Executive Summary

In the age of a warming climate, record-breaking temperatures are increasingly threatening people and wildlife across the globe. Ecosystem restoration, with its dual capacity to sequester carbon and enhance biodiversity, has the potential to be a huge part of the solution. However, its ability to do so up to now has been limited by considerable financial constraints. Turning the tide of environmental decline will require a significant upscaling of private investment into nature recovery, and the natural capital economy offers the potential to make this happen.

Carbon markets are key to driving the natural capital economy forwards incentivising both climate change mitigation and ecosystem restoration. By providing investors with the confidence that they'll see a return, forward pricing curves can be used to encourage up-front capital investment into restoration projects. However, the lack of future prices for carbon credits currently makes this difficult.

At Oxygen Conservation, we have been developing a forward pricing curve for the UK carbon market over the last twelve months. This tool will be pivotal in unlocking investment and kick-starting the UK natural capital economy, supporting our efforts to mobilise £1 billion to restore nature.

We aim to achieve this with carbon credits at the core of our model. Falling within the mitigation hierarchy, carbon credits will be crucial in the race to Net Zero, although they bring risks of greenwashing, market manipulation, and price volatility, alongside weak regulation and verification resulting in limited effectiveness and low market integrity. By working in line with the recently published Nature Market Principles, we will demonstrate that high-quality, high-integrity schemes can be a reality, delivering science-based nature recovery via transparent, verifiable, and genuinely impactful credits.

In this report, we outline our estimate of how carbon prices could evolve using our Stockdale-White curve. In doing so, we outline four chapters, taking us from today through to 2050 and beyond, accounting for carbon price fluctuations along the way. We anticipate a continuing rise in global emissions coupled with increased prices of high-quality carbon credits before their widespread demand and uptake leads the way towards climate positivity nearing the end of the century.

What if we're wrong? If the Stockdale-White forward pricing curve proves to be inaccurate and carbon pricing doesn't develop as we expect, there is a very real risk we will have helped drive significant amounts of money to the natural capital economy, delivering positive environmental and social impact in the process. And for this we can only apologise and say you're welcome!

The Era of Global Boiling

July 2023 was the hottest month ever recorded in human history. And this wasn't the only record broken this summer. Ten global climate records were smashed, from the longest heatwaves and highest temperatures, to the most torrential rainfall and largest area burnt. It seemed only appropriate when on the 27th of July 2023, the UN declared that *"the era of global warming has ended, the era of global boiling has arrived."*[1]

Alongside the catastrophic impacts on human society and our way of life, climate change is the biggest threat facing the natural world, threatening one in six species with extinction.[2] The one glimmer of hope is that there are opportunities to tackle both the climate and biodiversity crisis at the same time. Working with nature to restore the world's ecosystems could reduce net global carbon emissions by 11.7 gigatons each year by 2030, more than 40% of what is needed to limit global boiling.[3]

To get there will require a momentous shift in the amount of money we invest in nature restoration. Private-sector investment in nature-based solutions currently sits at $26 billion per year, just 0.03% of the estimated $87 trillion of global assets under management.[4] In the UK it's estimated that we need to invest an extra £100 billion in nature recovery over the next 10 years to meet our current targets.[5] To make this shift, we need to overhaul the existing financial system and build a natural capital economy.

Building A Natural Capital Economy

The first step in building a natural capital economy is to create a financial incentive to reduce greenhouse gases and restore nature. This means putting a price on carbon emissions and using the money raised through this to finance the restoration of nature at scale, leading to both a reduction in carbon emissions and a significant removal of carbon from the atmosphere.

One of the most exciting tools at our disposal are carbon markets. Organisations can purchase carbon credits representing one tonne of carbon prevented from entering or being removed from the atmosphere to offset or compensate for the emissions they produce. Where these carbon credits are created through high-quality nature-based solutions such as native woodland creation, they can provide both a financial incentive to reduce carbon emissions, as well as a source of revenue for restoring nature.

[1] https://unric.org/en/climate-10-records-broken-in-july-august-2023/
[2] https://www.unep.org/news-and-stories/story/five-drivers-nature-crisis
[3] https://www.unep.org/news-and-stories/story/five-drivers-nature-crisis
[4] https://www.pwc.com/gx/en/issues/esg/nature-and-biodiversity/closing-the-nature-investment-gap.html
[5] https://www.greenfinanceinstitute.com/news-and-insights/finance-gap-for-uk-nature-report/

This opens up the potential for private investment in nature recovery at scale and creates the building blocks for a natural capital economy.

The idea of the carbon market and the natural capital economy is not without its critics. However, other sectors have demonstrated how the climate crisis has created new ways of doing things, launching innovative 'green swans' that have led to huge changes in the way capital is invested. Arguably the most successful of these is the unprecedented momentum behind the renewable energy sector, with the world set to add as much renewable power in the next 5 years as it did in the past 20.[6] Last year 83% of all new power capacity was produced by renewables.[7] Wind and solar are now the cheapest options for new electricity generation in a significant majority of countries worldwide, and are expected to surpass fossil fuels to become the largest sources of power, creating a significant reduction in the world's greenhouse gas emissions.[8] This is something that was almost unimaginable a decade ago.

Key to this growth has been the use of forward pricing curves, which provide investors the confidence that putting their money into a renewables project, which requires a significant up-front capital investment, will give them a return on their investment based on the price of electricity in future years.

Carbon markets offer similarities to the renewables sector, with both markets providing an innovative opportunity to deliver environmental and social impact at scale, while generating a positive financial return. However, in comparison to the renewables sector, the natural capital economy is still embryonic. There are no future prices for carbon credits, and it is difficult to convince investors that investing trillions of dollars in restoring forests and wetlands is a more financially astute decision than investing in coal, oil, or gas. To get to that point, we need forward pricing curves for carbon that mirror those for the energy sector, so that investors can understand the potential returns on capital investment and unlock the trillions of dollars needed to restore nature at scale.

At Oxygen Conservation, we are working to mobilise £1 billion to restore nature through the natural capital economy. To support this, we have been developing a forward pricing curve for the UK carbon market over the last twelve months. Developing this tool is key to unlocking investment and kick-starting the UK natural capital economy, and this article presents our thoughts on what this curve might look like and what this means for this new alternative asset class.

[6] https://www.iea.org/news/renewable-power-s-growth-is-being-turbocharged-as-countries-seek-to-strengthen-energy-security
[7] https://www.irena.org/News/pressreleases/2023/Mar/Record-9-point-6-Percentage-Growth-in-Renewables-Achieved-Despite-Energy-Crisis
[8] https://www.iea.org/news/renewable-power-s-growth-is-being-turbocharged-as-countries-seek-to-strengthen-energy-security

About Us

I'm Rich Stockdale, CEO and Founder of Oxygen Conservation. I'm an environmentalist, entrepreneur, failed athlete, and data nerd, with a PhD in remote data acquisition and big data analysis. I have a decade of experience working for the Environment Agency, and a lifelong interest in competitive sports and performance (including an alleged interest in cricket). From the very beginnings of Oxygen Conservation, I wanted to create a company that was committed to delivering positive environmental and social impact first and generating a return as a result of what we do, not the purpose. Our ambition to become the world's first conservation-focused unicorn company is intentionally provocative and aspirational, based on the belief that if we achieve this, we will have helped Scale Conservation and played a significant role in getting the natural capital economy off the ground.

