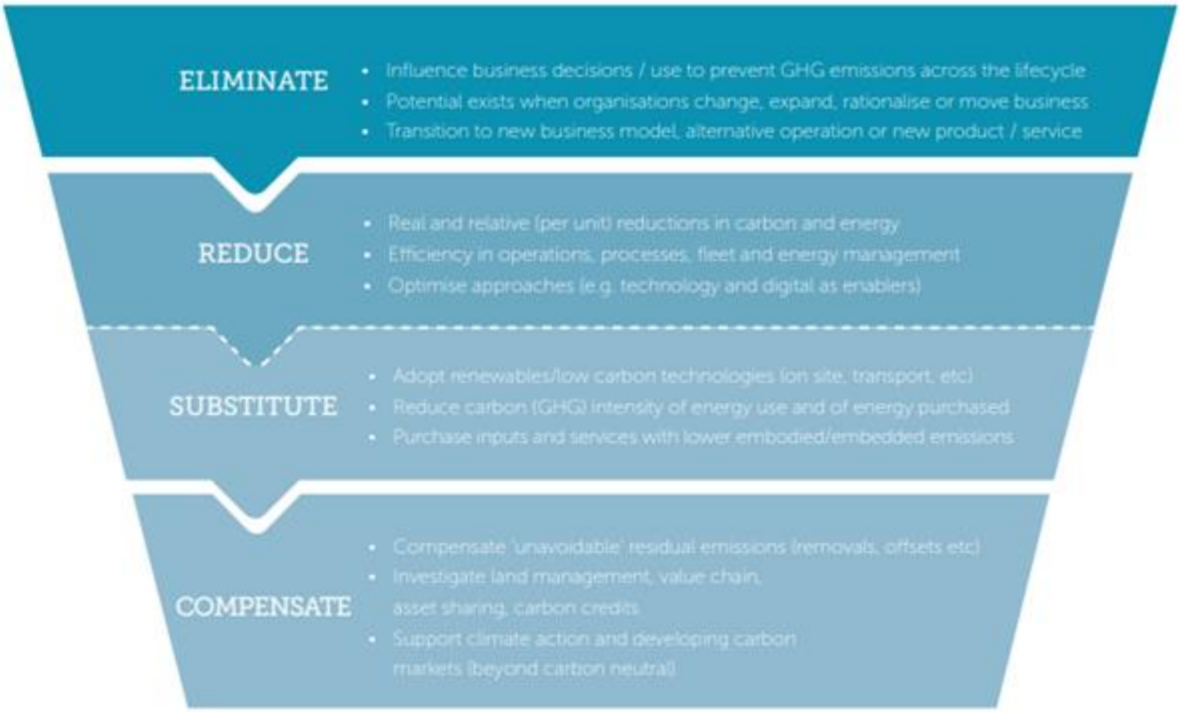

Figure 7: Greenhouse Gas Management Hierarchy (Source: IEMA, 2020).

[34] https://www.iso.org/standard/43279.html

[35] https://www.iema.net/resources/reading-room/2020/11/26/pathways-to-net-zero-using-the-iema-ghg-management-hierarchy-november-2020

5.3 Defining residuals

Residual emissions are frequently referred to as "hard-to-mitigate" emissions [36] or emissions that remain after "taking all possible actions to implement emissions reductions given current resources and technology" [37]. Whilst there is a consensus amongst voluntary net zero standards and guidance that the use of offsets and insets should be restricted to residual emissions, there is a lack of guidance or specific criteria as to how to define residual emissions [38]. For example, few standards define a numerical threshold or provide support to define what emissions can be considered as not feasible to eliminate, especially when financial criteria or resources are used to determine this feasibility.

The Science Based Targets Initiative (SBTi) recommends a reduction threshold of at least 90% by 2050 to inform the level of residual emissions for companies [39]. The SME Climate Hub recommends a threshold of 10% for residual emissions. A report prepared for the Hertfordshire Climate Change and Sustainability Partnership recommended that residual emissions should not go beyond 5% of the total carbon budget of the county [40].

The council could follow a similar approach and set a reduction threshold as part of its net zero strategy. This will help to focus attention on maximising efforts to reduce carbon in York prior to using offsets or insets. However, there is no clear guidance for local authorities wishing to set a threshold on use of offsets/insets so this may prove a challenge.

5.4 Carbon Offsetting – Best Practice

The vast majority of current offsetting approaches currently used by organisations are not net zero aligned and the use of offsetting has come under considerable criticism from the press, academics, and environmental advocates [41] [42] [43] [44] [45]. Common criticisms and concerns around carbon offsetting centre around two categories [46]:

- *How carbon offset credits are used* (demand-side) – concerns that the use of carbon offsetting could create perverse incentives and encourage mitigation deterrence if organisations rely on offsetting to achieve net zero targets instead of prioritising emissions reductions.
- *The quality of carbon offset credits* (supply-side) – concerns about the quality and integrity of projects and resulting credits that are purchased and used to make climate claims. The current supply of carbon credits within the VCM is dominated by low-quality carbon reduction credits that are not aligned with net zero standards.

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38 https://netzeroclimate.org/wp-content/uploads/2022/12/Summary-Report_Oxford-Net-Zero_October-2022.pdf

39

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41 https://www.theguardian.com/environment/2023/sep/19/do-carbon-credit-reduce-emissions-greenhouse-gases

42 https://policy.friendsoftheearth.uk/insight/dangerous-distraction-offsetting-con

43 https://www.weforum.org/agenda/2021/09/greenpeace-international-carbon-offsetting-net-zero-pledges-climate-change-action/

44 https://www.ft.com/content/9b02fcf7-9e04-4b71-ad14-251552d5a78e

45 https://www.tandfonline.com/doi/abs/10.1080/09644016.2021.1877063

46 https://www.offsetguide.org/common-criticisms/

5.4.1 Demand-side initiatives

A growing set of literature, guidance, standards, and regulations is contributing to international consensus on what constitutes credible use of offsetting to achieve net zero targets[47]. Efforts to define best practice as it pertains to offsetting or compensating emissions is set out within various voluntary standards such as: the Science Based Targets Initiative's (SBTi) Net Zero Standard[48] and Beyond Value Chain Mitigation guidance[49], the ISO Net Zero Guidelines[50], the Voluntary Carbon Markets Initiative's (VCMI) Claims Code of Practice[51], and the Oxford Principles for Net Zero Aligned Carbon Offsetting[52]. These initiatives provide guidance, mainly aimed at the corporate sector, to reduce the well-known risks associated with the current use of credits and improve the credibility and integrity of net zero claims.

The Oxford Principles for Net Zero Aligned Carbon Offsetting, recently updated in February 2024, contribute to this literature by outlining a best practice approach for offsetting that aligns with net zero targets. Organisations are encouraged to subscribe to four key principles when using carbon offsetting (see Table X).

Table 1: Four key principles for organisations to adopt when using carbon offsetting to achieve net zero targets taken from the Oxford Offsetting Principles for Net Zero Aligned Carbon Offsetting.

Principle	Description
1 Cut emissions, ensure the environmental integrity of credits used to achieve net zero, and regularly revise your offsetting strategy as best practice evolves.	Following best practices developed over the last decade to deal with carbon credits and projects, adherents to the Principles should: 1A Prioritise reducing your direct and indirect emissions – Minimise the need for offsetting. Reducing emissions has multiple co-benefits and there are limits to the availability of high-quality credits. 1B Ensure the integrity of carbon credits – Credits must be measured, reported, verified, and correctly accounted for. Credit-generated investments must yield results that are demonstrably additional to what otherwise have occurred, have a low risk of reversal, and avoid negative impacts on people and the environment. 1C Maintain transparency – Disclose current emissions, accounting and verification practices, targets, and transition plans to reach net zero, and the type of credits you employ, as well as your selection process and the verification

[47] https://www.smithschool.ox.ac.uk/sites/default/files/2024-02/Oxford-Principles-for-Net-Zero-Aligned-Carbon-Offsetting-revised-2024.pdf
[48] https://sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf
[49] https://sciencebasedtargets.org/beyond-value-chain-mitigation
[50] https://www.iso.org/obp/ui/en/#iso:std:iso:iwa:42:ed-1:v1:en
[51] https://vcmintegrity.org/vcmi-claims-code-of-practice/
[52] https://www.smithschool.ox.ac.uk/sites/default/files/2024-02/Oxford-Principles-for-Net-Zero-Aligned-Carbon-Offsetting-revised-2024.pdf

	processes associated with the credits.
2 Transition to carbon removal offsetting for any residual emissions by the global net zero target date.	Most credits in the voluntary market today are associated with emission reductions or avoided emissions. These can play a key role in the short and medium term to protect the carbon stored in vulnerable ecosystems and accelerate the transition to a low-carbon society, but the scope for further emissions reductions will decrease as we approach the net zero target date. Organisations must shift towards carbon removals, which remove carbon from the atmosphere to counterbalance residual emissions and achieve net zero. Those targeting net zero with the use of credits will need to increase the proportion that comes from carbon removal, rather than from emission reductions, aiming to reach 100% carbon removal credits by the global net zero date (2050 at the latest). Other mechanisms besides the use of credits will also be needed to avoid and reduce emissions, both before and after the net zero target date.
3 Shift to removals with durable storage (low risk of reversal) to compensate any residual emissions by the net zero target date.	All carbon dioxide (CO_2) removals need to be stored. Different storage methods vary in their susceptibility to releasing GHGs back into the atmosphere (hereafter 'risk of reversal'). To maintain a net zero balance, storage with low risk of reversal and high durability over the long term (centuries to millennia) is needed, such as storing CO_2 in well-selected geological reservoirs or mineralising carbon into a stable form. Some nature-based approaches that restore and protect the carbon stored in well-managed resilient ecosystems could also store carbon for centuries to millennia, provided future generations continue to maintain them and they are not destabilised by future climate change. However, the current deployment level of durable carbon removal and storage approaches is well below what is needed. It is critical that investment in these methods begins early and ramps up rapidly to ensure they are available at the scale needed to meet the demand required to achieve global net zero. Continuing to invest in high-integrity projects with a *moderate* risk of reversal (such as certain nature-based removals that may be susceptible to climate change) will also play a valuable role in the short to medium term whilst complementary approaches with a lower risk of reversal are developed and deployed. These may also have many other benefits beyond carbon removal and storage.
4 Support the development of innovative and integrated approaches to achieving net zero.	The market for high-quality removals, whether used to generate credits or for wider offsetting approaches, is immature and in need of early adopters to support its growth. Users of these Principles can develop the market to support net zero by: 4A Using long-term agreements that are bankable and investable to provide certainty to project developers so they can raise capital efficiently.

	4B De-risking project finance. 4C Forming sector-specific alliances to work collaboratively with industry peers to develop the market for projects aligned with net zero. 4D Supporting the protection and restoration of a wide range of ecosystems in their own right. Not only will this contribute to reducing emissions and removing CO_2, but it will also further secure the multiple ways society is supported by nature, including adaptation to the impacts of climate change. While high-integrity ecosystem restoration projects usually store carbon, such efforts should also be supported for their social and environmental benefits, not solely for the purpose of compensating for ongoing emissions. 4E Adopting and publicising the Principles and incorporating them into regulation and standard setting for net zero. 4F Investing in additional beyond value chain mitigation.

Several organisations have started to adopt the Oxford Offsetting Principles as the basis of their offsetting strategies, recognising their importance in ensuring the integrity and effectiveness of offsetting efforts in achieving a net zero future. Whilst the Oxford Offsetting Principles were not designed specifically for local authorities, many of the key principles will still apply. Therefore, it is recommended that the council recognises, adopts, and integrates these best practice principles into its own carbon offsetting and insetting strategy.

5.4.2 Supply-side initiatives

Carbon standards and codes are central to the operation of the VCM and act as regulators of the market. Codes and standards provide the framework of rules, procedures, and methodologies for measuring and certifying the volume of carbon emission reduction/removals of schemes [53]. Given the voluntary nature of the VCM, standards organisations safeguard the quality of VCM carbon credits and provide credibility to the use of carbon offsetting to achieve net zero claims.

Carbon standards both certify carbon projects and facilitate the trade of carbon credits. Standards convert certified emissions reductions and removals into tradeable carbon credits. To obtain certification of emissions reductions or removals and be issued credits to trade, projects must meet certain benchmarks and protocols outlined in detailed policies by the code or standard. This often includes complying with standards’ processes, rules, requirements, and safeguards; applying methodologies approved by the standards; and providing evidence of compliance this is then reviewed by an independent third-party auditor. Carbon standards use registries to track all credits generated, transfer tradeable credits, and trace transactions between buyers and sellers [54].

[53] https://web.kana.earth/p/code-comparison
[54] https://vcmprimer.org/chapter-1-what-is-the-voluntary-carbon-market/

Carbon standards vary in their approaches, methodologies, and requirements. The main carbon standards by volume of credits traded include the Verified Carbon Standard (VCS) [55]; Gold Standard (GS) [56]; American Carbon Registry (ACR) [57]; and the Climate Action Reserve (CAR) [58]. Other smaller standards include Isometric [59], Puro.earth [60], Social Carbon [61], and Plan Vivo [62]. The International Carbon Reduction & Offset Alliance (ICROA) [63] is a non-profit membership organisation which audits and promotes high-integrity standards around the world. ICROA essentially acts as the global umbrella body for offset providers in the voluntary market.

In the UK, there are two government-endorsed standards in place that provide investors the opportunity to buy high-quality verified credits from woodland creation and peatland restoration projects. These include:

- The Woodland Carbon Code (WCC) [64] – the quality assurance standard for woodland creation projects in the UK, and generates high integrity, independently verified carbon units. Maintained by the IUCN UK Peatland Programme.
- The Peatland Code (PC) [65] – voluntary certification standard for UK peatland projects wishing to market the climate benefits of peatland restoration and provides assurances to VCM buyers that the climate benefits being sold are real, quantifiable, additional, and permanent.

