KPMG

The (blue) wealth of nations

Net Zero ambitions require blue carbon solutions

eurasia group politics first

June 2023

KPMG International

—

kpmg.com/esg

You can't go green without blue

All around the world, countries and territories are looking to transition to a 'green' economy that is low in carbon, socially inclusive and resource efficient. Over 68 percent of global GDP is already covered by a Net Zero target[1] — the main focus of which has been to reduce human-driven emissions of CO_2 or global greenhouse gases (GHGs) as close to zero as possible through decarbonization.

But this will not be enough. In the short term, the political, commercial, and technological reality of decarbonization means that not all sectors will be able to hit increasingly widespread and strict interim targets. And in the longer-term, decarbonization of current economic activities will not reverse the impact we have already had — not the stock of carbon that has built up in the atmosphere from centuries of industrial activity, nor the 'natural' emissions that are on the rise due to the impact of climate change on these ecosystems.

This report argues that although decarbonization will always be the central focus of climate change mitigation, the Net Zero targets of companies and countries will only be achieved through the additional step of removing carbon from the atmosphere. And **to achieve the speed and scale of these ambitions in a cost-effective manner, the 'blue' carbon potential of the oceans must be unlocked.**

In the following pages, we cover:

01

The **demand-side dynamics** for carbon removal, where escalating prices will make these projects more commercially feasible. In *1: Net Zero or Net Negative?,* we look at the basics of carbon reduction and removal to explore why the latter is moving up on governments' green agendas. We then consider carbon market dynamics and the impact of COP26 negotiations on offsetting in *2: Allowances or offsets?,* arguing in *3: Avoidance or removal?* that carbon removal projects will likely capture an outsized share of demand for offsets over the coming decades.

02

The **supply-side dynamics** for these projects, where blue carbon removal solutions can address the potential constraints of 'onshore' offsets. In *4: Green or blue?,* we look at the full scope of blue carbon removal potential. Blue offset projects are arguably more efficient, permanent and scaleable than their terrestrial counterparts, potentially offering a valuable revenue stream to developing nations.

03

In *5: Private or public?,* we explore the remaining **barriers to the development of blue carbon removal offsets,** with high-level recommendations for governments to better realize the blue carbon wealth of their country.

[1] Approximately 61% of GHG emissions and 56% of the world's population are covered by national net zero commitments, as at 23 March 2021 ['Taking stock: a global assessment of net zero targets' (2021) Oxford Net Zero & ECIU].

Net Zero or Net Negative?

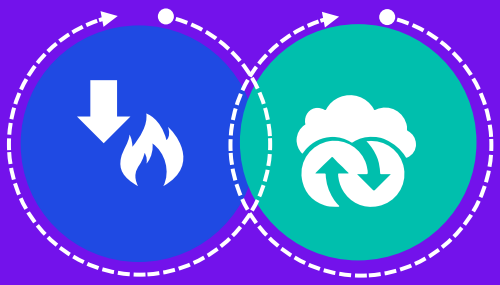
"The scale of recent changes across the climate system… are unprecedented over many centuries to many thousands of years… **Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO_2 and other greenhouse gas emissions occur in the coming decades."**

IPCC Report[2]

In its simplest terms, the ambition of the 'green' agenda is to decouple economic growth from environmental degradation and the emission of global greenhouse gases GHGs. To limit the increase in global temperatures to 1.5 degrees, countries, financial institutions and corporates alike are pledging to become Net Zero, in most cases by 2050[3]. This is a two fold process — it requires these entities to:

Reduce

GHG emissions caused by economic processes and human activity as much as possible — a process known as **decarbonization.**



Remove

and store an equivalent amount of carbon from the atmosphere to neutralize or 'net out' any remaining human-driven (anthropogenic) carbon emissions — a process known as **carbon removal.**

A mature Net Zero strategy aims first and foremost at avoiding (or reducing) emissions. Carbon removal is a complement, rather than a replacement for deep emissions cuts. The decarbonization of business and operating models will remain critical to achieving Net Zero in a sustainable and ideally cost-effective manner over the coming decades.