I'm writing this article with our multi-award-winning, Oxford-educated Environmental Economist and Director of Natural Capital Chris White, who has over a decade of experience researching, designing, and creating the building blocks of the natural capital economy through work in the public, private, academic, and charitable sectors. Chris has written books, papers, and articles about natural capital, and has been involved in the design and delivery of carbon and biodiversity markets across the world. His career is built around tackling the climate and biodiversity crises by creating a new financial system built on the recognition that the natural world is the most valuable asset we have.

Together, we have spent over twenty years closely involved in the development of natural capital from conceptual economics through to the collection and analysis of data, policy writing, and most recently founding and scaling a conservation start-up. Through our time together at Oxygen Conservation, we have developed proprietary data collection and analysis software that has identified, valued, and ranked over £2 billion of land acquisition opportunities across the UK, allowing us to deploy almost £100 million in eighteen months. We have acquired 11 estates in 8 counties totalling almost 30,000 acres. In the next 12 months we are aiming to double this, ultimately deploying £1 billion to protect, restore, and improve 250,000 acres of the UK's natural capital.

Our first portfolio has the potential to sequester a million tonnes of carbon and already has three projects registered on the UK Land Carbon Registry, with more pending in the coming months. We are in advanced discussions with a leading party for the purchase of all of the carbon credits we can produce, and have spent the last 12 months working with exceptional legal experts and advisors to develop bankable contracts and processes for selling high-quality carbon credits. We've spent many hours in board rooms and on hilltops talking with a huge range of stakeholders about carbon pricing and other natural capital products and services. We have also negotiated the UK's largest-ever conservation debt package borrowing £20.55m to be repaid based on the sale of carbon credits. It's from this experience that we are able to comment on the development of the natural capital economy and its future evolution.

It's also important to say that, while we are well-placed to talk about natural capital, nobody *(especially not economists)* can predict the future. We're all guessing. We base our guesses on the data we have collected through the extensive modelling work we've undertaken over the last two years, making them educated guesses but guesses all the same.

We are of course biased about the development of the natural capital economy. We believe it is a vital part of providing a future for life on Earth, and we're financially incentivised to advocate for and predict increasing future carbon credit prices. So we've tested our findings with leading thinkers working in the natural capital economy and taken on board their feedback. We believe the resulting curve represents a likely future for carbon pricing. Our plan is to share our thoughts further, take onboard the ideas and criticisms we receive, and update our approach each year to iterate and improve, helping to develop a forward pricing curve that can support the development of the UK's natural capital economy.

What Are Carbon Credits?

Carbon credits, also known as carbon offsets, are a market-based mechanism designed to incentivise and facilitate the reduction of greenhouse gas emissions. They represent a unit of measurement for one tonne of carbon dioxide equivalent (tCO_2e) that has been removed from, or prevented from being released into, the atmosphere. This allows organisations that emit carbon to pay to offset these emissions by removing or preventing the same quantity of emissions from being released elsewhere, thereby compensating for their impacts. Carbon credits provided through the restoration of the natural environment are often called nature-based solutions, and in the UK, typically take the form of woodland creation and peatland restoration.

The concept is rooted in the broader framework of carbon trading, which has been a key component of climate policy and efforts to combat global warming since the Kyoto Protocol in 1992. More recently, significant progress has been made in the development of carbon markets following the creation of the Taskforce for Climate-Related Financial Disclosures in 2015.

This framework requires organisations to disclose the risks that climate change poses to their operations, and the strategies and tools they are adopting in response. This often involves setting a target to reach Net Zero (i.e. total greenhouse gas emissions equal to or less than the total emissions removed from the atmosphere), and the use of carbon credits to offset emissions as part of reaching this goal.[9]

While they are a critically important tool in the fight against climate change, carbon credits are not without their dangers and pitfalls. Perhaps the biggest risk is the potential for 'greenwashing', where organisations claim to offset emissions through carbon credits without making substantial efforts to reduce their own emissions at the source. This can create a false sense of sustainability and undermine genuine climate action.

One thing that is important to state is that carbon credits are not, and can never be, a substitute for reducing or avoiding emissions in the first place. Carbon credits are part of a wider mitigation hierarchy which means that organisations must first avoid emissions, then reduce them, and only after that, compensate through offsets.

While there are organisations who do not follow this approach, the majority do, and recent research by Ecosystem Marketplace has found that two thirds of organisations buying carbon credits reported annual decreases in carbon emissions, while this was only reported by one third of those not engaged in carbon markets.[10] A report into the state of carbon credit markets by Sylvera[11] also found that companies purchasing carbon credits decarbonise twelve times faster than those that don't, further refuting the assumption that most organisations buy credits instead of reducing emissions.

When implemented as part of a robust and transparent strategy, such as the one set out in the Transition Plan Taskforce Disclosure Framework,[12] carbon credits can be a key part of a Net Zero strategy, providing a financial incentive to reduce emissions and a means of compensating for emissions that cannot be avoided or reduced. Without a functioning market for delivering carbon credits, it is unlikely that we will be able to reach our Net Zero targets or make the huge transition needed to avoid the worst impacts of climate change.

[9] Task Force on Climate-Related Financial Disclosures | TCFD) (fsb-tcfd.org)
[10] Companies in Voluntary Carbon Market Lead in Climate Action and Accountability (edie.net)
[11] The State of Carbon Credits 2023 (sylvera.com)
[12] Homepage - Transition Taskforce

Alongside greenwashing, there is also the risk of market manipulation and price volatility, which could make carbon credits vulnerable to speculation and financial exploitation rather than serving their intended purpose of reducing emissions. Further, if the standards and oversight mechanisms are weak, carbon credits may not deliver the promised emissions reductions, and may lead to negative impacts as people and biodiversity are displaced to generate credits, posing a risk to the integrity of the market and our climate goals. There are further challenges around accurately measuring and verifying emissions reductions, which can be complex and subject to inaccuracies. So, for carbon credits to be a useful tool, it is crucial that they address these risks and are delivered through high-quality, high-integrity schemes.

What Makes a High-Quality Carbon Credit?

There have been countless stories in the news about problems with poor-quality carbon credits, which either fail to effectively reduce emissions, lead to the displacement of people from the landscape, or have negative impacts on biodiversity through inappropriate land use decisions.

So, what makes a high-quality credit? In the UK, The Wildlife Trusts, National Trust, RSPB, Woodland Trust, Finance Earth, and Federated Hermes recently got together to publish the Nature Markets Principles[13] which set out key principles for building high-integrity natural capital markets.

These principals can be summarised as follows:

Science-based nature recovery: high-quality schemes aim to tackle both the climate and biodiversity crises, using carbon finance to fund the restoration of nature at scale. These credits contribute to nature recovery and are underpinned by the ecosystem approach which focuses on science-based restoration of ecological processes and functions, as well as building ecological resilience.

Environmental and social safeguarding: leakage, the unintentional increase in emissions in other areas or sectors due to a project's activities, is a risk that high-quality carbon credit projects must acknowledge and address. To avoid transferring the problem elsewhere, good projects identify potential sources of leakage, such as the displacement of damaging activities to other areas outside of the project, and implement measures to mitigate them through both environmental and social safeguarding measures. This may include designing projects to minimise indirect emissions consequences in nearby regions or sectors. Robust carbon credit projects aim to prevent or at least account for any emissions increases outside of their direct scope.