Both voluntary carbon codes provide a rigorous set of methodologies and procedures for landowners and developers to follow, to ensure credibility of carbon units, which are purchased by corporate buyers to offset against or contribute towards climate targets. Carbon units purchased from the UK VCM can only be used by organisations with UK operations to offset UK-related emissions. There are a number of other voluntary codes currently in development for projects such as hedgerow creation and saltmarsh restoration (see Figure X [66]):

[55] https://verra.org/programs/verified-carbon-standard/
[56] https://www.goldstandard.org/
[57] https://acrcarbon.org/
[58] https://www.climateactionreserve.org/
[59] https://science.isometric.com/
[60] https://puro.earth/
[61] https://www.socialcarbon.org/
[62] https://www.planvivo.org/
[63] https://icroa.org/
[64] https://woodlandcarboncode.org.uk/
[65] https://www.iucn-uk-peatlandprogramme.org/peatland-code-0
[66] https://www.greenfinanceinstitute.com/wp-content/uploads/2023/03/ENABLER-3.pdf

	Markets and Codes	Developers
Compliance Markets	Biodiversity Net Gain Credit Markets (in development)	Natural England & Defra – Sept 2023
	Nutrient Neutrality	Natural England
Established Voluntary Codes	Woodland Carbon Code	Scottish Forestry
	Peatland Code	IUCN
	Soil Carbon Minimum Standards	SWAG SW
	Wilder Carbon Standard	Wilder Carbon, led by Kent Wildlife Trust
Codes in Development	Agroforestry Carbon Code	Soil Association
	Hedgerow Carbon Code	The Allerton Research & Educational Trust
	UK Saltmarsh Carbon Code	UK Centre for Ecology & Hydrology
Codes in Early Development*	Seagrass Carbon Code	Plymouth City Council
	Sussex Bay Kelp Carbon Code	Adur & Worthing Council
	UK Freshwater Biodiversity Code	Bristol Avon Rivers Trust

Figure 8: Environmental markets and codes in the UK (Source: Green Finance Institute, 2023).

The International Council for the Voluntary Carbon Market (ICVCM) [67] is an independent governance body for the VCM. Its role is to set and enforce a definitive global threshold standard for high-quality carbon credits and ensure that the VCM accelerates a just transition to 1.5°C of global warming. In March 2023, the ICVCM published 10 Core Carbon Principles (CCPs), that set out key principles for identifying high-integrity carbon credits that create real, verifiable climate impact, based on the latest science and best practice [68] (see Figure X).

The ICVCM is currently assessing for adherence to the CCP Assessment Framework [69]:

1. Carbon-crediting programmes to determine whether a carbon-crediting programme can be approved as CCP-Eligible.
2. Categories of carbon credits, to determine whether a Category of carbon credits may be labelled as CCP-Approved by a CCP-Eligible programme.

Once assessments are complete, Programmes deemed to be CCP-Eligible will be able to issue CCP-Approved carbon credits from CCP-Approved Categories of carbon credits. As a potential buyer of carbon credits, the council should seek to purchase credits from CCP-Approved projects to ensure that it is purchasing high-integrity credits.

67 https://icvcm.org/
68 https://icvcm.org/the-core-carbon-principles/
69 https://icvcm.org/program-assessment-status/

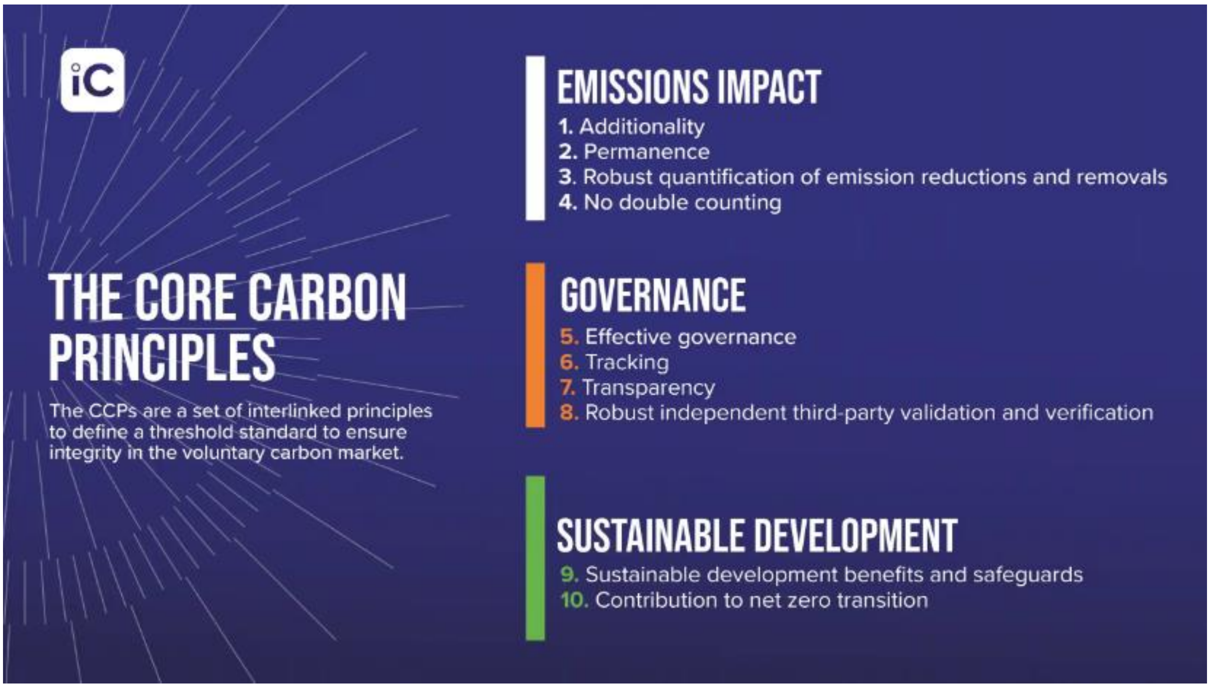

Figure 9: The Integrity Council's Core Carbon Principles (CCPs)

Carbon ratings agencies such as Sylvera [70], BeZero [71], Calyx Global [72], and Renoster [73] have emerged recently with the aim of bringing clarity and confidence to the VCM and supporting organisations to clearly understand the quality of carbon credits. Based on independent and objective analysis, a carbon credit rating agency issues ratings (often in the form of letter grades such as AAA, AAA-, AA, etc.) to assess the likelihood that a carbon project delivers real climate impact [74]. This approach mirrors that of financial credit ratings or ESG ratings. Like with debt or ESG ratings, carbon credit ratings help buyers understand the risk associated with a specific credit, and support in comparing different projects against each other. For example, a low carbon credit rating would indicate the project is high risk (i.e., likely not delivering the claimed avoided or removed emissions). As a potential buyer of market-based offsets, the council must be educated about the various assessment approaches and understand the risks involved.

5.5 Carbon Insetting – Best Practice

Within the corporate sector, for example, insetting has emerged as a promising approach for companies to drive carbon reductions and removals within their value chains and harmonise their operations with the ecosystems they depend on [75] [76].

Carbon insetting also provides an alternative means through which local authorities can address their residual emissions whilst maximising benefits for local communities by ensuring projects and investments are retained within the local authority boundary. Councils could, for example, directly deliver their own carbon insetting projects and/or work with other

70 https://www.sylvera.com/
71 https://bezerocarbon.com/
72 https://calyxglobal.com/
73 https://www.renoster.co/
74 https://www.sylvera.com/blog/what-is-a-carbon-credit-agency/
75 https://www.insettingplatform.com/wp-content/uploads/2022/03/IPI-Insetting-Guide.pdf
76 https://www.abatable.com/reports/insetting-scope-3-carbon-emissions

local stakeholders (i.e., community groups, local businesses, project developers) to identify and fully or partially fund local projects in return for a claim on the achieved carbon savings. Carbon insetting can also help to minimise other challenges faced by local authorities when using carbon offsetting such as lack of return on investment and exposure to unpredictable market prices for carbon credits.

Due to the relatively nascent nature of insetting, there is only a limited set of literature, standards, and guidance available setting out what constitutes credible use of insetting to achieve net zero targets. This includes standards and guidance produced by organisations such as the International Insetting Platform [77] [78] [79], Anthesis [80], and the Scottish Government [81].

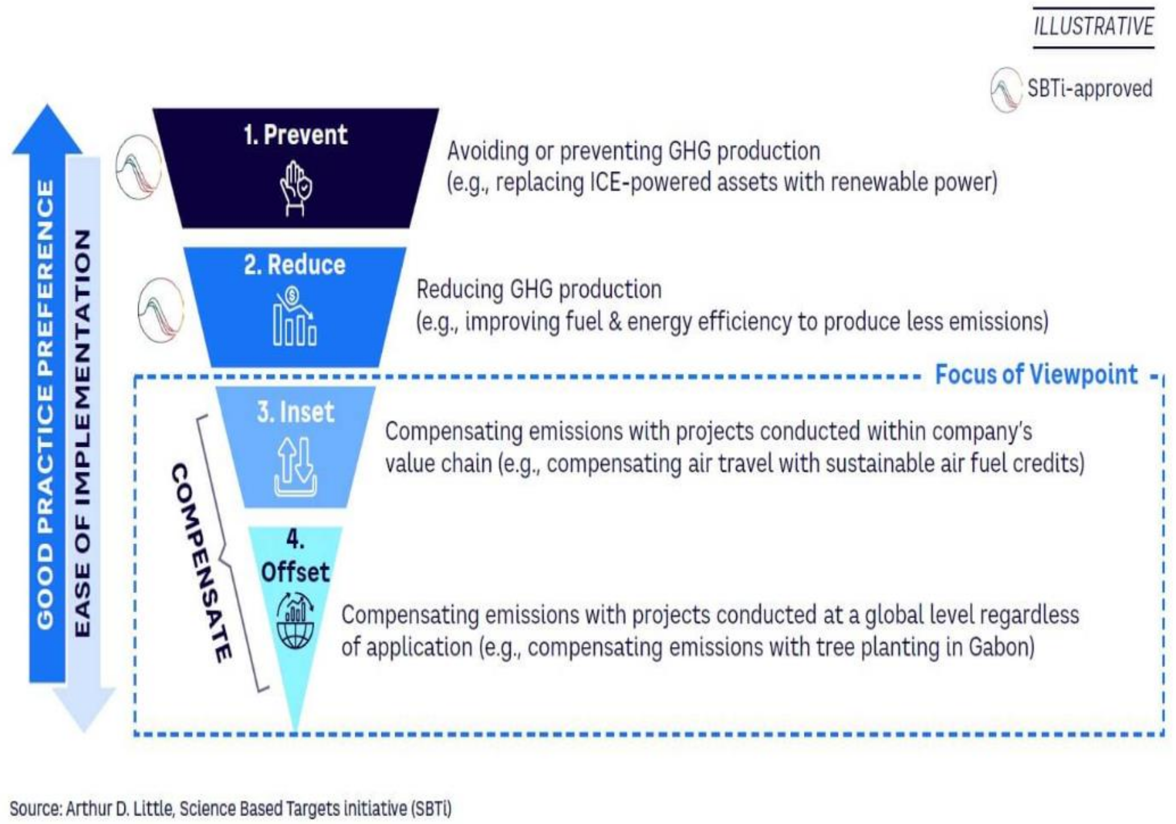

Figure 10: Decarbonisation hierarchy adapted to illustrate the need to prioritise insetting over offsetting in order to compensate for residual emissions.

[77] https://www.insettingplatform.com/

[78] https://www.insettingplatform.com/wp-content/uploads/2020/09/INSETTING_PROGRAM_STANDARD_IPS_V2.0_Final.pdf

[79] https://www.abatable.com/reports/insetting-scope-3-carbon-emissions

[80] https://www.anthesisgroup.com/solutions/carbon-projects-offsetting/area-based-insetting/

[81] https://www.gov.scot/publications/public-sector-leadership-global-climate-emergency/pages/12/

Within the literature, carbon insetting is often promoted as a solution that should be prioritised over traditional carbon offsetting, particularly amongst public bodies with access to significant landholdings (see Figure X). The Scottish Government, for example, has issued guidance for public bodies on offsetting and insetting which states that "investment in insetting projects should be prioritised ahead of the purchase of carbon offsets" [82]. Anthesis suggest that "for local authorities, traditional offsetting options may present even greater challenges than for the corporate market" and suggest the insetting activity within a local authority's boundary ("area based insetting") should be the focus of investment [83].

5.6 Offsetting vs Insetting

Carbon offsetting

The council could consider counterbalancing its residual emissions through carbon offsetting – i.e., purchasing carbon credits via the VCM in order to counterbalance organisational and/or city-wide carbon emissions. This is an approach that is commonly used within the corporate sector and has been deployed by councils such as Devon County Council and Basingstoke and Deane Borough Council. In the view of APSE Energy, "carbon offsetting is both a legitimate and useful tool which has a proper place in local authority climate emergency action plans" [84].

In line with Principle 1B of the Oxford Offsetting Principles, purchasing carbon credits requires proper due diligence to ensure that the council is investing in high-quality projects (see Section X). Within the UK, two Government supported certification codes have emerged for both woodland creation and peatland restoration projects – the Woodland Carbon Code (WCC) [85] and Peatland Code (PC) [86]. These set clear criteria to validate and verify carbon sequestration from woodland creation and peatland restoration projects to create a transparent market for the sale of these credits. Carbon credits can be purchased through the WCC or PCC as either Woodland or Peatland Carbon Units or Pending Issuance Units (PIUs):

- A Woodland or Peatland Carbon Unit represents one tonne of CO_2e which has been sequestered in a WCC-verified woodland or PCC-verified peatland project. Woodland Carbon Units (WCUs) or Peatland Carbon Units (PCUs) can be retired upon purchase in the UK Land Carbon Registry by a UK-based organisation to counterbalance its residual emissions and make carbon neutral or net zero claims.

- A Pending Issuance Unit (PIU) is effectively a 'promise to deliver' a WCU or PCU in the future, based on predicted sequestration volumes. As PIUs are not guaranteed, they cannot be used by organisations to counterbalance their residual emissions until they are verified and converted into WCUs.