But despite this continued focus on decarbonization, carbon removal is moving up on governments' green agendas[4]. And for good reason — it will likely be the main mechanism to achieve:

01 **Net Zero and interim targets in the short to medium-term,** where ambitions may exceed capability or capacity to directly decarbonize. This is particularly the case in harder-to-decarbonize industries where technologies may not be scientifically, politically or economically feasible or scalable.

02 **'Net Negative' emissions**[5] for countries and companies that have pledged more ambitious restorative strategies. These attempt to account for and reverse our historical impact on the climate by addressing the overall 'stock' of carbon that has built up in the atmosphere. Without human intervention, it is anticipated that the build-up of anthropogenic GHGs would take from 100 to 1,000 years to dissipate[6].

03 **'Natural' Net Zero —** relatedly, there is growing recognition that we will also need to address emissions released 'naturally' by the biosphere or geosphere, that are attributable to human-driven climate change. For example, extreme weather events can damage carbon sinks (such as mangrove forests), while other climate-related impacts (like ocean warming) can impact the productivity of these ecosystems in storing carbon[7].

Carbon emissions from wildfires in California exceeded state-based fossil fuel emissions by more than 25 percent in 2020[8].

[2] 'AR6 Climate Change 2021: The Physical Science Basis' (2021) IPCC [IPCC Report].
[3] Pledges generally refer to carbon dioxide, although emissions of methane, sulfur dioxide and nitrous oxide are also relevant contributors to climate change. 2050 targets align with IPCC recommendations. For more information, KPMG's Net Zero Readiness Index compares the progress of 32 countries towards Net Zero.
[4] For example, the EU Commission's Net Zero modelling includes nature and technology-based direct air capture, and the Horizon 2020 program funds large-scale carbon removal projects. 'Carbon Dioxide Removal Policy in the Making: Assessing Developments in 9 OECD Cases' (2021) Frontiers in Climate.
[5] 'Net Negative' emissions refers to the scenario when anthropogenic removals of CO_2 exceed total anthropogenic emissions. IPCC scenarios SSP1-1.9 and SPP1-2.6 presume varying levels of Net Negative emissions after Net Zero is achieved around or after 2050. It should be noted that the IPCC report suggests that even under scenarios of net negative emissions, it would take several centuries to millennia for some carbon-induced climate change effects to reverse (such as the global mean sea level).
[6] Depending on the type of GHG.
[7] 'Attenuation of sinking particulate organic carbon flux through the mesopelagic ocean' (2014) Proceedings of the National Academy of Sciences of the US.
[8] Global Fire Emissions Database; Mongabay.

"The full potential of carbon removal solutions is becoming very apparent to governments and the business community, and even at this early stage, institutional investor interest can be observed. We **are witnessing the beginnings of a new industry** that is likely to grow exponentially as the climate crisis becomes more real."

Mike Hayes, Global Head of Climate Change & Decarbonization, KPMG

With the urgency to take action growing, carbon removal technologies will likely become more important — particularly as the 'drop dead' timeframes of global warming scenarios draw nearer. Carbon removal will not only be essential to achieving carbon neutrality, but also any carbon negative and restorative strategies.

But these types of carbon removal are typically indirect. They involve:

The **removal of equivalent emissions from the atmosphere** (such as through direct air capture), rather than directly from the source of emissions (like in carbon capture, utilization and storage technologies);

Sometimes over significantly **different time horizons** from release to capture; and

Potentially undertaken by **different actors and industries, in different geographies** to the original emitters.

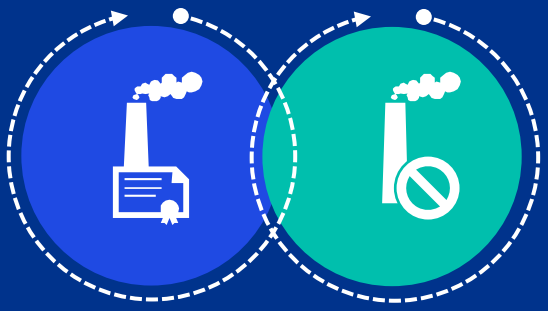
This means both a protocol for recognition and a market mechanism for exchange — between the carbon removalists and the emitters — is needed.