[13] Nature Markets Principles - Voluntary Principles for Science-based Investment to create High Integrity Natural Capital Markets in the UK

Additionality: high-quality carbon credits are generated by projects that demonstrate 'additionality' with strong evidence. Additionality means these projects can convincingly demonstrate that the emissions reductions achieved are beyond what would have naturally occurred under standard, business-as-usual circumstances. They undergo rigorous assessments to show that, without the financial incentive provided by the carbon market, these projects would not have taken place. This proof may include historical data analysis, modelling, or other quantitative and qualitative methods to establish a clear contrast between the project's emissions trajectory and a business-as-usual scenario.

Permanence and financial prudence: high-quality carbon credit projects are also characterised by their commitment to achieving long-term emissions reductions. These projects don't focus solely on short-term fixes but demonstrate a dedication to sustained reductions over time. This long-term perspective is vital for addressing the ongoing challenge of climate change and demonstrating a genuine contribution to climate mitigation. High-quality carbon credits prioritise achieving permanent or long-lasting emissions reductions. They consider the risk of potential reversals, which could occur due to unforeseen events or changes in project conditions. These credits incorporate strategies like setting aside finance, buffers, or reserve credits to account for possible emissions rebounds and develop measures to ensure that reductions remain stable over time. This commitment to permanence ensures the integrity of carbon credits and that the emissions reductions are a lasting contribution to climate change mitigation.

Seeking co-benefits: high-quality carbon credit projects prioritise delivering additional social and environmental benefits beyond emissions reductions. These co-benefits can encompass various aspects, such as supporting local communities through job creation or access to clean energy, protecting biodiversity and ecosystems, and contributing to the UN Sustainable Development Goals, like education, access to food, and provision of clean water. These benefits enhance the overall positive impact of the project, making it a more valuable contributor to the climate, biodiversity, and local communities.

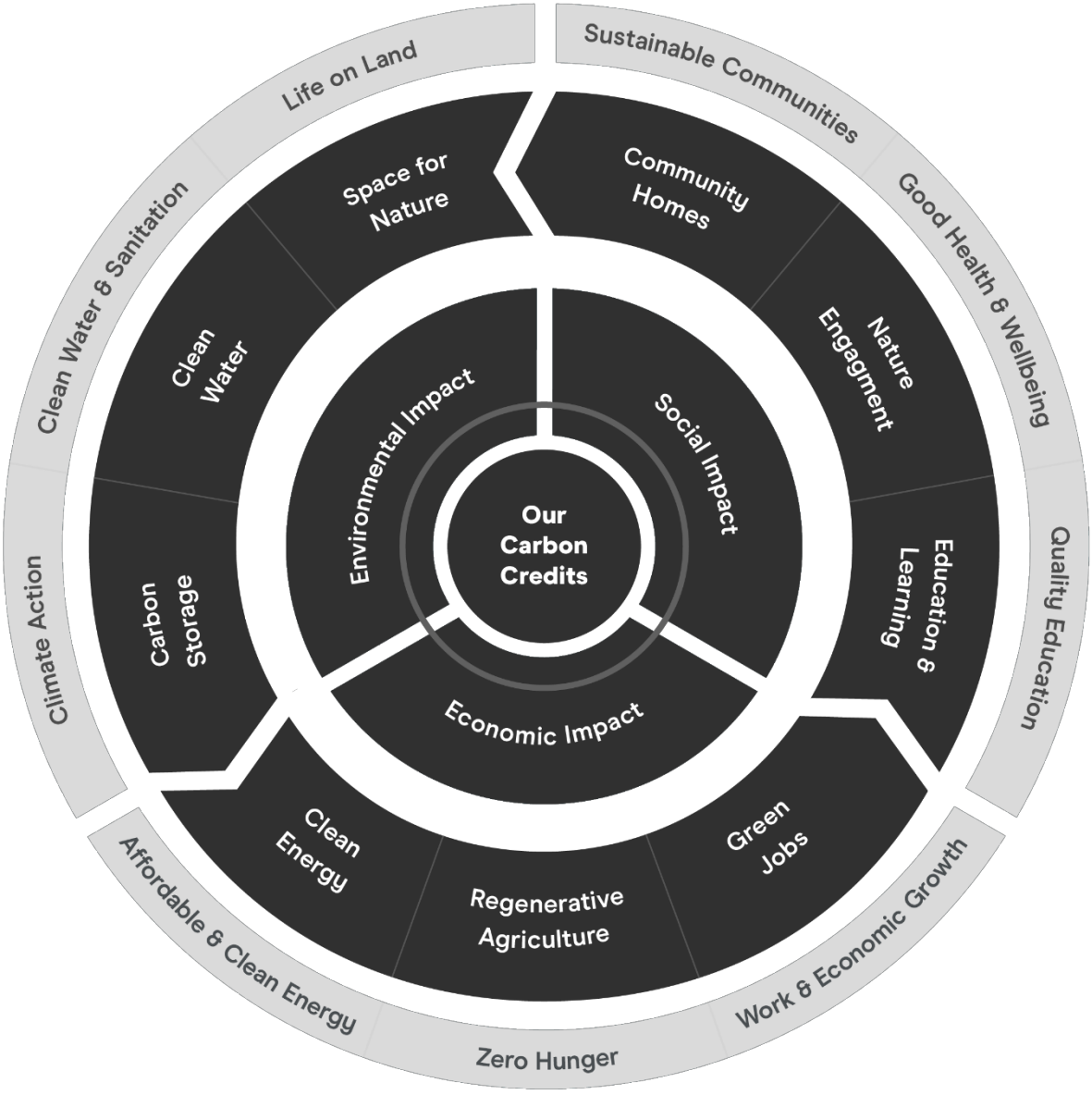
Verifiability: to ensure credibility, high-quality carbon credits are subject to rigorous and transparent verification processes through respected standards such as the Woodland Carbon and Peatland Codes in the UK. Third-party auditors with expertise in emissions accounting and climate science review all project data and documentation. They assess the project's methodology, emissions calculations, and monitoring processes to ensure they adhere to recognised standards. This verification process is critical for confirming that the emissions reductions claimed by the project are real and accurately quantified. It also involves site visits, data audits, and extensive scrutiny of project activities. Better yet, high-quality projects allow the buyers to physically come to see and touch their carbon in person, allowing them to verify the project's impact for themselves.

Transparency: transparency is a foundational attribute of high-quality carbon credits. The project's documentation, methodologies, data, and outcomes used to generate carbon credits must be transparent and open to public scrutiny. This transparency fosters trust and allows stakeholders, investors, and the public to assess the legitimacy and credibility of the project's claims. It also includes making information accessible through comprehensive reports, data sharing, and a clear account of emissions reduction activities.

We are currently in the process of developing how we can adopt these principles to develop a suite of high-quality UK-based carbon credits that will define high quality for the UK carbon market. You can see our developing carbon offer on our website: Our Carbon Credits | Oxygen Conservation.

Each of our credits is generated through high-quality nature-based restoration schemes that contribute to a range of the UN Sustainable Development Goals (see Figure 1). We believe that all credits should be high-quality and set at a price which provides the finance needed to deliver high-integrity schemes while also providing a financial disincentive to resort to offsets, and a corresponding financial incentive to avoid and reduce emissions first. Our credits are part of a growing carbon market in the UK principally based around the generation of credits through woodland creation and peatland restoration.