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[82] https://sustainablescotlandnetwork.org/uploads/store/mediaupload/2110/file/Public%20Bodies%20and%20Climate%20Change%20Duties%20-%20Guidance%20on%20carbon%20insetting%20and%20offsetting%20-%20February%202023.pdf
[83] https://www.anthesisgroup.com/solutions/carbon-projects-offsetting/area-based-insetting/
[84] https://www.apse.org.uk/apse/index.cfm/local-authority-energy-collaboration/apse-energy-publications1/the-relevance-and-legitimacy-of-carbon-offsetting-in-local-government/
[85]
[86]

There are, however, several challenges that the council may face if it decides to pursue this option [87]. First, there is only a limited supply of high-quality verified UK-based carbon credits available for the council to purchase, particularly as woodland and peatland projects take time to mature and reach full carbon sequestration potential [88]. Very few woodland projects were planted and registered with the WCC long enough ago to be yielding WCUs. Of the projects that have been verified, only small amounts of WCUs are available, as trees do not sequester significant amounts of carbon until around Year 15 onwards. Similarly, Peatland Carbon Units are not currently available under the UK Peatland Code, as these units can only be obtained after a project has been verified, which takes place 5 years after a restoration process has occurred [89].

Second, it is expected that the costs of UK nature-based credits will increase significantly in the future as pressures to achieve climate mitigation targets will increase demand from corporate buyers. The Climate Change Committee estimate that offset credits for peatland restoration will cost between £5-40/tCO_2e and woodland creation £65-105/tCO_2e [90]. Similarly, a report from LSE and the Grantham Institute suggests that, to meet net zero targets, shadow carbon prices would increase to £75/tCO_2e in 2030 and to circa £160/tCO_2e in 2050 [91]. The council will have no control over future prices of carbon credits and will be exposed to any future price changes in the market.

Third, council expenditure on carbon credits will be largely funded by taxpayers' money, subjecting the council's offsetting activity to significant public attention and scrutiny. Taxpayers will demand transparency around how their money is invested by the council and to ensure that it provides local benefit to residents. This is difficult to achieve using carbon offsets as they commonly relate to projects outside of the local authority boundary and/or outside of the UK. As a result, there is a risk that any use of carbon offsetting by the council will be the subject of strong opposition from local residents.

Lastly, purchasing carbon credits will not provide the council with any financial return on investment. Meeting the council's net zero target in 2030, and each year thereafter, would require an annual investment in carbon credits with no direct financial payback. As a result of the challenges of carbon offsetting, many councils are now considering local approaches such as carbon insetting as an alternative to compensate for their residual emissions (see Section X).

Carbon insetting

Partly in response to criticisms around carbon offsetting, some councils are now pivoting towards carbon insetting as an alternative measure to compensate for residual emissions. The council could directly deliver its own carbon insetting projects and/or work with other local stakeholders in York (i.e., community groups, local businesses, project developers) to identify and fully or partially fund projects in return for a claim on the realised carbon removals.

The council should select projects that will maximise benefits for local communities, and any carbon reductions and co-benefits will be retained within the local authority boundary. By

[87] https://www.anthesisgroup.com/solutions/carbon-projects-offsetting/area-based-insetting/
[88] https://cdn.forestresearch.gov.uk/2022/07/QFORC_Summary_Report_rv1e_final.pdf
[89] https://www.iucn-uk-peatlandprogramme.org/peatland-code/introduction-peatland-code/buyers
[90] https://www.theccc.org.uk/publication/voluntary-carbon-markets-and-offsetting/
[91] https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2019/05/GRI-POLICY-BRIEF_How-to-price-carbon-to-reach-net-zero-emissions-in-the-UK.pdf

keeping projects within the local authority boundary, carbon insetting creates a more relevant and meaningful impact for local residents. Carbon insetting will also help to bring down city-wide emissions over time as a result of more carbon removal projects being delivered within the city. It is therefore recommended that the council prioritises opportunities for insetting projects within the local authority boundary before purchasing credits from out-of-boundary projects.

As with carbon offsetting, there are some challenges that the council may face if it decides to use carbon insetting. First, significant resources and funding will be required to identify, develop, and implement carbon inset projects in York. Compared to carbon offsetting, this will require significantly greater capital and revenue expenditure. The council will also be responsible for the third-party verification, monitoring, maintenance, and operation of any inset projects which will require further expenditure.

Second, not all nature-based removal projects will be suitable within the City of York local authority area. For example, there are no coastal areas within York, so the council will not be able to deliver blue carbon projects that capture and store carbon in marine and coastal ecosystems (i.e., seagrass and saltmarsh restoration). As a result, there may only be limited opportunities for insetting projects on the council's landholdings or other land within the local authority boundary.

Third, carbon removal inset projects will require a significant period of time to develop and implement. Once implemented, there will be a further length of time before nature-based removal projects are verified and begin to sequester significant volumes of carbon. For example, the council's York Community Woodland will not produce its first WCUs until 2029; the 102 WCUs that will be produced will not be enough to counterbalance the council's corporate residual emissions in 2030 and each year thereafter. As a result, it is very unlikely that the council will be able to deliver insetting projects that generate sufficient carbon removals to counterbalance the corporate residual emissions by 2030.

If the council is unable to address all of its residual emissions through carbon insetting projects within the local authority boundary, it could consider supplementing this with carbon credit purchases from the VCM as a last resort.

6 Draft Carbon Offsetting/Insetting Principles

Until there is convergence on a common set of standards and accountability mechanisms for local authorities around net zero claims and carbon offsetting/insetting, it is recommended that the council develops its own guiding principles. These principles, derived from existing best practice guidelines and standards (see Section X), will provide the overarching framework by which the council and its partners can assess the alignment of any potential carbon offsetting or insetting investment opportunities with its net zero ambitions. Given that the council aims to deliver its Climate Change Strategy through partnership working across the private, public, and voluntary sectors in York, it is also recommended that these principles are adopted by local businesses and organisations within York.

A set of draft carbon offsetting/insetting principles is set out below. Further work will be required to test these principles through internal and external consultation, and the principles will likely need to be adapted and expanded on before they are integrated into a final Carbon Offsetting/Insetting Strategy for York.

Principle 1 – Develop a dedicated Carbon Offsetting/Insetting Strategy

The council's Climate Change Strategy includes a commitment to develop a dedicated 'Carbon Offsetting/Insetting Strategy' that defines the council's approach to carbon offsetting and insetting to achieve its net zero target. The council will collaborate and consult with key internal and external stakeholders to develop a strategy that is supported by local stakeholders and maximises benefits for York. The council will develop a strategy that aligns with best practice to ensure that its use of carbon offsetting/insetting actually contributes towards achieving net zero.

Principle 2 – Ensure use of carbon offsetting and/or insetting is aligned with best practice

A growing set of literature, guidance, standards, and regulations is contributing to international consensus on what constitutes credible use of offsetting and insetting to achieve net zero targets[92]. A number of voluntary initiatives have emerged such as the Science Based Targets Initiative's (SBTi) Net Zero Standard[93] and Beyond Value Chain Mitigation guidance[94], the ISO Net Zero Guidelines[95], the Voluntary Carbon Markets Initiative's (VCMI) Claims Code of Practice[96], and the Oxford Principles for Net Zero Aligned Carbon Offsetting[97]. These initiatives provide guidance and best practice around what an organisational net zero claim should entail and ensure that any offsetting/insetting is compatible with transitioning to a net zero society. The council will ensure its use of carbon offsetting and/or insetting is aligned with existing best practice standards and guidance. This best practice guidance is integrated within these principles.

Principle 3 – Update strategy over time as best practice standards, guidance, and legislation emerges

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[92] https://www.smithschool.ox.ac.uk/sites/default/files/2024-02/Oxford-Principles-for-Net-Zero-Aligned-Carbon-Offsetting-revised-2024.pdf
[93] https://sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf
[94] https://sciencebasedtargets.org/beyond-value-chain-mitigation
[95] https://www.iso.org/obp/ui/en/#iso:std:iso:iwa:42:ed-1:v1:en
[96] https://vcmintegrity.org/vcmi-claims-code-of-practice/
[97] https://www.smithschool.ox.ac.uk/sites/default/files/2024-02/Oxford-Principles-for-Net-Zero-Aligned-Carbon-Offsetting-revised-2024.pdf

The emerging strategy and principles have been developed to align with existing best practice guidance and standards around the use of carbon offsetting and insetting to support net zero claims. Guidance around net zero claims and the use of offsetting and insetting is, however, an area of climate action which continues to evolve rapidly and unpredictably. Whilst the strategy and principles align with current best practice, it is likely that this will change over time as common sets of standards and accountability mechanisms around net zero claims emerge.

The council's strategy and principles will serve as 'living documents' and will be updated over time as best practice standards, guidance, and legislation emerges. This will require the council to be agile and flexible in its approach to offsetting and insetting whilst on its journey to net zero.

Principle 4 – Prioritise reducing emissions before using carbon offsets and/or insets

Emissions reductions are the core component of any credible net zero strategy. In line with best practice, it is recommended that the council prioritises reducing its emissions as much as possible before using carbon offsets or insets. The introduction of carbon offsets and/or insets should not replace, nor detract from, the rollout of carbon reduction measures across York. Offsetting and insetting must only be used to address residual carbon emissions that cannot be reduced or avoided by the net zero target date of 2030. Maximising carbon reduction will also help to minimise the council's dependence on carbon offsets/insets in order to achieve its net zero targets.

Principle 5 – Address residual emissions through investment in high-quality carbon removals by the net zero target date

The scientific consensus and best practice is clear that any residual emissions must be balanced with removals, not avoidance or emissions reductions in order to make net zero claims. Therefore, to achieve and maintain net zero, the council must counterbalance its residual emissions through investment in high-quality removals either within the local authority boundary (i.e., carbon insetting) or by purchasing carbon credits from carbon removal projects in the UK (i.e., carbon offsetting).

This does not mean that carbon offsetting/insetting approaches that rely on carbon avoidance or reduction activities should be entirely discounted. In the short term, they will play a useful role in accelerating the rate of GHG emission reductions. However, carbon offsets or insets from avoidance or reduction activities cannot be used to counterbalance residual emissions for the purposes of making a net zero claim.

There are a variety of different carbon removal project types that the council could use to counterbalance its residual emissions, including nature-based and engineered carbon removal solutions (see Appendix 2 and 3). Each potential project opportunity will be assessed through the development of a business case that will consider the benefits, costs, and risks of any potential investment opportunity. A portfolio-approach could be used, whereby the council seeks to maximise benefits and reduce risks by diversifying its investment into a range of different project types.

In line with best practice, the council will consider shifting its investments over time towards higher durability carbon removal projects as these technologies become more commercially viable in the future. This includes technologies such as direct air carbon capture and storage (DACCS), bioenergy with carbon capture and storage (BECCS), and enhanced rock weathering (ERW).

The council will conduct due diligence and ensure that any carbon credits that are purchased are high-integrity and externally verified by ICROA endorsed and CCP-Eligible standards bodies. This will ensure that any carbon credits purchased are real, measurable, additional, unique and traceable, avoid leakage, and are durable/permanent. Carbon removals from insetting projects will also be externally verified, however, there is no requirement to do so, assuming that any carbon removals are intended for internal use.

Principle 6 – Prioritise opportunities for developing carbon insetting projects within the local authority boundary prior to investing in external carbon offset schemes

Both removal-based carbon offsetting and insetting can be used to counterbalance the council's residual emissions and make a net zero claim. However, as the council has access to significant assets and landholdings, the council will prioritise opportunities for removal projects within the local authority boundary before purchasing carbon credits from out-of-boundary schemes.

Developing local carbon insetting projects will help to retain co-benefits within the local authority boundary for the benefit of local residents and communities. Developing carbon insetting projects will also help to bring down city-wide emissions over time as a result of more carbon removal projects being delivered within the city. Lastly, developing local carbon removal assets will enable the council to secure carbon credits at a stable price, ensure continuity of supply, and reduce reliance on expensive carbon offset purchases.

Opportunities for insetting projects on the council's landholdings will be balanced with other local, regional, and national priorities and give consideration to wider linked issues and policies. This could, for example, include food security, housing, and energy. It is also important that care is taken not to harm other objectives, especially climate adaptation and nature recovery. When considering changes to land use as part of insetting projects, carbon leakage must be avoided – i.e., where actions taken on landholdings displace carbon-generating activities elsewhere which then take place outside the reporting boundary. Lastly, partnership working, collaboration and area-based approaches will be important to achieve the highest quality outcomes.

The council recognises, however, that not all carbon removal project types will be suitable within the City of York local authority area. For example, there are no coastal areas within York, so the council will not be able to deliver blue carbon projects that capture and store carbon in marine and coastal ecosystems (i.e., seagrass and saltmarsh restoration). As a result, there may only be limited opportunities for insetting projects on the council's landholdings or other land within the local authority boundary. If the council is unable to address all of its corporate residual emissions through carbon insetting projects within the local authority boundary, it will consider supplementing this with carbon credit purchases from the Voluntary Carbon Market.

Principle 7 – Disclose details of any carbon offsetting and/or insetting investments

The council will publicly disclose details of any carbon offset purchases or carbon insetting projects that it invests in. This will include key details such as the project type, number of credits, total investment etc. The council will also ensure that proper carbon accounting practices are used to report the carbon savings of any carbon offsets or insets against the council's carbon footprint.

Principle 8 – Ensure any investments in offsetting and/or insetting projects represent value for money

The council will ensure that any investments in carbon insetting projects or carbon credits are guided by a value for money assessment and backed with a robust business case for investment. The council will ensure that it considers the benefits, costs and risks of investment proposals and appraises a range of options. If costs are unaffordable, the council will explore alternative options, or seek alternative funding opportunities to meet funding gaps.

Principle 9 – Address residual emissions from corporate activity before selling credits to other local organisations

The council will prioritise addressing its own corporate residual emissions before selling any surplus credits generated by insetting projects to other organisations. This ensures that the council is meeting its obligation to counterbalance its own residual emissions from its own operational activity before seeking revenue generating opportunities.

For some local authorities with larger landholdings, carbon insetting projects may enable the removal and storage of more carbon than they emit through their operations. Local authorities with carbon savings surplus to their requirements to reach net zero should give careful consideration as to the most appropriate use for this surplus. The council will ensure that decisions made in relation to the end-use of such carbon savings/credits are transparent and equitable and will prioritise the sale of credits to local organisations.