Allowances or offsets?

Carbon markets were created so that allowances and reductions could be traded between entities. There are two key market mechanisms, which provide companies (and countries and territories) the:

Permission to emit

a capped volume of GHGs, via carbon allowances issued under regulation (a 'cap-and-trade' emissions trading scheme [ETS]). Excess allowances (i.e.e missions permitted, but not released) can be sold to parties exceeding their quota to meet their own compliance obligations[9].



Ability to 'net out' emissions

by avoiding or reducing emissions elsewhere – i.e., the indirect mitigation of climate change via carbon offsets (also known as a baseline-and-credit ETS)

Offsetting can be regulated or voluntary. Carbon-intensive industries (such as energy and industrial manufacturing) may be caught by compliance markets, while all public, private and non-governmental organizations can 'opt-in' to reduce their 'net' emissions through voluntary offsets.

There is no globally consistent standard for determining the criteria of an offset. Compliance markets are determined by the regulating authority, while voluntary markets tend to be more flexible, are often cheaper as a result, and can address a broader range of environmental and social issues (such as climate adaptation, biodiversity or poverty). That said, offsetting methodologies generally agree[10] that these projects must:

01 Create a **real, verifiable** and **measurable** reduction in emissions, above and beyond what would have occurred if the offsetting project had not taken place[11];

02 Of **unique** and otherwise unclaimed tCO2e, with issues of double-counting avoided;

03 That is **permanent**, with the removed emissions not being released at a later date;

04 **Additional,** in that the project would not have occurred unless it was financially supported by the offset scheme; and

05 Without **leakage** (i.e. displacement) of emissions-inducing activities elsewhere.

Simplistically, **carbon allowances incentivize decarbonization by placing a 'cost' on direct emissions, while offsetting can act as the key mechanism to enable (indirect) carbon removal.**

Although by nearly any definition carbon reduction will need to remain the primary focus of Net Zero strategies. Carbon removal via offsets will be increasingly in demand over the coming decade and beyond, particularly as the interim target date of 2030 draws nearer.

Countries and companies without clear plans, the political and economic space to implement, or the ability to cost-effectively abate by other means, are likely to turn to offsets as a mechanism that allows these entities to 'net out' emissions in time to meet stricter interim targets.

Both voluntary and compliance offsets will be a critical complement to decarbonization strategies. There is already some fungibility between voluntary offset activities and compliance market obligations — for example, in Mexico and South Africa — but further international agreement is needed to efficiently coordinate emissions reduction outcomes at a global level.

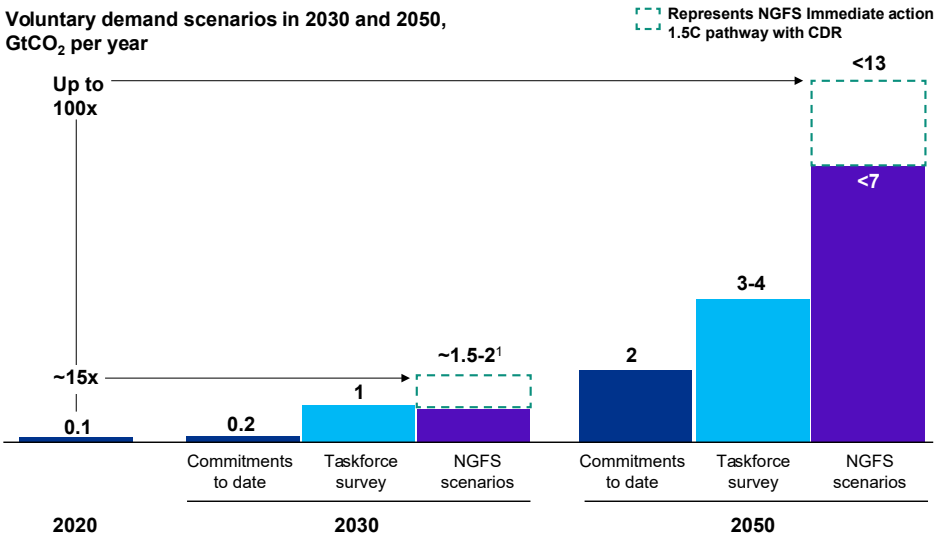
Anticipated changes to compliance markets stemming from COP26 negotiations may also place upwards pressure on demand. The introduction of an exchange mechanism under Article 6 of the Paris Agreement for 'excess reductions' by countries will financially incentivize these types of activities. Tighter rules around double-counting will likely also restrict supply in practice, increasing demand for carbon removal and reduction by the country hosting (but no longer counting) these offsetting projects, in order to meet their own targets.