Figure 1: Our Carbon Credits Contribute to the Delivery of the UN Sustainable Development Goals



Current State of the UK Carbon Market

Earlier this year Ecosystem Marketplace released an overview of prices in the UK carbon market, focused on the two most established schemes, the Woodland Carbon and Peatland Codes.[14] The average price of woodland carbon credits increased from £16 in 2021 to £24 in the first half of 2023, growing at an annual rate of 22% in 2022 and 26% in 2023. There is less data available for the peatland market, with credits in 2022 trading at around £24. The total volume of credits recorded as traded was around 200,000 per year. Data on the spread of prices suggests that the price of higher quality, more expensive credits was around £30 in 2021, £36 in 2022, and £43 in the first half of 2023[15], again growing at an average annual rate of more than 20%. This is despite the large market correction in carbon credits following the release of reports in the press about challenges associated with some of the most established schemes.[16]

From our extensive discussions with a range of organisations buying and selling UK carbon credits, we have seen a similar range of prices, ranging from £20 for a mixed conifer/broadleaf woodland in Dumfries & Galloway up to £75 for a high-quality biodiversity-focused scheme registered under the Wilder Carbon standard. The average price, not accounting for the volume of credits sold at each price point, appears to be around £25 at the lower end, £36 at the mid-range, and £53 at the higher end based on our observations of the market (see Figure 2).

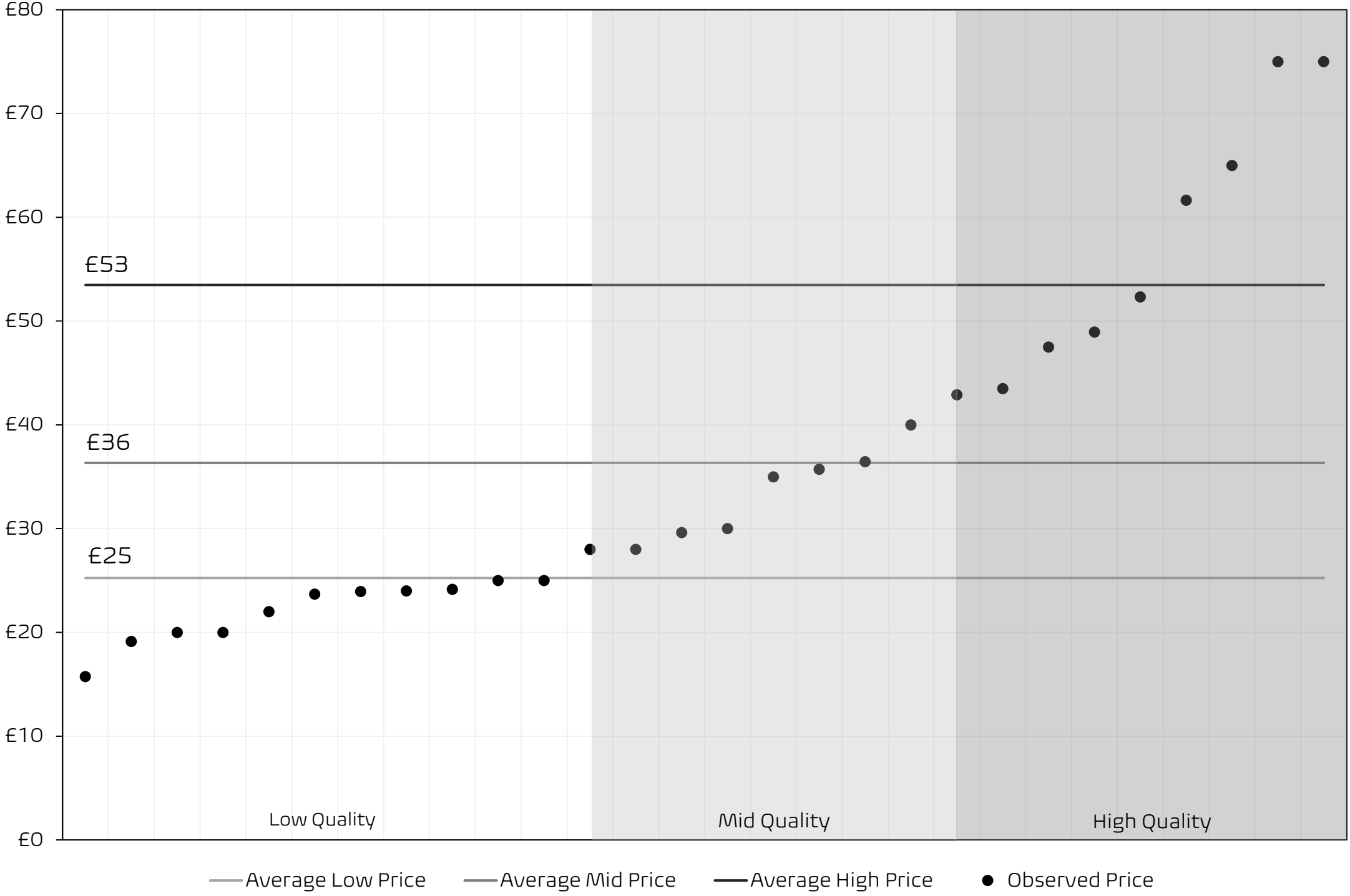
At Oxygen Conservation we are particularly interested in the high-quality credit market. We believe that carbon credits need to be high-quality and high-integrity in order to function as a key part of the transition to Net Zero. They must provide a clear price signal to buyers to first avoid and reduce their emissions, and to credit suppliers to provide the confidence needed to invest in large-scale restoration on the back of strong credit prices. However, while the quality of a credit has a significant impact on its price, it's not the only thing that determines carbon pricing.

[14] New Ecosystem Marketplace Price Transparency for UK Voluntary Carbon Market - Ecosystem Marketplace

[15] These prices are calculated as the average price plus 50% of the spread price.

[16] Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows | Carbon offsetting | The Guardian

Figure 2: Distribution of Observed Carbon Prices in the UK Carbon Market



Factors That Influence Carbon Pricing

There are a wide range of factors that can impact the price of carbon credits including global emissions, supply and demand, regulatory environment, market confidence, economic conditions, technology advancements, geography, type of credit, external events, voluntary vs. compliance markets, investor and speculator activity, carbon market maturity, and global events.

Global emissions: the total level of global greenhouse gas emissions can impact the cost of carbon credits. When global emissions are on the rise, there is generally more pressure on governments, industries, and organisations to reduce their emissions. This can lead to increased demand for carbon credits as organisations seek ways to offset their environmental impact, potentially driving up prices. Conversely, if global emissions show signs of decreasing or stabilising due to coordinated climate action, there may be reduced demand for carbon credits, which could lead to lower prices. The relative importance of global emissions as a factor in carbon credit pricing is moderate to high, as it sets the broader context for emissions reduction efforts and can influence the overall demand for carbon credits on a global scale. However, it's important to note that global emissions trends alone may not directly translate into price changes, as regional and market-specific dynamics also play a significant role.

Supply and demand: the relationship between supply and demand is a foundational factor influencing carbon credit pricing. If the supply of credits is scarce in comparison to the demand, prices tend to rise significantly. Conversely, an oversupply of credits can lead to lower prices. The relative importance of this factor is high, as it directly reflects market dynamics. When supply is constrained due to a lack of approved emissions reduction projects or a sudden surge in demand, prices can soar. However, when supply surpasses demand, prices may drop significantly.

Regulatory environment: the regulatory environment plays a vital role in shaping carbon credit pricing. Stricter government regulations that mandate emissions reductions or cap-and-trade systems can create a strong demand for credits, increasing prices. Conversely, the relaxation of regulations may reduce demand and lower prices. The relative importance of this factor is also high as it has a direct and immediate impact. For example, in 2018, the US State of New Jersey mandated power plants' participation in the Regional Greenhouse Gas Initiative (RGGI), a regional cap-and-trade program. This change in policy significantly increased the demand for carbon credits within New Jersey, leading to a surge in prices amid an increasingly competitive market. Providing an example of how a shift in regulatory policies can cause sudden price fluctuations, affecting both compliance and voluntary markets.