Principle 10 – Support local businesses and organisations in York to address their residual emissions

As well as directly addressing its own contribution of emissions from its corporate activity, the council can play a leading role in supporting and enabling other businesses and organisations across York to address their residual emissions and transition to net zero. There are a range of approaches that the council could take to address city-wide residual emissions such as:

- Developing further carbon removal projects – the council could develop additional carbon removal projects and sell any surplus carbon credits generated to local organisations that are unable to reach net zero within their own organisational boundaries.
- Establishing an “Area Based Insetting (ABI)” framework – a framework developed by Anthesis to identify potential carbon reduction and removal project opportunities and connect project developers with local project funders.
- Knowledge sharing and collaboration – the council could play a role in sharing knowledge and experience of carbon offsetting and insetting with local organisations and neighbouring local authorities.
- Establish a council carbon offset fund – used to support net zero carbon development in York through planning policy.

6 Addressing council's residual emissions

The council has set a target to reduce carbon emissions from its own corporate activity and achieve an organisational net zero target of 2030, in line with the city-wide target. An Annual Carbon Emissions Report is produced each year to monitor progress against this target and identify areas of improvement. The council's latest Annual Carbon Emissions Report for 2022/23 calculated that the council's total corporate emissions equated to 5,491tCO_2e, which is less than 3% of city-wide greenhouse gas emissions (see Figure X) [98].

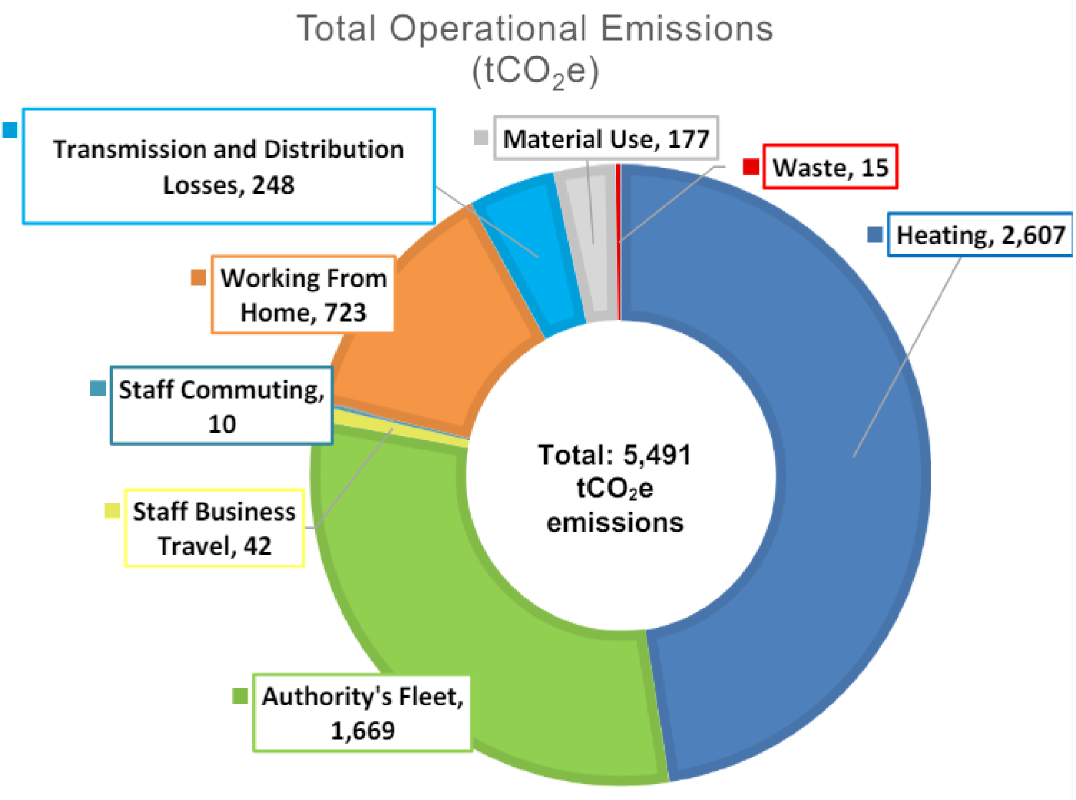

Figure 11: Total emissions produced across the Council's operations 2022/23.

It is recommended that the council continues to prioritise and maximise opportunities to reduce carbon across its corporate activities (i.e., Scope 1, 2, and 3 emissions). However, even after maximising emissions reductions, it is likely that some residual emissions will remain in 2030. The CYC Carbon Reduction Team has calculated a high-level forecast of corporate emission reductions up to the net zero target date of 2030 (see Figure X). Based on this analysis, it is estimated that **1326 tCO_2e** of residual emissions will remain in 2030, an 80% reduction on base year emissions in 2019/20.

[98] https://democracy.york.gov.uk/documents/s171185/Decision%20Report%20Annual%20Carbon%20Emissions%20Report%20202223.pdf

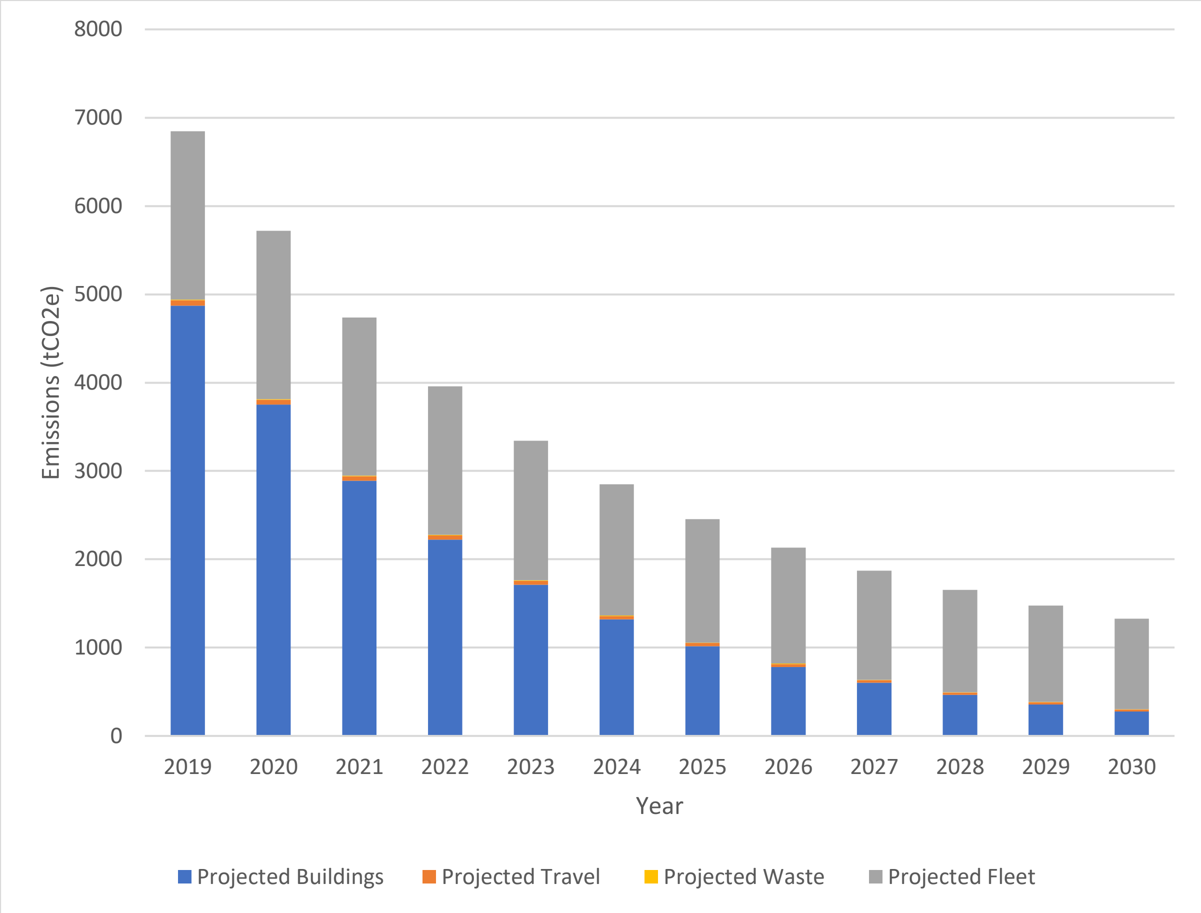

Figure 12: Projection of council's organisational emissions from 2019 to the net zero target date of 2030.

Please note: the projections only include emissions for council buildings (i.e., heating and lighting), business travel, waste, and fleet; they do not include a full suite of scope 1, 2, and 3 emissions. Furthermore, the projections have been calculated using an average reduction rate from 2019/20 base year emissions and not based in delivery of carbon reduction actions and interventions.

As part of the next stage of strategy development, it is recommended that the council updates its projections and estimates future emissions in each financial year to 2030 based on differing levels of project intervention (i.e., business-as-usual, pipeline, and stretch). This pathways analysis work would support the council to calculate likely residual emissions depending on the level of decarbonisation delivered and reinforce the need to maximise decarbonisation in order to reduce the requirement for offsetting/insetting (see example from Wiltshire Council [99]).

Ultimately, the council will be directly responsible for addressing any residual emissions that remain using carbon offsets and/or carbon insets. The emerging carbon offsetting/insetting strategy will need to set out the direct actions that the council will take to address its corporate residual emissions. In line with the best practice principles set out in Section X & X, it is recommended that the council adopts the following hierarchical approach within the strategy in order to address its residual emissions:

[99] https://www.wiltshire.gov.uk/media/9233/Anthesis-Report-Wiltshire-Council/pdf/Anthesis_Report_Wiltshire_Council.pdf?m=637892410222900000

1) Remove carbon via insetting projects on council land or other land within the local authority boundary

In line with best practice (see Section X), it is recommended that the City of York Council prioritise the delivery of local carbon removal projects (i.e., carbon insetting) in order to address its own organisational residual emissions. The council should explore opportunities to maximise the carbon removal potential of its own landholdings, and other land within the local authority boundary, before considering traditional offsetting to counterbalance its corporate residual emissions.

The council could directly deliver its own carbon insetting projects and/or work with other local stakeholders (i.e., community groups, local businesses, project developers) to identify and fully or partially fund projects in return for a claim on the achieved carbon removals. These removals could then be used by the council to counterbalance its residual emissions and support a net zero claim (see Section X). A range of carbon removal project types could be considered by the council such as nature-based removals (i.e., Type IV) and technology-based removals with more durable storage (i.e., Type V). A detailed appraisal of the various types of carbon removal projects is provided in Appendix X.

Woodland creation, for example, is one of the most established nature-based carbon removal technologies in the UK, reflected by the creation of the Woodland Carbon Code (WCC). The council is already delivering its first carbon insetting project through its 78-hectare York Community Woodland Project. Once fully planted, the woodland is expected to remove 18,070 tCO_2e over a 100-year period. By 2030, the project is expected to remove 102 tCO_2e, a small but significant contribution towards addressing the council's corporate residual emissions. There may be further opportunities for the council to deliver woodland creation projects and tree planting on either its own landholdings, or other land in York.

The challenge with relying upon woodland creation to meet the council's 2030 net zero target is that trees must grow sufficiently before they can reliably be used to claim carbon savings. As shown in Figure X, the time needed for trees to reach maximum carbon sequestration rates can take several years (typically around 15 to 30 years). Thus, trees must be planted years in advance of an organisation's net zero target date in order to reach the requisite maturity to sequester enough carbon. It is unlikely that the council will be able to rely upon tree planting alone in order to offset the entirety of its corporate residual emissions by 2030. However, tree planting could provide a cost-effective long-term solution to eliminate residual emissions and diminish the need for the council to purchase carbon credits in later years up to the 2050 UK net zero target date.

Other nature-based removal approaches such as soil carbon sequestration and hedgerow creation may emerge as potential options for the council and/or local partners to develop by 2030. At the time of writing there are a number of new codes in the process of development including a new Soil Carbon Code [100] and Hedgerow Carbon Code [101]. The development of codes will support project developers to calculate and verify the carbon sequestration potential of their projects and incentivise them to develop and manage projects in return for

[100] https://sustainablesoils.org/soil-carbon-code/
[101] https://www.allertontrust.org.uk/projects/hedgerow-carbon-code/

revenue streams from carbon credit sales. Some nature-based removal solutions such as the restoration of peatlands, coastal and marine habitats (i.e., saltmarsh, seagrass) will not be viable within York due to the geographical constraints of the city and surrounding area.

The council could consider deploying technology-based options such as Direct Air Capture and Storage (DACCS), Bioenergy with Carbon Capture and Storage (BECCS), and Enhanced Rock Weathering (ERW) to remove carbon (i.e., Type V). However, the majority of technologies are at an early stage of technological and commercial readiness and are significantly more expensive to develop than nature-based solutions. Hence, it is unlikely that the council will be able to develop and build its own engineered carbon removal projects in York at scale before the 2030 net zero target date. Therefore, the council will likely need to rely upon nature-based solutions such as tree and hedgerow planting and soil carbon sequestration in order to counterbalance its organisational residual emissions. This may present a challenge to the council as it is unlikely that the council will be able to develop sufficient nature-based removals within York in order to counterbalance the entirety of its organisational residual emissions by 2030.

To inform the development of its carbon offsetting/insetting strategy, the City of York Council should conduct an assessment of land use within the wider local authority boundary, including its own landholdings, in order to identify opportunities for carbon sequestration projects. Opportunity mapping will enable the council to quantify the total nature-based sequestration potential of landholdings in York and to identify a pipeline of projects that it could deliver within the local area.

2) Purchase carbon credits from verified nature-based carbon removal schemes in the UK

If the council is unable to address all of its corporate residual emissions through carbon insetting project within the local authority boundary, the council could consider purchasing carbon credits from the VCM (i.e., carbon offsetting). The council should ensure that its approach to offsetting aligns with net zero best practice and purchases high-quality verified carbon credits from projects in the UK. This option should be used as a last resort once all efforts to reduce carbon across the council's operations, and to maximise insetting opportunities within the local authority boundary have been exhausted.

Currently, only verified WCU's (from the Woodland Carbon Code) or PCU's (from the Peatland Code) are recognised in the UK Government's Environmental Reporting Guidelines [102]. However, a suite of other UK carbon codes are currently under development or in pilot phase for other types of nature-based removal methods including soil carbon [103], hedgerows [104], saltmarshes [105], seagrass [106], and kelp forests [107]. These emerging codes may create new sources of UK-based verified carbon credits for the council to purchase up to 2030 and beyond.