[9] One carbon emission unit is equal to a tonne of carbon dioxide equivalents (tCO2e).
[10] In accordance with United Nations Framework Convention on Climate Change (UNFCCC) principles. Initiatives such as the Task force for Scaling Voluntary Carbon Markets (TSVCM) are also working to develop minimum quality standards by establishing Core Carbon Principles for the global voluntary market.
[11] To avoid creating perverse incentives (for example, commercial harvesting to then receive credits for 'additional' tree planting), the 'baseline scenario' may include a longer time horizon. For example, Gold Standard carbon credits for reforestation and afforestation requires an additional approval process for projects where the planting area was deforested within the previous decade.

Demand for carbon offsets will need to increase by a factor of at least 15 by 2030[12]

Voluntary carbon markets currently only represent 0.5 percent of the reductions pledged in Nationally Determined Contributions (NDCs) by 2030 — and only 0.2 percent of the reductions needed to limit the global temperature rise to 1.5 degrees.

The Taskforce on Scaling Voluntary Carbon Markets (TSVCM) has estimated that carbon offsets could grow in value to between **US$5 and US$50 billion by 2030.**



Analysis and visual from TSVCM Report; Network for Greening the Financial System (NGFS). Does not take into account the split of credits traded in compliance vs. voluntary markets, and does not include portions of removal / sequestration that will be funded by compliance markets and mechanisms other than offsets. Additional avoidance / reduction offsets (e.g. household appliances, avoided deforestation) are not included. Commitments to date: commitments of 700 companies and does not include likely growth. Taskforce survey: TSVCM projection of offset demand. NGFS scenarios: removal / sequestration for 1.5 and 2 degree scenarios.

eurasia group politics first

COP26: Achieving Net Zero in a G-Zero world[13]

Article 6 of the Paris Agreement is (theoretically) set to expand one of the world's most active compliance-driven carbon offset programs — the UN Clean Development Mechanism (CDM) covering signatories to the Kyoto Protocol. Renamed as the Sustainable Development Mechanism (SDM), the scheme would include projects beyond those undertaken in developing countries (Article 6.4), and would establish a related market to allow countries to sell 'excess' emissions reductions beyond their target (Internationally Transferred Mitigation Outcomes [ITMO] under Article 6.2).

In short, it would **allow countries to generate emission reductions abroad, to count against their domestic targets.** The appeal is that these efforts could be potentially more cost effective, and less politically and economically disruptive, than what could be achieved at home.

If landed, Article 6 will also address **double-counting** — when a single carbon emission reduction or removal is used more than once to achieve climate targets. This tends to occur when offsetting projects occur in a third country — i.e. Country A (where the project takes place) claims the reduction as part of their NDC under the Paris Agreement, but an organization is also claiming the reduction to offset its emissions in Country B (and potentially counting towards Country B's NDCs). Switzerland has already struck a bilateral carbon offsetting agreement with Peru; the resulting emissions cuts will only be counted against Switzerland's (Country B's) emissions targets. Voluntary markets are likely to mirror any agreement reached; the second largest offset program has already proposed that 'corresponding adjustments' should be made to the NDC of Country A.