Market confidence: market sentiment and investor confidence can influence pricing to a considerable extent. When there is a strong belief in the effectiveness of carbon credits and a high level of trust in market integrity, prices are likely to rise as more organisations participate. Conversely, doubts about the credibility of the carbon credit market can lead to decreased demand and lower prices, we saw the impact of this recently following the Guardian's critique[17] of Verra's carbon standards[18]. The relative importance of market confidence is moderate; it can sway prices, especially in the voluntary market where perception and reputation are crucial.

Economic conditions: economic conditions are significant but indirectly factor into carbon credit pricing. Economic downturns can lead to lower industrial activity and emissions, reducing demand for credits and causing lower prices. Conversely, economic upswings may boost demand and prices. The relative importance is moderate; economic trends have an impact, but other factors like regulations often exert a more direct influence on pricing.

Technology advancements: advances in new technologies can reduce the cost of emissions reductions, leading to decreased demand for carbon credits and potentially lower prices. They can also provide alternative approaches to nature-based solutions in terms of generating carbon credits which may affect the demand for certain types of credit. However, technology advancements can also enhance the efficiency, scalability, and reliability of carbon credit projects, making them more appealing and potentially increasing demand. The relative importance of technology advancements is moderate, as it depends on the direction in which they develop, the rate of technological progress, and how quickly industries can adopt new methods.

Geography: geographic differences in carbon credit pricing result from a range of factors including land availability, labour costs, extent of existing habitat, and potentially most importantly, varying levels of regulatory stringency and environmental policies. Regions with stricter regulations are likely to experience higher prices. Relative shifts in prices across regions are unlikely to change rapidly unless there are significant shifts in regional policies, and companies operating in multiple regions may diversify their credit sources across different regions to manage costs.

[17] https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe
[18] https://verra.org/verra-response-guardian-rainforest-carbon-offsets/

Type of credit: the type of carbon credit chosen by an organisation can affect the price they pay. Some credits, like those generated through renewable energy sources are typically more affordable due to a higher volume of supply and lower cost of delivery, while credits generated through afforestation, reforestation, and revegetation schemes command higher prices due to their cost, complexity, and wide range of co-benefits[19]. The relative importance of credit type is moderate, as it depends on the specific goals and preferences of the entity purchasing the credits.

External events: localised natural disasters, extreme weather events, and high-profile climate initiatives can temporarily influence carbon credit pricing. The relative importance of external events is, however, relatively limited in the development of long-term pricing patterns as their impact tends to be temporary and spatially specific. When considered globally, the impact of external events – especially natural disasters and extreme weather events – is more significant and likely to lead to some regions having much riskier projects. For example, the increasing risks of wildfires in Australia have made new forest restoration projects virtually uninsurable.

Voluntary vs. compliance markets: the difference between voluntary and compliance markets is significant. Prices in voluntary markets can be influenced by consumer demand and corporate sustainability initiatives, making the relative importance moderate. Compliance markets, driven by government regulations, often exhibit greater price stability due to the legal requirement to purchase credits.

Investor and speculator activity: the influence of investors and speculators on carbon credit pricing is moderate. While they can introduce volatility, they often participate in the market for financial gain rather than emissions reduction purposes. This factor can lead to short-term fluctuations but doesn't have a long-term impact on prices.

Carbon market maturity: the maturity of the carbon market affects pricing stability. Established markets with well-defined rules tend to have more stable prices. The relative importance is moderate, as a mature market provides a level of predictability and trust, but emerging markets can still experience significant growth and price fluctuations.

[19] The State of Carbon Credits 2023 (sylvera.com)

Global events: global events, like international climate agreements, can significantly impact carbon credit pricing. The relative importance of global events is moderate to high, as they can result in long-term shifts in climate policy that affect the demand for carbon credits on a global scale. Major agreements can create sustained changes in pricing, as they signal long-term regulatory intentions.

The relative importance of each factor can vary depending on the specific context, region, and time frame. However, supply and demand, as well as the regulatory environment, are consistently among the most influential factors affecting carbon credit pricing.

The Stockdale-White Forward Pricing Carbon Curve

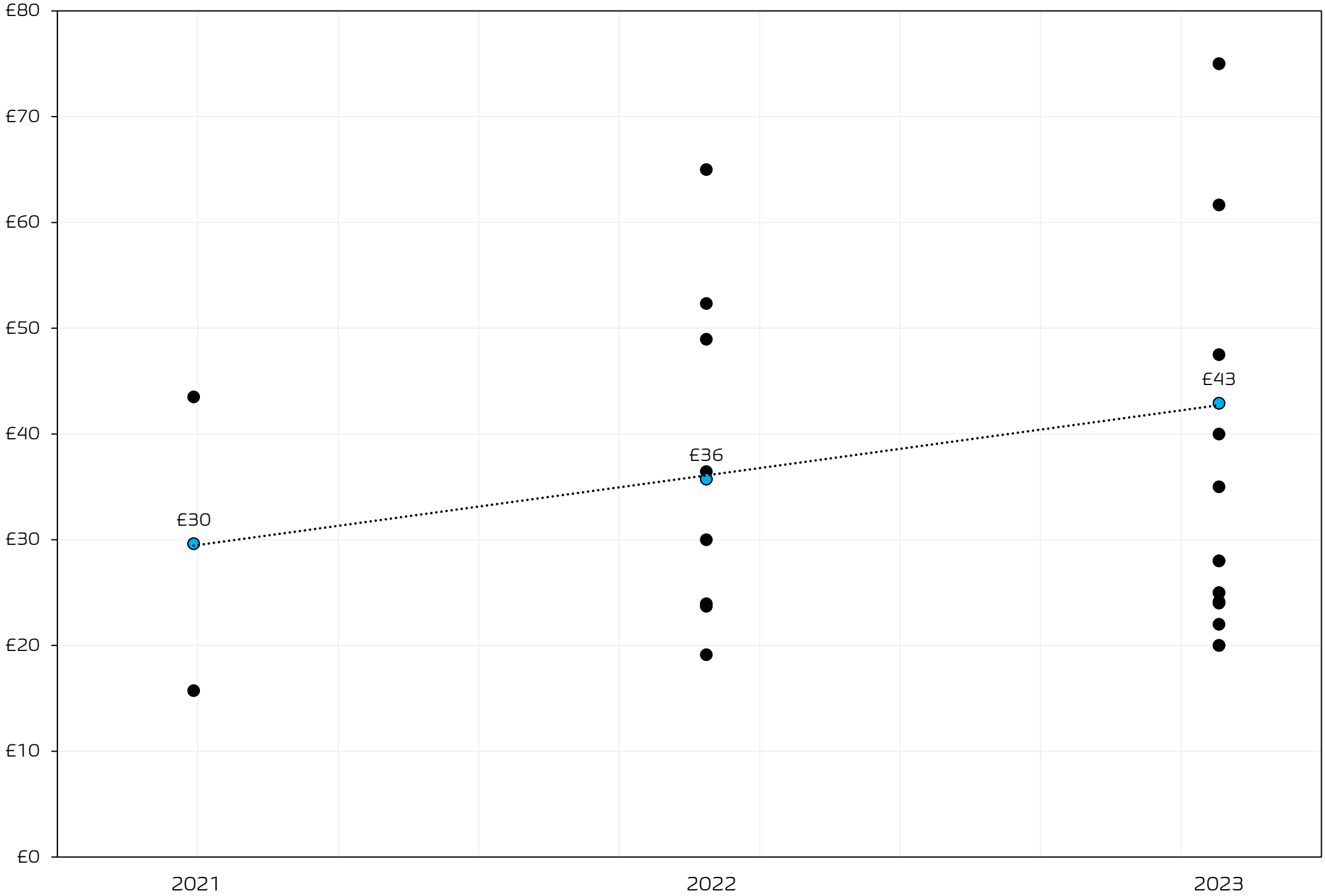
There are a wide range of factors influencing the pricing of carbon, and each will cause the development of prices to shift over time. In order to make sense of this complex situation, the Stockdale-White curve is a simplified, smoothed illustration over time intended to describe how we believe carbon pricing will develop for high quality UK based credits.