[102] https://assets.publishing.service.gov.uk/media/5de6acc4e5274a65dc12a33a/Env-reporting-guidance_inc_SECR_31March.pdf
[103] https://sustainablesoils.org/soil-carbon-code/
[104] https://www.allertontrust.org.uk/projects/hedgerow-carbon-code/
[105] https://www.ceh.ac.uk/our-science/projects/uk-saltmarsh-code
[106] https://www.agile-initiative.ox.ac.uk/wp-content/uploads/2023/11/A-blue-carbon-code-for-UK-seagrass-Nov23.pdf
[107] https://www.gov.uk/government/news/50-projects-receive-up-to-100000-each-to-boost-investment-in-nature

The council could seek to purchase Woodland or Peatland Carbon Units or Pending Issuance Units (PIUs) on the open market via a Request for Quotation (RfQ) advertised on the council's procurement portal, YORtender. This is the approach that was used by Devon County Council to acquire carbon credits [108]. Alternatively, the council could purchase Woodland or Peatland Carbon Units or PIUs directly from a broker or project developer. The Woodland Carbon Code (WCC), for example, provides a list of project developers with PIUs and WCUs available to sell on their website [109].

The latest data on carbon credit prices indicates that PIUs from the WCC can be purchased for an average price of £25.36 [110]. There is limited data available on PIUs purchased from peatland restoration projects, due to the low volume of transactions. As only a small number of verified WCUs have been sold, it is difficult to determine whether the price for these differs. PCUs are not currently available under the UK Peatland Code, as these units can only be obtained after a project has been verified, which takes place 5 years after the restoration process has occurred. As no peatland restoration project has yet reached the verification stage, no price can be ascertained for PCUs.

The current limitation of UK-based schemes is the availability of credits, particularly as many of these projects require time to mature and sequester significant carbon. There is also considerable speculation in the commercial market about carbon prices skyrocketing in the near future, and therefore, project developers and carbon brokers are increasingly reluctant to sell verified Carbon Units or PIUs at current prices [111]. In addition, some landowners may, in time, be required to use any carbon credits themselves for compliance purposes and so are opting to retain any PIUs, WCUs, and PCUs as an insurance policy.

If insufficient credits are available under the WCC and PC (or other emerging UK carbon codes), the council could consider supplementing this by purchasing high-quality credits from UK-based carbon removal projects that have been verified by high-integrity international standards. Although the majority of UK-based credits available in the VCM are from carbon reduction or avoidance projects (i.e., Type I – III), there are an increasing number of verified credits available from carbon removal projects such as biochar. The council should ensure that it purchases credits that have been verified under standards that have been endorsed by the International Carbon Reduction and Offset Alliance (ICROA) [112] and are CCP-eligible [113] such as VERRA, Gold Standard, and Puro.earth.

Best practice states that organisations should progressively shift their focus to financing carbon removal projects with long term durable storage (i.e., Type V). This includes investing in technologies such as direct air carbon capture and storage (DACCS), bioenergy with carbon capture and storage (BECCS), and enhanced rock weathering (ERW). However, there is currently a very limited supply of high integrity externally verified credits from durable removal projects available for purchase within the VCM.

Large corporations such as Microsoft, Stripe, and Shopify are committing to forward purchases of durable carbon removal credits to provide developers with early-stage finance to support the development and commercialisation of these technologies. The council could

[108] https://www.local.gov.uk/case-studies/offset-options-achieve-net-zero-2030
[109] https://www.woodlandcarboncode.org.uk/buy-carbon/woodland-carbon-projects
[110] https://woodlandcarboncode.org.uk/uk-land-carbon-registry/uk-carbon-prices
[111] https://www.local.gov.uk/case-studies/offset-options-achieve-net-zero-2030
[112] https://icroa.org/endorsed-organisations/
[113] https://icvcm.org/the-core-carbon-principles/

also consider opportunities for forward purchase of credits to support the cultivation of this market in the UK. This is, however, significantly more expensive, and carries additional risk (i.e., failure to deliver credits), making it difficult to justify the additional expenditure.

It is not recommended that the council purchase carbon credits sourced from projects in other countries outside the UK as any carbon reductions or co-benefits that result from the purchase will not be retained within the UK. Furthermore, the council should not invest in carbon credits from carbon avoidance or reduction projects as these do not align with net zero.

7 Addressing city-wide residual emissions

The council has set a target for York to reach net zero emissions by 2030. City-wide emissions accounted for 816 ktCO_2e in 2020, with the council responsible for less than 3% of city-wide emissions [114]. Based on the Projected Emissions Reduction Pathway for York, it is estimated that emissions will be reduce to 361 ktCO_2e by 2030, a 77% reduction in 2005 levels. The remaining 361 ktCO_2e residual emissions will need to be counterbalanced through local carbon removals in order for the city to achieve its 2030 net zero target.

Whilst not solely responsible for addressing the entirety of the city's residual emissions, the council recognises the important role that it can play in contributing towards addressing these emissions. As well as directly addressing its own corporate emissions, the council can play a leading role in supporting and enabling other local businesses and organisations to address their residual emissions and transition towards net zero.

A number of potential actions that the council could consider taking to address city-wide residual emissions are outlined below. Further work will be required as part of the development of the strategy to determine the suitability of these options:

Action 1: Develop carbon removal projects

The council could focus on developing carbon removal projects within the local authority boundary beyond that required to address its own corporate residual emissions in order to generate new income streams. These projects could be developed on the council's landholdings or by acquiring additional land within the local authority boundary. Any surplus carbon credits generated by these projects could then be sold to local organisations with residual emissions to enable them to achieve their net zero targets. Revenue generated through the sale of carbon credits could be used to bridge funding gaps for further project development and support further carbon reduction or removal projects throughout the city. As recommended in Section X, an assessment of the council's landholdings and wider land across York would help the council and other local organisations to identify a pipeline of opportunities for carbon removal projects.

Developing further carbon removal projects will only be financially viable if there is sufficient demand from local businesses to purchase any carbon credits that are generated. Whilst carbon offsetting is still the most frequently used approach by corporates to address residual emissions, it is becoming less attractive due to public criticism and a limited supply of high-quality certified credits that are locally relevant. Therefore, it is expected that local businesses may have a preference to purchase carbon credits from council carbon removal projects if they are developed within the local authority boundary.

The potential future demand from local businesses and value of local investment into local carbon insetting projects could be assessed by performing a top-down and bottom-up evaluation. Through a top-down evaluation, secondary research, and national literature on carbon market value growth can be scaled down to the local authority level to assess the estimated value of the local insetting market. Through a bottom-up evaluation, the climate commitments of large local employers can be assessed through desk-based research to determine the likely demand for local carbon credits in the future.

[114] https://www.gov.uk/government/statistics/uk-local-authority-and-regional-greenhouse-gas-emissions-national-statistics-2005-to-2021

Furthermore, developing further carbon removal projects will only be financially viable if the carbon credits produced can be sold at a high enough price to cover the costs of project development and ongoing maintenance. At current carbon credit prices, it is unlikely that the revenue from credit sales will cover the cost of project development without additional grant funding. However, it is expected that the cost of carbon credits will increase significantly in the future as demand for carbon credits increases.

In conclusion, the council should only consider this option if it is affordable, presents good value for money, there is sufficient access to land within the local authority boundary to develop insetting projects, and if there is sufficient project management capacity and capability in-house. It is also recommended that the council only consider the option of selling credits to other local organisations once it has secured sufficient carbon credits to counterbalance its own residual emissions from its corporate activity.

Action 2: Develop an area-based insetting (ABI) framework

The council could lead on establishing an area-based insetting (ABI) framework in York. ABI is an innovative framework developed by Anthesis that aims to support councils and other local organisations to identify local carbon reduction and removal project opportunities within their administrative boundaries that require funding and drive investment into these projects from local investors. Within ABI, there are three key user groups:

- Project Developers – local project developers can use ABI to advertise any carbon reduction or removal projects to local investors that it is seeking funding for.
- Project Funders – can use ABI to direct funding into local projects to generate socio-economic benefits in the local community as a route to direct Corporate Social Responsibility (CSR) or Environment, Social, Governance (ESG) spend locally. Alternatively, funders may use ABI to invest in local projects in return for carbon credits as an alternative to credits sourced from other UK-based or international projects.
- ABI Administrator – local authorities can acts as an administrator, setting up the local mechanism and facilitating connections between project developers and project funders, ensuring ABI guidance is followed.

In addition to the ABI Administrator role, the City of York Council could act as both a Project Developer and/or Project Funder where opportunities arise. For example, the council could take an active role in developing its own local carbon reduction and removal projects on its land and assets and use the ABI mechanism to seek funding from local investors to address funding shortfalls. The council could also direct funding into local carbon reduction and removal projects led by other local developers, generating socio-economic benefits in the local community and reporting the carbon saving impact it has enabled.

Anthesis has developed a practical guide for local authority representatives seeking to establish their own ABI mechanism. This guidance helps local authorities to consider a number of options to be able to adopt and implement ABI and to understand the various commercial, legal, and reputational implications across a number of operational models (e.g., in-house, hybrid, and outsourced approaches).

Action 3: Knowledge sharing and collaboration

The council could also play a role in sharing its knowledge and experience of carbon offsetting and insetting with local organisations, partners, and neighbouring local authorities.

The council could offer advisory support to York-based organisations to assist them with developing their own carbon offsetting/insetting strategies and ensure these are aligned with the city-wide 2030 net zero target. The council could also launch a survey/consultation with local businesses and organisations to assess current knowledge and practice of carbon offsetting and insetting in York.

The council is also well placed to facilitate collaboration and mobilise partnerships between local communities, businesses, project developers, and investors across the city to promote best practice and support local activity in carbon offsetting and insetting within York.

Action 4: Carbon Offsetting Fund

6.3 Project-based Emissions

How to treat residual emissions at project level

- Reduce emissions as much as possible
- Project types:
    - Construction projects (see guidance)
    - Land use change and forestry etc. (see guidance)
- Purchases – record scope 3 emissions and look to offset/inset these emissions where possible

Net Zero Carbon Events

Example: New Build Housing Project

Project Background

Estimated Emissions

Solutions:

- Emission reduction
- On-site removal
- Off-site removal – carbon credits, or carbon insetting

Additional Value – Natural Capital

8 Carbon Accounting and Claims

How to properly communicate about and claim carbon offsets/insets

The following key points should be considered when claiming carbon offsets:

- Be specific about the scope and boundaries of the emissions that have been offset.
- Provide information about the type of projects you have purchased and do not overstate your role in offset creation (unless you have originated the project).
- Purchasing carbon credits does not equal emission reduction from your boundary. Accordingly making net zero claims based solely on offsets is false. Claims of carbon or climate neutrality should always be accompanied by disclaimers that not all emissions have been eliminated.

The accounting for offsetting/insetting is likely to evolve over the coming years and as more international and national guidance is developed.

Offset credits

For an organisation to show they have met a net zero target hey must still complete their GHG report showing total emissions. They must be able to demonstrate that any direct emissions they are offsetting are unavoidable, and all direct emissions that can be reduced to absolute zero have been.

Offset credits can then be shown in the annual GHG accounts. It must be recorded separately to the organisation's emissions. If using UK based credits then verified carbon units must be used. The offset credits that are being used within that years GHG accounting must be 'retired' so that they cannot be used again.

The net balance of emissions and offsets should then be shown to equal zero, allowing a net zero claim to be made.

Insetting

Carbon insets are treated as carbon sinks within the operational boundary of an organisation. These should be reported within the GHG reporting of the organisation under land use emissions reporting.

If carbon removals are reported then all land use emissions must be included within the organisations operational boundary and reported annually.

The GHG protocol is developing clear guidance on accounting for removals, due to be published by the end of 2022. Their current guidance is available online.

9 Financing

Options for funding delivery of projects (see Anthesis)

Internal Carbon Pricing (ICP)

11 Conclusions

12 Recommendations

10 References

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Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Carbon Engineering - https://carbonengineering.com/our-technology/

Chapter 6

Chapter 7

Chapter 8

Chapter 9

Chapter 10

Chapter 11

11 Appendices

Appendix 1 – Carbon Offsetting Standards and Guidance

Appendix 2 – Project Types

Appendix 3 - Case studies – LAs

Devon County Council

Basingstoke & Deane Borough Council

Plymouth City Council

Ocean City Nature

ABI councils

Appendix

4.1 Carbon Reduction Projects

5.1.1 Oxford Type I – Renewable energy

Retrofit Projects – i.e., household insulation, Retrofit Credits

Renewable Energy Generation Projects – i.e., solar farms

5.1.2 Oxford Type II – Avoidance of ecosystem degradation

5.1.3 Oxford Type III - CCS

4.2 Carbon Removal Projects

Removal projects have several advantages over other types of carbon offsets. They can be permanent, meaning that the carbon they remove will be stored for thousands of years. Additionally, removal projects can help to mitigate climate change by directly reducing the amount of carbon dioxide in the atmosphere. However, removal projects also have limitations. They can be expensive, and there is still some uncertainty about their long-term effectiveness. An immediate transition to 100% carbon removals is not necessary, nor feasible, but organisations must commit to gradually increase the percentage of carbon removal offsets they procure with a view to exclusively sourcing carbon removals by mid-century. Most offsets available today are emission reductions, which are necessary but not sufficient to maintain net zero in the long run. Carbon removals directly reduce the amount of carbon in the atmosphere which can counteract ongoing emissions after net zero is achieved, as well as create the possibility of net removal for those actors who choose to remove more carbon than they emit.

Use Environment Agency report as background!

Nature-based offsets have several advantages over other types of carbon offsets. They can provide several benefits, such as improved water quality, increased biodiversity, and reduced flood risk. However, nature-based offsets also have limitations. They can take a long time to generate carbon offsets, and they can be vulnerable to natural disasters or other disruptions, creating issues with permanence, meaning the amount of time the removed or avoided carbon is stored.

Afforestation and Reforestation

The City of York Council has set a target to increase York's tree canopy coverage from 11% to 13% by 2050[115]. The council has already taken action to deliver tree planting projects within York including the York Community Woodland[116] and York Green Streets[117] projects.

Hedgerow Creation

Blue Carbon

Soil Carbon Sequestration

4.2.2 Engineered Solutions (Oxford Type V)

Technology-based offsets have several advantages over other types of carbon offsets. They can be generated quickly, and they can be scaled up to meet the needs of a growing global economy. Additionally, some technology-based offsets can be permanent. However, technology-based offsets also have limitations. They can be expensive, and there is still some uncertainty about their long-term effectiveness.

There are an increasing number of engineered carbon removal projects (Type V) in development using technologies such as Direct Air Capture (DAC); Bioenergy with Carbon Capture and Storage (BECCS); biochar; and Enhanced Rock Weathering (ERW). It is estimated that there are over 500 of such projects in various stages of development offering another potential source of carbon credits for corporate purchase[118]. Whilst the majority of these projects are situated in the USA, a growing number of projects are emerging in the UK.

CDR.fyi report that cumulatively, the equivalent of 4.1 MT of carbon dioxide removals have been purchased as credits[119]. These transactions are largely driven by a core group of major corporate buyers such as Microsoft, Airbus, JPMorgan Chase, and Shopify. The vast majority of these purchases consist of forward purchases for the future delivery of carbon creidts (see, for example, Frontier's Advanced Market Commitment in Annex X). This is because many engineered removal technologies are in an early stage of technological and commercial readiness and not able to deliver large-scale carbon removals yet. To date, only 2.6% of the carbon removal credit purchases (~109k tonnes) have actually been delivered.

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[115] https://www.york.gov.uk/downloads/file/9262/council-plan-2023-to-2027
[116] https://www.forestryengland.uk/article/york-community-woodland
[117] https://www.york.gov.uk/YorkGreenStreets
[118] Allied Offsets (2023). Carbon Dioxide Removal Report: Summer 2023 [online]. Available from: https://alliedoffsets.com/reports/ [Accessed 17 August 2023].
[119] CDR.fyi tracks 100+ year permanence carbon removal purchases and deliveries (i.e., Type V engineered removals).

There continues to be a wide price variance between different engineered carbon removal methods, as well as within methods (see Annex X). This indicates that the market is still highly illiquid, and dependent on individual transaction terms and negotiations. However, the cost of carbon credits from engineered carbon removal projects is currently prohibitively expensive for smaller buyers. For example, CDR.fyi reported that the weighted average price per tonne across durable removal methods for 2023 Q2 was $537.

The prices for five of the most promising CDR technologies are biochar, DAC, BECCS, Ocean Alkalinity Enhancement, and mineralisation (Enhanced Rock Weathering (ERW)).

The highest volume of companies in the VCM are DAC (82) and biochar (62), with average prices of $886/tCO2 and $250/tCO2 respectively.

Buyer Data

Methodology	Number of Different Buyers	Number of Credits	Number of total transactions
BECCS	3	2,760,000	3
DAC	48	491,000	112
Biochar	33	104,365	117
Ocean Alkalinity Enhancement	5	5,804	5
Enhanced Rock Weathering (Ex-Situ)	9	4,340	54
Enhanced Rock Weathering (In-Situ)	4	2,673	6

Appendix 1 – Carbon reduction projects (Type I – III)

Intro

Carbon reduction projects are a type of project that prevents or reduces greenhouse gas emissions from being released into the atmosphere. There are three broad categories of options for reducing emissions:

I. **Avoid or reduce emissions from the geosphere** – emissions can be avoided by deploying renewable energy to replace fossil fuel use, or by improving efficiency.

II. **Avoid or reduce emissions from the biosphere –** by protecting ecosystems and their soils and vegetation from damage or degradation.

III. **Reduce emissions from the geosphere by capturing and storing fossil carbon –** from industrial point sources or fossil-fuelled power stations.

Example projects

Retrofit credits

Appendix 2 – Carbon removal to the biosphere (Type IV)

Ewdsvsdbvds

1 Reforestation

2 Soil Carbon

3 Peatland restoration

4 Blue carbon

5 Others

Appendix 3 - Carbon removal to the geosphere (Type V)

Carbon removal to the geosphere involves extracting CO_2 from the atmosphere and storing it in the geosphere, such as through direct air capture with geological storage (DACCS) or converting atmospheric carbon into rock through remineralisation (enhanced rock weathering) [120]. Within the literature, these technologies are often referred as technology-based or engineered carbon removal technologies.

The following Type V technologies are outlined below:

- Direct Air Carbon Capture and Storage (DACCS)
- Bioenergy with Carbon Capture and Storage (BECCS)
- Enhanced Rock Weathering (ERW)
- Biochar
- Others –

The portfolio of greenhouse gas removal methods is rapidly growing; however, most engineering-based approaches are at an early stage of commercial development and have not yet been deployed at scale in the UK [121].

1. Direct Air Carbon Capture and Storage (DACCS)

Direct Air Capture (DAC) describes the process by which CO_2 is directly removed from the atmosphere at any location through physical or chemical processes. This varies from carbon capture which is generally carried out at the point of emission, such as a steel plant [122]. The technology is typically coupled with carbon storage to store the CO_2 in deep geological reservoirs. When coupled with long-term carbon storage, the technology is often referred to as Direct Air Capture with Carbon Capture and Storage (DACCS), which is a form of negative emission technology (NET).

There are two main types of DAC used to physically extract CO_2 from the air [123]. These are categorised based on the medium of the chemical used to capture the CO_2:

- Liquid Direct Air Capture (L-DAC) – the most technically mature method for capturing CO_2 is to place air into contact with a strong liquid base (i.e., liquid solvent), such as potassium hydroxide or sodium hydroxide, which dissolves the CO_2. This method is already in use by technology providers such as Carbon Engineering.
- Solid Direct Air Capture (S-DAC) – the most common alternative method is to use a solid sorbent to adsorb CO2 rather than absorb it. This method is already in use by technology providers such as Climeworks.

With the application of heat, the CO_2 can then be released in a concentrated form for geological storage or utilisation applications (see Figure X).

[120] https://www.smithschool.ox.ac.uk/sites/default/files/2024-02/Oxford-Principles-for-Net-Zero-Aligned-Carbon-Offsetting-revised-2024.pdf
[121] https://assets.publishing.service.gov.uk/media/64d4b25a5cac65000dc2dd1f/task-finish-group-report-ability-beccs-to-generate-negative-emissions.pdf
[122] https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/direct-air-capture
[123] https://www.oxfordenergy.org/wpcms/wp-content/uploads/2023/12/CM07-Scaling-Direct-Air-Capture-DAC-technology.pdf

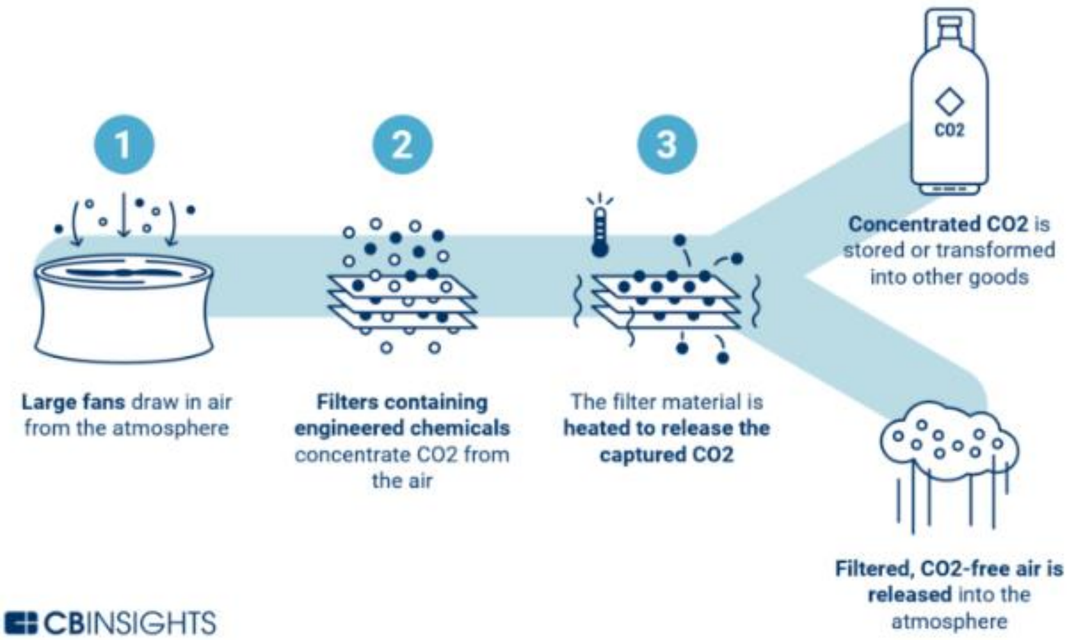

Figure 13: Illustration of the direct air capture process (Source: CB Insights, 2021)

Within this broad conception of DAC technologies, there are many different types of design. The most common design type is to use banks of fans to circulate large volumes of air among solid or liquid sorbents. This design type is being used by technology providers such as Carbon Engineering, Climeworks, and Global Thermostat, and is capable of capturing >1MtCO_2/yr.

To ensure that DACCS technologies provide significant CO_2 removal, all electricity and heat input required to operate the technology needs to come from low-carbon sources. Otherwise, if a DAC facility is operated with electricity generated from fossil fuel sources such as gas, for example, it is estimated that the gas combustion alone would return the equivalent of 70-90% of all CO_2 captured by the DAC plant back to the atmosphere[124].

The UK's Sixth Carbon Budget, published by the Climate Change Committee in 2020, calculated that DACCS will need to account for 5MtCO_2e/yr removals by 2050 in the UK's Net Zero Balanced Pathway. The UK Government's Net Zero Strategy identified the need for around 80 Mt of CO_2 removal by 2050 using predominantly DACCS and BECCS technologies. It also pledged to deliver £100m innovation funding for DACCS and other GGRs. As part of the £100m funding, the Government launched the Direct Air Capture and other GGR Innovation Programme. Several UK-based DAC projects have been funded throughout the first two phases of the programme. Moreover, the Government's latest Spring Budget, announced on 15 March 2023, included funding of up to £20 billion for CCUS applications, including DAC.

Technology Readiness

DAC plants currently operate on a small scale, but with plans to grow. The IEA report that 27 DAC plants have been commissioned to date worldwide, capturing almost 0.01MtCO_2/yr. All these plants are small-scale, with only a few commercial agreements in place to sell or store the captured CO_2, while the remaining plants are operated for testing and demonstration purposes.

124 Gambhir & Tavoni (2019)

Plans for at least a further 130 DAC facilities are now at various stages of development. Large-scale demonstrations are yet to become operational, however there are several large projects under development. This includes:

- DAC 1 – Led by Carbon Engineering, one of the main DACCS technology developers in Canada, plans are to build a plant with the capacity of 1 $MtCO_2$/yr removal. DAC 1 is expected to begin operations in 2024 and will become the world's largest DAC facility. Financed and developed by 1PointFive, a development company created by Oxy Low Carbon Ventures (OLCV). It will be located in the Permian Basin of the US.
- Storegga Dreamcatcher Project - partnership with Carbon Engineering to develop the UK's first large-scale DAC facility. Awarded a £249,000 grant by BEIS to develop the project.

Costs

A wide range of cost estimates have been reported for the development of DACCS in the literature. This ranges from low-end ambitious cost estimates often provided by DACCS technology to high-end estimates derived from other academic and market intelligence sources. DAC technologies range from \$600 - \$1100/tCO_2e removed. UK cost estimates are provided below:

- BEIS (2021) – estimate that the cost of DACCS in the UK will likely range from £150-700/tCO_2e in 2030 to £70-250/tCO_2e in 2050.
- Climate Change Committee (2020) – early-stage DACCS plants in the UK will cost an estimated £400/tCO_2e during the 2020s, before reducing to £180/tCO_2e by 2050 as the technology develops and is scaled up globally.

Long term costs of DACCS remain uncertain because the technology has yet to be commercialised, and cost reductions through learning-by-doing and scale-up have yet to take effect. Overall, DACCS is one of the most expensive GGR options available relative to other GGR technologies because capturing CO_2 directly from the air is very energy intensive. Nevertheless, the modular nature of DACCS technology, as well as its relative immaturity, suggests there is considerable scope for innovation and cost reduction over time.

The market for DAC-based CO_2 removal has grown significantly over recent years. Suppliers of DAC-based CO_2 removal, such as 1PointFive and Climeworks have recently started to sell carbon credits in advance of delivery via forward purchases. CDR.fyi report that the main purchasers of these credits have been from large corporations (e.g., Airbus, Shopify, and Microsoft) and demand aggregators such as Frontier. AlliedOffsets report that the average price of carbon credits from DACCS projects is currently \$886/tCO_2e. CDR.fyi report that the current spot price for carbon credits from DACCS projects is \$690.

Despite the high price compared to other carbon removal solutions on the market, there is significant demand for DAC-based carbon removal credits from corporate buyers. This is because they offer carbon removal with high durability storage which aligns with net zero best practice. For example, the Oxford Principles for Net Zero Aligned Offsetting and the Science-Based Targets Initiative's Net Zero Standard encourage organisations to shift their purchases towards high durability carbon removals over time in order to maximise contributions towards net zero targets.

There are also a range of voluntary standards and methodologies that are being developed to provide standardised frameworks for measuring and verifying removals from DAC projects and ensuring high integrity credits are created. This includes the following:

- Puro.earth – developed the Puro Standard, a carbon removal standard for engineered carbon removal methods in the VCM. It consists of high-quality carbon removal methodologies for several carbon removal projects including one for Geologically Stored Carbon from DACCS and BECCS.
- Climeworks – developed a methodology to measure the net emissions removed from the atmosphere from a DAC project after adjusting for emissions resulting from plant construction, operation, and disposal.
- Isometric – has developed the DAC Protocol which provides the requirements and procedures for the calculation of net CO_2e removals from the atmosphere via Direct Air Capture (DAC) projects.
- CCS+ Initiative – is developing methodologies for CCUS methods including a draft methodology for DAC under Verra's Verified Carbon Standard (VCS).