We would like to note that the curve we are presenting in this paper is not strictly a forward price curve (i.e. a series of prices that we could achieve right now for agreements to exchange cash for voluntary carbon credits with both delivered in the future), and is more accurately described as a price projection for voluntary carbon credits delivered at a spot date. We have chosen this terminology to generate engagement and excitement about the natural capital economy.

Our curve is driven principally by the intersection of rising global emissions, the worsening impacts of climate collapse and biodiversity loss, alongside the desire for people to do something to make a difference. It is representative both of a sadly deteriorating future but also one that ultimately sees us finding a way to give the next generations a future on this planet.

In developing the curve, we started with the price points collated to date for projects registered under the Woodland Carbon Code for 2021 (£30), 2022 (£36), and 2023 (£43) – see Figure 3. This data was then extrapolated into the future to provide a high level prediction of future prices; meaning we are not predicting anything outside of observed behaviours. To undertake this prediction, we considered four chapters influencing the future of carbon pricing which are described in the following sections and summarised in the diagram in Figure 4.

Figure 3: Distribution of Observed Carbon Prices in the UK Carbon Market (WCC and SW curve points in blue)



Chapter One. 2021 – 2029. Start Price £30/t. End Price £154/t. Growth 20% p.a.

Real world prices for UK carbon credits started at £30/t in 2021 and grew at 20% per annum in the period up to 2023, despite the significant market corrections that happened during this period.

We project that this trend of rapid growth continues throughout the remainder of the decade, as global emissions continue to rise and almost all large corporations and businesses make commitments to achieving Net Zero by 2030 or 2050. While many prioritise reductions and removals in their own processes, virtually all require offsets to meet their targets. Ongoing issues with international markets and concerns over the credibility of cheap low quality credits leads to an enormous drive and flight to safety to high quality UK credits.

Increasingly supportive attitudes towards carbon reduction among businesses, politicians, and the wider public leads to the merging of the voluntary and compliance markets, causing a continued growth in demand for credits. By contrast, supply, especially of high-quality carbon credits that contribute to wider ESG goals, remains limited due to the high barriers to entry and long lag times needed to bring credits to market, in line with predictions by the UK Climate Change Committee.[20]

These factors combine to create a continuation of the current 20% per year growth in the market we have seen since 2021, as organisations race to meet the first set of Net Zero targets in 2030. The Stockdale-White Curve predicts a high point approaching £154 a tonne by 2030. While prices are high relative to today, they remain significantly below the marginal abatement cost of reducing or avoiding emissions.

Chapter Two. 2030 – 2040. Start Price £156/t. End Price £176/t. Growth 1.5% p.a.

The psychological focus on 2030 passes by with barely a dent made in global emissions. The rapid rise in prices over the previous decade brings new entrants to the market, with millions of acres of new woodlands being planted across the UK. At the same time, the development of new technological solutions to removing carbon from the atmosphere increases the range of credits available, broadening the supply of credits in the market and closing the gap relative to demand.

[20] Supply and Demand in the UK Voluntary Carbon Market (Allied Offsets) - Climate Change Committee (theccc.org.uk)

High carbon prices also force organisations to invest further in avoidance and reduction of emissions over offsetting. Organisations that are buying credits look to get more for their money, focusing on projects that deliver on both carbon and wider ESG targets. The growing implications of global biodiversity collapse lead to widescale adoption of the Taskforce for Nature Related Financial Disclosures framework and demand for biodiversity as well as carbon credits. As a result, demand remains for high quality nature-based solutions which deliver for both carbon and biodiversity, while demand for other credits is muted. This results in a relative depression hitting the carbon market with prices continuing to rise but at a much slower rate of around 1.5% for much of the next decade.

Chapter Three. 2040 – 2050. Start Price £193t. End Price £501/t. Growth 10% p.a.

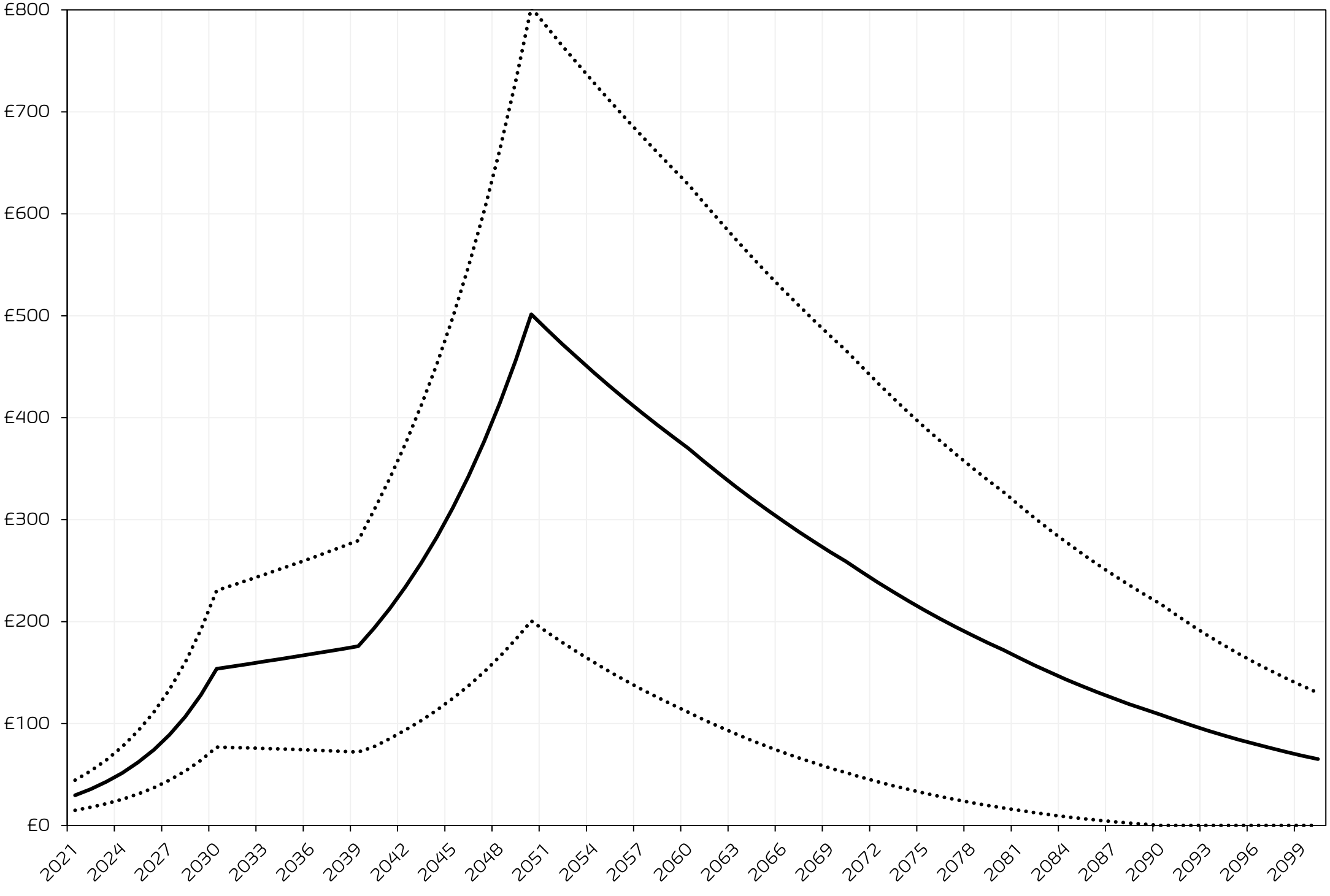
The Greta Thunberg generation is now leading the way across business and government with climate and biodiversity being the primary focus of discussion and debate. Legal requirements to achieve Net Zero are signed across much of the world and the best businesses have committed to go beyond these requirements to become regenerative in everything they do. Businesses routinely use investment in high-quality carbon credits to develop partnerships with the most respected developers delivering positive climate, biodiversity, and social impacts.