Benefits

There are several benefits associated with DACCS:

- DACCS can technically be deployed anywhere, provided low-carbon energy inputs and appropriate CO_2 transport and storage facilities are available.
- Compared with other carbon removal technologies, DACCS does not require significant land and has limited ecological impacts. One estimate suggests that DACCS has a land intensity (ha/tCO_2/yr) of <0.1% that of BECCS (although this would increase if accounting for land area of dedicated solar PV to provide renewable energy input to DACCS plant) [125].
- DACCS can produce several co-benefits associated with industrial and infrastructure projects such as skills development, job creation, and Gross Value Added (GVA) [126].

Challenges & Limitations

Aside from the benefits outlined, deploying DACCS technologies also presents unique challenges:

- DACCS requires energy in the form of electricity or heat in order to operate and are thus exposed to heat and electricity price volatility. DACCS does not provide a co-product revenue compared to carbon removal technologies that use biomass (e.g., BECCS, Building with Biomass) [127].
- There are also potentially adverse consequences if the chemicals used for sorbent manufacture, and the disposal of sorbents at the end of their useful lives, are not handled in an environmentally responsible manner[128].
- Whilst the evidence base around DACCS has developed significantly over recent years, the technologies are still in an early stage of commercial readiness.

Further Reading

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[125] https://linkinghub.elsevier.com/retrieve/pii/S2590332219302167

[126] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1026988/ggr-methods-potential-deployment.pdf

[127] http://www.element-energy.co.uk/wordpress/wp-content/uploads/2022/06/BEIS-Engineered-GGR-policies-FINAL-REPORT.pdf

[128] https://linkinghub.elsevier.com/retrieve/pii/S2590332219302167

Element Energy, E4Tech, & Cambridge Econometrics (2022). Policy Mechanisms for First of a Kind Direct Air Carbon Capture and Storage (DACCS) and Other Engineered Greenhouse Gas Removals - http://www.element-energy.co.uk/wordpress/wp-content/uploads/2022/06/BEIS-Engineered-GGR-policies-FINAL-REPORT.pdf

Gambhir, A., Tavoni, M. (2019). Direct Air Carbon Capture and Sequestration: How It Works and How It Could Contribute to Climate-Change Mitigation. 1(4): 405-409. https://doi.org/10.1016/j.oneear.2019.11.006

IEA (2023). Direct Air Capture. [Online]. Available from: https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/direct-air-capture [Date Accessed: 17/04/2024]

Joss et al (2023). EIRO – Direct Air Carbon Capture & Storage (DACCS). [Online]. Available from: https://es.catapult.org.uk/report/direct-air-carbon-capture-storage/ [Date Accessed: 18/04/2024]

Webb et al (2023). Scaling Direct Air Capture (DAC): A moonshot or the sky's the limit?. [Online]. Available from: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2023/12/CM07-Scaling-Direct-Air-Capture-DAC-technology.pdf [Date Accessed: 17/04/2024]

2. Bioenergy with Carbon Capture and Storage (BECCS)

Bioenergy with carbon capture and storage (BECCS) involves capturing and permanently storing CO_2 from processes where biomass is converted into fuels or directly burned to generate energy [129]. The combination of bioenergy and CCS achieved greenhouse gas removal by taking atmospheric CO_2 temporarily locked in plants and storing it permanently in geological formations, while using the biomass to generate energy. Biomass includes both dedicated energy crops and waste, such as those from forestry, agricultural and municipal sources. These can be used as the single fuel source for power generation (dedicated use) or in combination with other conventional fossil fuels, such as coal and gas (co-fired generation) [130].

There is no singular definition of BECCS since it can include a variety of industries, biomass feedstocks, and methods of energy conversion. A number of BECCS technologies exist which can be divided into the following categories [131]:

1. BECCS Power – the combustion of biomass for the primary purposes of exporting power to the grid, combined with either post-combustion or pre-combustion carbon capture technology and permanent sequestration of captured biogenic CO_2.
2. BECCS Energy from Waste (EfW) – the application of CCS onto energy from waste incineration facilities. The energy from waste part of this refers to incinerating municipal solid waste (MSW) or commercial and industrial waste with co-generation of electricity or heat, where the primary function remains that of sanitary waste

[129] https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/bioenergy-with-carbon-capture-and-storage
[130] https://royalsociety.org/-/media/policy/projects/greenhouse-gas-removal/royal-society-greenhouse-gas-removal-report-2018.pdf
[131] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1026988/ggr-methods-potential-deployment.pdf

disposal to avoid landfill. The associated GGR option is the use of post-combustion carbon capture technology, followed by CO_2 transport and permanent storage, allowing the permanent storage of any biogenic CO_2 produced by the EfW facility.

3. BECCS Industry – the application of CCS on industrial processes that use biomass derived feedstocks for fuel. This could be existing users of biogenic fuels or sites which switch to biogenic fuels prior to the net zero target date.
4. BECCS Hydrogen & Other – the application of BECCS to the production of hydrogen and other applications (e.g., biofuel production). This covers the application of CCS to plants that provide gasification of biomass to syngas with subsequent conversion to products such as hydrogen, biofuels or biomethane.

Like DACCS, BECCS is also one of the key GGR technologies of focus in the UK. Out of the 23 projects selected in Phase 1 of the DAC and Other GGR Technologies Competition, four were BECCS projects, including three biohydrogen projects. Two of these projects have been selected for Phase 2 of the programme [132], including:

- Ince Bioenergy Carbon Capture & Storage (INBECCS)
- BECCSH$_2$: Carbon Capture and Hydrogen

The £5m Hydrogen BECCS Innovation Programme[133] was also launched in January 2022, specifically aiming to support technologies that can produce hydrogen from biogenic feedstocks that are combined with carbon capture.

Technology Readiness

The IEA report that only 2 Mt of biogenic CO_2 are currently captured per year, 90% of which is captured in bioethanol facilities [134]. However, plans for around 20 facilities together capturing 15 Mt CO_2 per year have been announced. Based on projects currently in the early and advanced stages of deployment, carbon removal via BECCS could reach just under 50 Mt CO_2/yr by 2030 [135].

In the UK, Drax Power Ltd currently operates two pilot BECCS facilities at the Drax Power Station in North Yorkshire, UK, with plans for commercial-scale capture as of 2027 [136].

Costs

BECCS spot price of $160

[132] https://www.gov.uk/government/publications/direct-air-capture-and-other-greenhouse-gas-removal-technologies-competition/projects-selected-for-phase-2-of-the-direct-air-capture-and-greenhouse-gas-removal-programme
[133] https://www.gov.uk/government/publications/hydrogen-beccs-innovation-programme
[134] https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/bioenergy-with-carbon-capture-and-storage
[135] https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/bioenergy-with-carbon-capture-and-storage
[136] https://www.drax.com/about-us/our-projects/bioenergy-carbon-capture-use-and-storage-beccs/

There are also a range of voluntary standards and methodologies that are being developed to provide standardised frameworks for measuring and verifying removals from BECCS projects and ensuring high integrity credits are created. This includes the following:

- Puro.earth – developed the Puro Standard, a carbon removal standard for engineered carbon removal methods in the VCM. It consists of high-quality carbon removal methodologies for several carbon removal projects including one for Geologically Stored Carbon from DACCS and BECCS.
- Climeworks – developed a methodology to measure the net emissions removed from the atmosphere from a DAC project after adjusting for emissions resulting from plant construction, operation, and disposal.
- CCS+ Initiative – is developing methodologies for CCUS methods including a draft methodology for DAC under Verra's Verified Carbon Standard (VCS).

Benefits

Challenges and Limitations

While investment in BECCS is gaining momentum, a suite of policies are required to address barriers in BECCS applications (e.g., high upfront investment needs, long payback periods, uncertain carbon markets (carbon price), the sustainability of biomass supply, and access to CO_2 transport and storage (T&S) infrastructure)[137].

BECCS is susceptible to upstream carbon leakage, primarily associated with the cultivation, harvesting, processing, and transport of biomass. It is therefore important to quantify and minimise carbon leakage across the biomass supply chain [138].

The impact of BECCS on resources, soil health and biodiversity have been identified as important limitations for its projected deployment.

Land use – major concern because requires significant land – using high quality land such as grassland or cropland to grow bioenergy crops for BECCS is likely to result in competition with other land-based activities, such as food production, potentially increasing food prices.

Negative emissions – the ability of BECCS to deliver genuine negative emissions relies on the assumption that burning wood to generate power is carbon neutral. However, a large and growing majority of scientific evidence shows that burning wood for power is often not carbon neutral and in some circumstances can be a worse pollute than coal. There is also strong evidence that wood-sourcing practices are damaging to natural forests, risking further ecological harm [139].

Water-use – significant amount of water required in order to deploy BECCS unsustainable

CCS dimension – BECCS deployment is intrinsically dependent on the existence of carbon capture and storage (CCS) infrastructure. To date, there are 17 operating CCS projects in

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[137] https://www.iea.org/reports/bioenergy-with-carbon-capture-and-storage
[138] https://assets.publishing.service.gov.uk/media/64d4b25a5cac65000dc2dd1f/task-finish-group-report-ability-beccs-to-generate-negative-emissions.pdf
[139] https://ember-climate.org/app/uploads/2024/01/Draxs-BECCS-project-climbs-in-cost-to-the-UK-public.pdf

the world, reaching a cumulative capture capacity of 31.5 Mt of CO2 per year, of which only 3.7 is stored in geological formations. Though technology advances have brought down the cost of capture, low investor confidence remains the main bottleneck in the way of unlocking a CCS economy. [140]

Further Reading

DESNZ (2023). The ability of BECCS to generate negative emissions: Task and Finish Group Report. [Online]. Available from: https://assets.publishing.service.gov.uk/media/64d4b25a5cac65000dc2dd1f/task-finish-group-report-ability-beccs-to-generate-negative-emissions.pdf [Date Accessed: 18/04/2024]

Fajardy et al (2019). BECCS deployment: a reality check. [Online]. Available from: https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/BECCS-deployment---a-reality-check.pdf [Date Accessed: 18/04/2024]

3. Enhanced Rock Weathering (ERW)

Enhanced rock weathering (ERW) is a carbon removal method that accelerates the natural carbonate-silicate cycle and durably removes carbon dioxide from the atmosphere. It achieves this by spreading certain types of ground alkaline material (i.e., silicate rocks such as basalt, olivine, and serpentinite) over agricultural soil. This ground alkaline material reacts with CO_2 in the soil to form stable bicarbonate ions – accelerating the time scale of natural weathering from centuries and millennia to months and years [141]. The bicarbonate travels through the soil and river networks to the ocean where it is stored for tens of thousands of years.

The choice of rock depends on factors such as availability, reactivity, cost, and suitability for specific project locations. Different ERW projects may employ different rock types based on their specific requirements and circumstances. These rocks are crushed or ground into fine particles to increase their surface area and enhance their interaction with carbon dioxide [142].

Technology Readiness

ERW, like other carbon removal methods, is a relatively new technique, and many projects are still in their early stages.

Substantial short-term financial investment is required to develop and scale up these projects to effectively remove significant amounts of CO2 from the atmosphere.

Costs

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[140] https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/BECCS-deployment---a-reality-check.pdf

[141] https://static1.squarespace.com/static/6054db4efc6c3622f12682fe/t/65faf8e2048ccf04bf5561e7/1710946576798/EnhancedWeathering.pdf

[142] https://www.kita.earth/blog/school-of-rock-unearthing-the-potential-of-enhanced-rock-weathering

A range of voluntary methodologies are being developed to provide standardised frameworks for measuring and verifying removals from ERW projects and ensuring high integrity credits are created. This includes the following:

- Puro.earth - published the world's first ERW methodology which provides a framework for project developers to measure and verify removals from ERW projects. The methodology opens up new possibilities for scaling up the ERW process and expanding the purchase of carbon credits generated through it.
- Isometric – currently publicly consulting on its EW Protocol which provides the requirements and procedures for the calculation of net CO_2e removal from the atmosphere via enhanced weathering (EW) in agricultural settings.

Benefits

ERW carbon credits are particularly attractive due to their additional co-benefits as they create more value than some other carbon removal technologies, making them an attractive option for buyers. Beyond its significant carbon removal capacity, ERW has a number of other co-benefits, including:

- Agronomic co-benefits – the application of crushed alkaline material to agricultural land raises soil PH, and therefore reduces soil acidification. It also increases the bioavailability of important crop nutrients such as nitrogen, phosphrous, and potassium which can improve soil health, increase crop yields, and optimise the use of costly and emissions-intensive chemical fertilisers [143].
- Income stream for farmers – selling credits generated by ERW projects offers a potentially significant recurring incremental income stream for farmers.
- Local jobs - by utilising locally obtained crushed basalt rock and existing farming equipment, local individuals are empowered to actively participate in carbon removal initiatives within their own communities, avoiding the need for external machinery or expertise.
- Ocean deacidification – ERW captures biocarbonate ions that are then released into the sea supporting the deacidification of the oceans and providing marine organisms with calcium carbonate to construct their shells.

Challenges and Limitations

The biggest challenge in ERW is accurately measuring and quantifying the amount of carbon dioxide removed. To ensure transparency and credibility of the carbon credits, rigorous data management systems are necessary to provide full visibility across the supply chain. This involves traceability from feedstock sourcing to end-use application.

While ERW shows great promise, further research is needed to fully understand its long-term impacts, cost-effectiveness, and potential side effects on ecosystems.

Further Reading

Carbon Business Council (2024). Enhanced Weathering Policy Primer: Assessing the Opportunity. [Online]. Available from:

143

https://static1.squarespace.com/static/6054db4efc6c3622f12682fe/t/65faf8e2048ccf04bf5561e7/1710946576798/EnhancedWeathering.pdf [Date Accessed: 18/04/2024]

Kita (2023). School of Rock: unearthing the potential of enhanced rock weathering. [Online]. Available from: https://www.kita.earth/blog/school-of-rock-unearthing-the-potential-of-enhanced-rock-weathering [Date Accessed: 18/04/2024]

4. Biochar

Biochar is a charcoal-like substance that is produced by heating organic material such as wood, crop residues or manure in the absence of oxygen through a process called pyrolysis (see Figure X) [144]. Pyrolysis involves heating the biomass to a high temperature (typically between 350 – 700ºC) in a container with limited air supply, which causes the biomass to undergo a chemical transformation and break down into a solid, carbon-rich material. Biochar is a stable and durable form of carbon which resists decay and can store carbon for approximately 2000 years, making it an ideal technology for CDR [145].

In addition to biochar, the pyrolysis process also yields byproducts including syngas and pyrolysis oil. These by-products can be suitable for fuel, making the process self-sustaining. The feedstock input and sophistication of the technology used to create the biochar can determine the quality of its output and, thus, its applicability to different use cases [146].

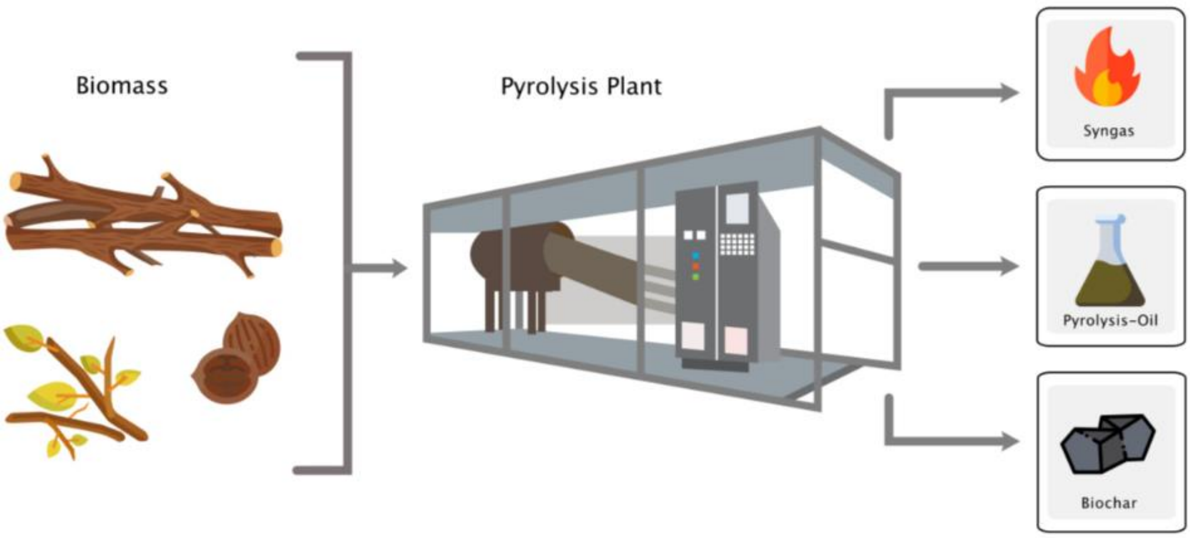

Figure 14: Biochar production process (Source: Bier et al, 2020)

[144] https://cloverly.com/ultimate-business-guide-to-biochar/
[145] https://medium.com/alliedoffsets/biochar-in-the-vcm-a-cdr-primer-31e726eb7bce
[146] https://www.abatable.com/blog/biochar

In the UK, it is estimated that 6-41 $MtCO_2$ will be able to be removed through biochar per year [147]. Globally, the estimated potential of greenhouse gas removal for biochar is between 1.9 and 4.8 $GtCO_2$ per year [148].

Technology Readiness

While there are various technology types to produce biochar, they can broadly be classified into three categories [149]:

1. Continuous and high-technology systems – an automated process that uses high technology equipment such as gasifiers or pyrolysis machines, using a continuous system to produce biochar. This type of system is highly efficient and is used to produce larger quantities of biochar.
2. Batch systems – the process of heating biomass in a container or kiln with limited airflow to produce biochar, repeating the process for multiple small batches.
3. Artisanal based systems – the labour-intensive process of using low-technology equipment such as a pit kiln or open fire to produce biochar in small quantities.

Compared to other durable carbon removal technologies (i.e., Type V), biochar has the highest Technology Readiness level (see Figure X) [150].

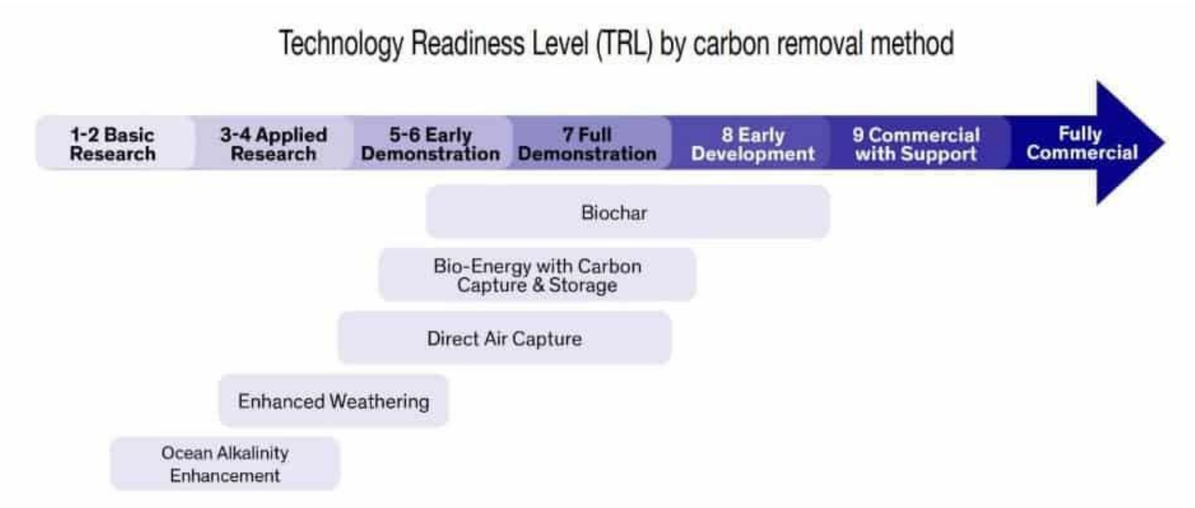

Figure 15: Technology Readiness Levels (TRL) by durable carbon removal method (Source: Carboncredits.com)

Costs

The average price for biochar carbon credits in 2023 was $131/tCO_2e$ removed which is significantly cheaper than the average cost across all durable carbon removal technologies which is $488/tCO_2e$ [151]. Due to the lower cost, biochar credits are an attractive option for companies looking to purchase durable carbon removal credits as part of their portfolio of credits.

147

148

149 https://www.kita.earth/blog/feel-the-burn-exploring-biochars-climate-benefits

150 https://carboncredits.com/biochar-makes-the-grade-a-rating-engineered-carbon-removals/

151 https://www.cdr.fyi/blog/2023-year-in-review

According to CDR.fyi, biochar carbon credits accounted for more than 90% of the durable carbon removal credits delivered in the voluntary carbon market in 2023 (see Figure X). Corporate buyers like Microsoft and JP Morgan Chase are ramping up their investment, signalling greater buyer confidence in the biochar carbon credit market. The prospect of being able to trade carbon credits relating to biochar is viewed as a potential means to transform this commodity into a scalable form of carbon removal [152].

Currently the market now has three approved methodologies that have been developed to provide standardised frameworks for measuring and verifying removals from biochar projects and ensuring high integrity credits are created. This includes the following:

- Verra – developed a globally applicable methodology which provides criteria and procedures for the quantification of GHG benefits from biochar utilisation in soil and non-soil applications.
- Puro.earth – developed the first ever carbon removal crediting methodology for biochar in 2019. This methodology quantifies the net CO_2 removal achieved over the time horizon of 100 years by the production of biochar, when using in applications placed in the environment.
- European Biochar Certificate – voluntary standard that ensures the quality and safety of biochar products in Europe.

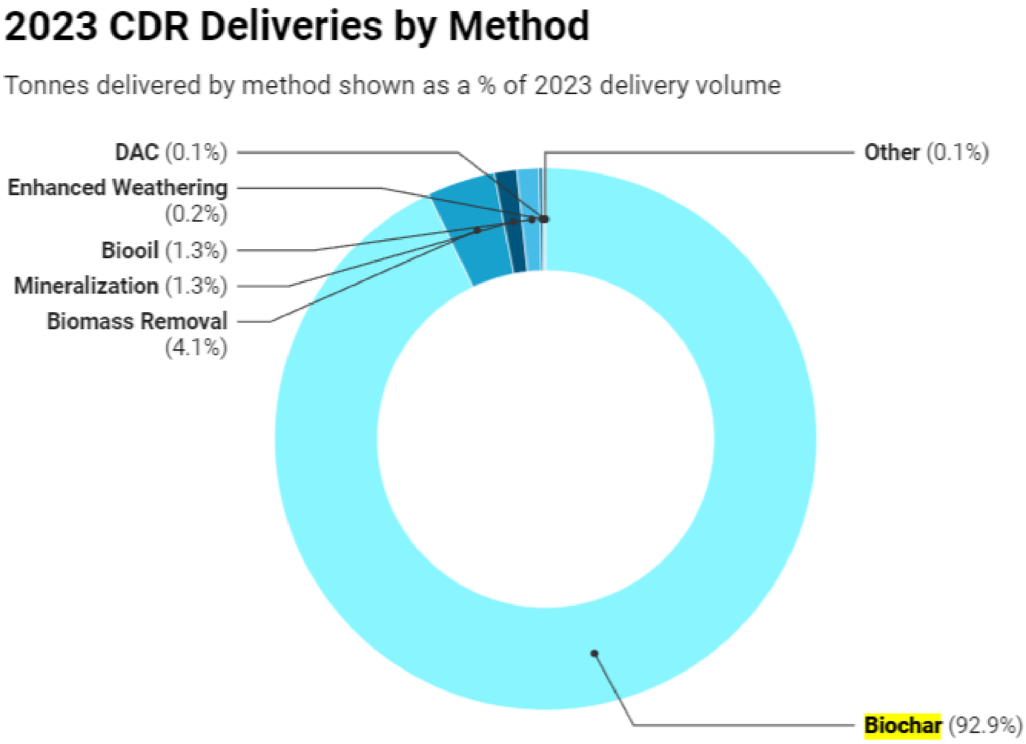

Figure 16: Carbon credit deliveries by durable carbon removal method (Source: CDR.fyi)

Benefits

[152] https://www.sciencedirect.com/science/article/pii/S1462901124000388?via%3Dihub

Beyond carbon removal, biochar offers several important co-benefits. A number of primary uses and benefits of biochar are outlined in Figure X [153].

Soil amendment	Biochar can be added to soil as an organic amendment to enhance soil fertility, water retention, and crop productivity. It also improves soil structure, providing a habitat for beneficial soil microorganisms and reducing the need for synthetic fertilisers.
Carbon sequestration	Biochar has the potential to sequester carbon in the soil for long periods, thereby reducing greenhouse gas emissions and mitigating climate change.
Waste management	Biochar can be produced from a wide range of organic waste materials, such as agricultural residues, forestry waste, and animal manure. This helps divert waste from landfills and reduces greenhouse gas emissions from organic waste decomposition.
Energy generation	Biochar can be used as a renewable energy source through the process of pyrolysis, which produces bio-oil, syngas, and biochar. The bio-oil and syngas can be used to generate heat and electricity, while the biochar can be used as a soil amendment.
Water filtration	Biochar can be used as a water filtration medium to remove contaminants such as heavy metals and organic compounds from contaminated water.
Animal feed supplement	Biochar can be added to animal feed as a supplement to improve animal health and reduce greenhouse gas emissions from animal agriculture.

Figure 17: Range of benefits of biochar (Source: Kita, 2023)

Challenges and Limitations

Further Reading

Bier et al (2020). EBI Whitepaper: Biochar-based carbon sinks to mitigate climate change. [Online]. Available from: https://www.biochar-industry.com/wp-content/uploads/2020/10/Whitepaper_Biochar2020.pdf [Date Accessed: 17/04/2024]

Cloverly (2024). The Ultimate Business Guide to Biochar: Everything You Need To Know. [Online]. Available from: https://cloverly.com/ultimate-business-guide-to-biochar/ [Date Accessed: 17/04/2024]

Kita (2023). Feel the burn: exploring biochar's climate benefits. [Online]. Available from: https://www.kita.earth/blog/feel-the-burn-exploring-biochars-climate-benefits [Date Accessed: 18/04/2024]

Price et al (2024). Biochar carbon markets: A mitigation deterrence threat. *Environmental Science and Policy, 154*: 103704. https://doi.org/10.1016/j.envsci.2024.103704

5. Others

Range of other technologies not discussed in detail within report:

[153] https://www.kita.earth/blog/feel-the-burn-exploring-biochars-climate-benefits

Wood in Construction

Ocean Alkalinity Enhancement

Standards and guidance

The Oxford Principles are an important step towards ensuring that carbon offsetting is used in a way that is credible and contributes to achieving net zero emissions. They provide a framework for organisations to develop and implement offsetting programs that are aligned with the Paris Agreement goals.

VCMI Claims Code of Practice

A rulebook for company level on credible use of high quality carbon credits on the path to net zero.

The following table describes net zero pathway types, with 1 being the most and 5 being the least ambitious (adapted from VCMI):

Net Zero Pathway Type	Target, Strategy and Performance	Use of Carbon Credits
Type 1	Target Company adopts a 1.5oC abatement target as well as a long-term net zero target. Target covers full Scope 1-3 emissions and non-CO2 emissions. The target is validated by a reputable third-party initiative or standard (e.g., SBTi)	Company purchases carbon credits to compensate all unabated emissions and neutralise residual emissions. Company also purchases carbon credits to compensate for all its historical emissions.
Type 2	Strategy Company has a net zero aligned (short- and long-term) low carbon transition strategy and a concrete plan/roadmap to meet its formally adopted target.	Company purchases carbon credits to compensate all unabated emissions and neutralise residual emissions. Company does not purchase carbon credits to compensate for its historic emissions.
Type 3	Performance Company is on track to meet the formal net zero aligned target on a rolling average	Company purchases carbon credits to neutralise residual emissions. Company does not compensate all unabated emissions in the short to medium term. Company does not purchase carbon credits to compensate for its historic emissions.
Type 4	Target, strategy, and performance criteria not met (but company may have a non-validated net zero target OR may have a validated target but is not on track to achieve it).	Company purchases carbon credits for "offsetting as a substitute for within value-chain science-based action".