While the carbon price has so far been trading significantly below the costs of avoiding or reducing emissions, as companies races towards Net Zero by 2050 there is a growing realisation that credits are still needed. The scale of credits required to hit these targets is significantly above the available supply, causing continued upward pressure on prices. While there is significant investment in carbon avoidance and reduction, particularly among those who have acted fast and early, there are a number of organisations with significant work to do. Those that have left it too late scramble to secure the credits they need, pushing the voluntary credit price above the abatement cost of carbon in the last couple of years before 2050 hits. We estimate annualised growth of 10% per year with prices hitting a peak of around £500 per tonne by 2050.

Chapter Four. 2050 – 2100. Start Price £486/t. End Price £65/t. Growth -4% p.a.

The use of carbon credits has largely served its purpose and we have made advancements such that they become less important over time. Trading volume and value steadily decrease until at the end of the century we are living in a largely climate-positive way – or sadly we're not!

Figure 4: Stockdale-White Forward Pricing Curve for High Quality UK Carbon Credits



The Impact of Stockdale-White

If this forward look is broadly accurate, the demand for high-quality, UK-based carbon credits is likely to rise with credit prices reaching a high point of £500 tCO_2e. Carbon pricing at this level would make investment in UK nature-based solutions financially lucrative, unlocking significant volumes of private capital and creating the UK's biggest alternative asset class, as well as the next big export for UK PLC.

Although these prices seem high, the curve predicts that they will remain significantly below the estimated marginal abatement cost of meeting the UK's carbon targets by 2050 as predicted by HM Treasury, and thereby the price level needed to incentivise avoidance and reduction before offsetting (see Figure 5). It is not until 2047 that the price per credit is predicted to meet and exceed the marginal abatement cost of carbon in the UK, predicated by the last-minute scramble for credits by organisations that have failed to deliver on their 2050 Net Zero targets.

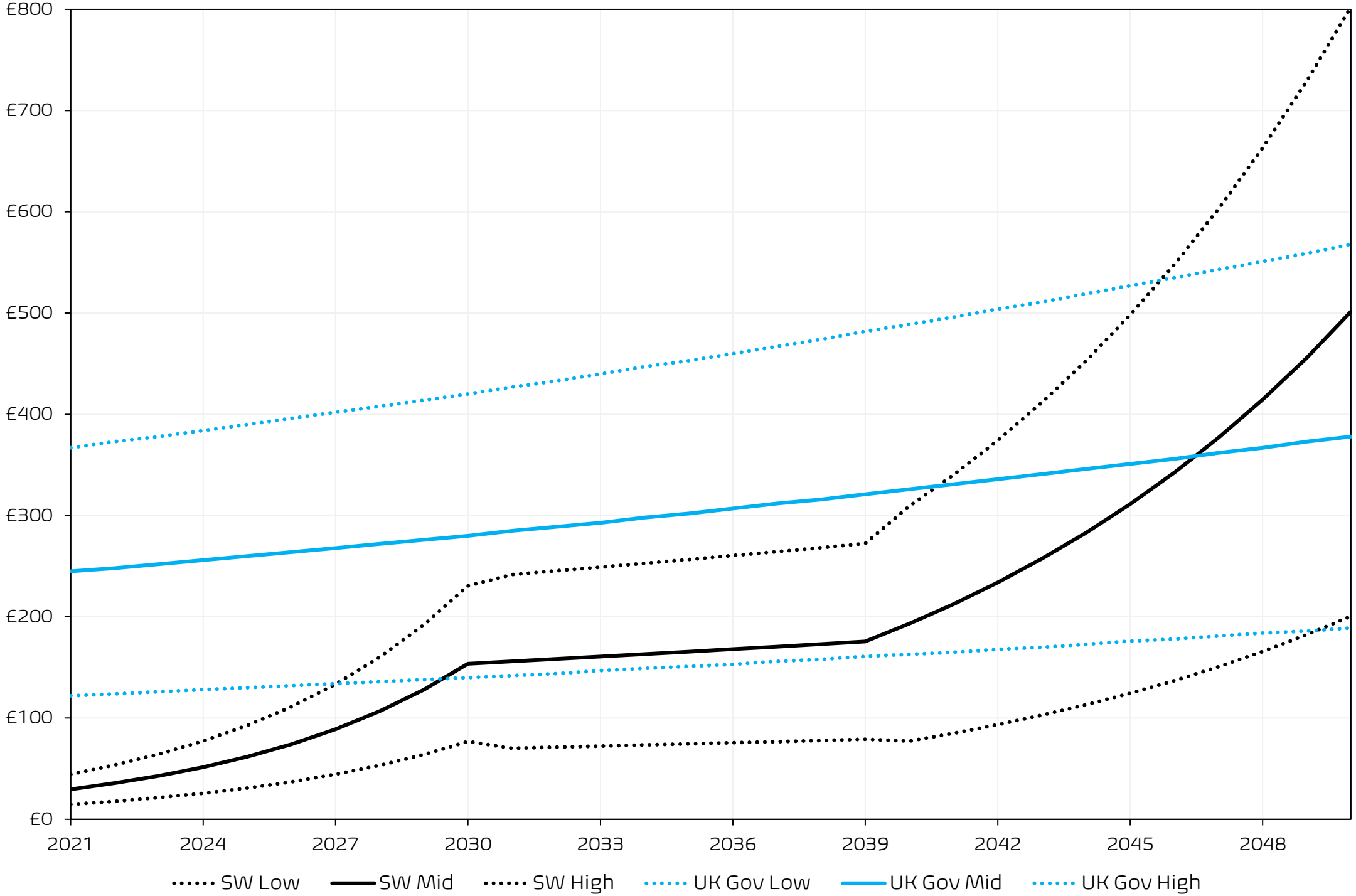
As we've shared previously, there are risks associated with the development of the natural capital economy. Many of these will be exacerbated by the impacts of rising prices, while others may be reduced.

Based on our understanding of the market, the following risks may be reduced:

Commodification of nature: there's a concern held by some that nature credits could reduce nature to a tradable commodity, prioritising profit over conservation goals. Whilst a legitimate emotional argument, the economic reality is that nature *is* a tradable commodity and profit *is* being prioritised over conservation already. In the absence of a framework that is actively valuing nature, its destruction and exploitation will continue to be practised. Increasing the recognition of the value in nature will also lead to a wide range of professional systems and services to help ensure the integrity and quality of products and credits offered.

Greenwashing: the risk of companies or governments appearing environmentally responsible without implementing effective conservation measures is a valid concern. Natural capital credits can create opportunities for organisations to see the purchase of credits as a licence to carry out destructive practices. For credits to be effective, they need to be used as part of a mitigation hierarchy which puts avoidance and reduction of harm first, and compensation for unavoidable damage second. Higher quality and higher cost carbon credits may significantly reduce this risk.

Figure 5: Stockdale-White Forward Pricing Curve Compared Against UK Government Estimate of Marginal Abatement Costs of Carbon



At the same time, the following risks are likely to be exacerbated:

Land price rise: land prices in rural communities will rise dramatically as people rush to create natural capital products and services. While the media would have you believe that this is already the case with regular scare stories about farming being forced from the land by widespread woodland creation, the UK remains one of the most nature-depleted countries in Europe and land price rises remain between 5-7%, in line with both the Savill's 30-year and 100-year long term averages. Moreover, there is an inherent suggestion that the owners of these landscapes are not well-placed to determine their value, with those wishing to sell these assets to pursue other opportunities and adventures, this presents an opportunity, not a risk. For those aspiring to start a business in the rural economy, the price of entry will be high, although it always has been. On our part, across the Oxygen Conservation portfolio we will always look to provide opportunities for employment and collaboration across the estates we own and manage to address this issue.

Ecosystem simplification: natural capital credits often focus on specific ecosystem services, a legitimate challenge levied at carbon credits which may incentivise the development of monocultures or simplified ecosystems optimised for credit generation rather than diverse and resilient natural ecosystems. The increasing value of carbon credits especially between now and 2030 heightens this risk, therefore making it important that buyers understand what they're purchasing.

Short-term focus: market-driven approaches may prioritise short-term gains over long-term ecological health. Conservation efforts often require sustained, multi-generational commitments, which can be undermined by market pressures. This could be exacerbated by the significant interest and investment in the sector.

Market volatility: just like financial markets, natural capital markets can experience volatility and almost certainly will in the immediate future. The value of such credits can fluctuate, potentially leading to unexpected economic outcomes or disincentivising long-term conservation efforts. However, two tech bubbles have previously (incorrectly) signalled the end of Silicon Valley; demonstrating that short term shocks do not necessarily undermine a sector. If you don't remember these, you can Google them!

What If We're Wrong?

If the Stockdale-White forward price curve proves to be inaccurate and carbon pricing doesn't develop as we expect, there is a very real risk we will have helped drive significant amounts of money to the natural capital economy, delivering positive environmental and social impact in the process. And for this we can only apologise and say **you're welcome!**

Thoughts, Fears, Criticisms & Support for Stockdale-White

We want to share our thinking to generate discussion and debate about the UK carbon market. Our intention is to expand and improve on the curve in future iterations, looking at issues such as the stacking of natural capital credits, integrating more detailed supply and demand modelling, and exploring different climate scenarios to test the impacts on credit prices. To help us do so please send your comments and feedback. We have been lucky to receive some fantastic insights and inputs from some of the leading thinkers in the UK carbon market, we have responded to much of their feedback in the revised version of this document but wanted to include key sections of their feedback in the spirit of being transparent and encouraging further discussion.

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"Super interesting (and nice job) – we are working on the challenge of valuation from a slightly different angle but getting to the same conclusion in that the direction will be upwards until the climate strategy has been successful."

Andy Creak, Founding Investor & CEO, Kana Earth

"I love the optimism of the scenario, and it's one we can all aspire to - and it can be used to engage with investors. In practice, our work into the history of offset systems shows that whenever prices become restrictive on economic activity, government intervenes to bring down credit markets by bringing in exemptions or reducing the stringency of legislation - so I would be surprised if industry ever let credit prices get this high. But hell, we all need a positive vision to aspire to!"

Sophus zu Ermgassen, Ecological Economist, University of Oxford

"I love this so much – if there is no market, create the market! I found this to be an incredibly positive and hopeful paper. It voices much of my thought behind setting up TreeStory but with more eloquence and boldness than I had dared. Thank you for sharing your work. Carbon credits simply need to cost significantly more than they do at present, and if the UK financial market can realise that, I truly believe there will be a noticeable dial shift in land use across the UK. Properly priced credits will also encourage more high-quality projects, seeing a shift away from trees growing like lollipops on a moorland, to projects truly creating functioning ecosystems for the future. Imagine the UK landscape if carbon credits received even £250 per unit – it could truly be a different country."

Gordon Brown, Managing Director, TreeStory

"Firstly, congratulations on the paper – it is a very compelling piece of analysis, which neatly navigates the backdrop of economic, political, social and regulatory factors that feed into carbon prices, many of which have been brought into sharp focus during the course of this year. It will no doubt provoke necessary debate and discourse."

Adam Hedley, Partner, Clifford Chance

"In terms of the logic behind the 'chapters' and how it would impact the shape of future pricing, I broadly agree. Unless government mandates it, organisations change culture and practices as new generational attitudes percolate up from the bottom of the org chart. Preferences for spending on climate action will follow this path, however you probably haven't factored in enough of an impact from the substitution effects between types of VCCs and types of land use as prices rise. If we breach £150 within the decade then the scale of investment into engineered CDR will be dramatic and the numbers of companies switching away from 'less certain' NBS to 'less risky' engineered solutions will temper the price rise for NBS. Influx of supply, switching of demand away from NBS. An additional headwind will be the pushback on land use change, we already see this and it remains contained whilst we can evidence it is confined to marginal agricultural land, however the kinds of prices envisaged here would blow this up into a front page debate and this would certainly hamper demand. The more angry the debate becomes the more companies will kick the can down the road for the next CEO to deal with. By our calculations above £85 in every region of the UK the average hectare of agricultural land will break even as carbon vs total net income from farming (over a 50y period), that is going to be a very noisy situation."

Expert in Carbon Markets

"A good benchmark for the Stockdale-White Curve may be forecasts for emission trading schemes (ETS), e.g., the UK- or EU-ETS. These represent the closest comparable with liquid markets. The comparison is not without drawbacks, however, given that the framework for an obligatory energy-based scheme versus a voluntary reforestation and rewilding scheme are quite different. Though as a rough guide, I think it could be instructive for how you model and benchmark your curve. Considering the myriad issues with voluntary carbon credits cited in your report, it is safe to argue that low-quality voluntary schemes should be priced below ETS forecasts. On the other hand, given that high-quality voluntary schemes can provide services in addition to carbon sequestration, they could be priced between an ETS and direct air capture and storage (DACS) levelized costs (600-1,000 USD/tCO2). As an example, Frontier's portfolio of carbon reduction projects has averaged around 500 USD/tCO2 over the past 12 months."

Jack Gregory, PhD, Energy Economist

"punchy", "incredibly impressive piece of work", "keep up the bold, clear-minded thinking", "this is absolutely brilliant", "super-cool", "super-interesting and will definitely get people talking", "really impressed", "excellent work all round", "really helpful", "congratulations and thank you", "I love the sign off, it's definitely the attitude more people need to take", "I have registered the Stockdale White trademark, domain name and patent ;)".

The Enthusiastic Supporters.