But **these proposed changes require consensus at COP26 — and the prospects are not looking good**. Technical negotiations on the Paris 'rulebook' (that would see agreement on Article 6) have been fraught through the course of 2021, with limited progress made from where the last COP negotiations left off. Certain countries will continue to push for the legacy of the Kyoto Protocol to remain or for material wealth transfers to compensate those countries that stand to lose out on Kyoto-era credits. The stakes will only grow for these countries if the developed world continues to delay and dilute their climate finance commitments made as part of the Paris Agreement.

[12] 'Future Demand, Supply and Prices for Voluntary Carbon Credits' (2021) Trove Research and USL [Trove Report]; Final Report (2021) Taskforce on Scaling Voluntary Carbon Markets [TSVCM Report].
[13] Coined by Eurasia Group, it refers to a world with plenty of global leaders, but no real global leadership.

Avoidance or removal?

But the same speed of change required to decarbonize economies and meet interim 2030 targets will demand a more nuanced categorization of carbon offsets.

While not clearly defined as such in practice, offsets can be created from projects that:

Avoid

additional carbon emissions 'that otherwise would have been released', such as from land conversion and deforestation. These offsets can provide a revenue stream to support conservation, particularly for developing governments; for example, offset projects can provide financing for endangered national parks.

Reduce

carbon emissions from economic activity, for example by supporting the roll-out of renewable energy, cooking, or heating infrastructure that 'would not otherwise have gone ahead'.

Remove

carbon emissions from the atmosphere, through nature- and technology-based solutions (like afforestation and direct air capture).

While offset markets have a lot of runway left to grow, there is already an observable shift in the perceptions of governments, the public, and investors as to the credibility associated with company-level Net Zero commitments if they prioritize offset usage to be Paris-aligned.

Part of this backlash against the use of offsets as a climate change mitigation tool is to incentivize 'prevention' (i.e. direct decarbonization) over 'compensation' (i.e. indirect carbon avoidance, reduction and removal). For example, the EU has excluded the use of offsets from the world's largest ETS, to focus on domestic carbon reduction[14].

But much of this concern also stems from the continued complexity and lack of standardization in climate accounting — let alone the definition of 'Net Zero'. Some multinationals have already found themselves subject to media challenge around the legitimacy of Net Zero claims based on avoided emissions.

Offsetting relies on the creation of a baseline scenario — what would have happened, in the absence of the project. But even with this underlying principle of 'additionality', it can be argued that carbon avoidance offsets do not equate to a genuine reduction in, let alone removal of, direct emissions.

Although parallels can be drawn with carbon reduction offsets, these projects are distinct — although they similarly 'avoid' future emissions (such as through the degradation of a carbon sink), carbon avoidance offsets effectively are targeted towards prevention. These offsets tend to be the least expensive as they simply help maintain business-as-usual emissions — i.e. preventing backsliding — without progressing towards a target.

Without wading into the valid debate on how these mechanisms make conservation efforts more commercially competitive, they arguably cannot be used to 'net off' a company's or country's level of emissions to zero, as no reduction to current levels of emissions has been made.

Reflecting this, we are likely to see more informal (via investors, shareholders and stakeholders) and formal (via increasingly stringent policy) pressure for credible, 'genuine' indirect carbon reduction and removal solutions. Multinationals will likely become more discerning in their purchases of offsets — the laggards to avoid claims of 'greenwashing', and the leaders to progress towards Net Negative.

Despite limited availability currently, we expect that carbon removal will be the main beneficiary of this trend. The indirect nature of these projects is the very argument for its additionality — removing carbon that has already been released, directly from the atmosphere, 'owned' by no one.

Although direct decarbonization technologies will also benefit from market dynamics (such as the escalating price of carbon allowances), anticipated demand amidst already tight supply will likely drive up the price of these 'premium' carbon offsets, making these projects more economically viable and competitive.

[14] 'Use of international credits' (2021) European Commission.

Carbon removal projects could capture an outsized share of the growth in demand for offsets

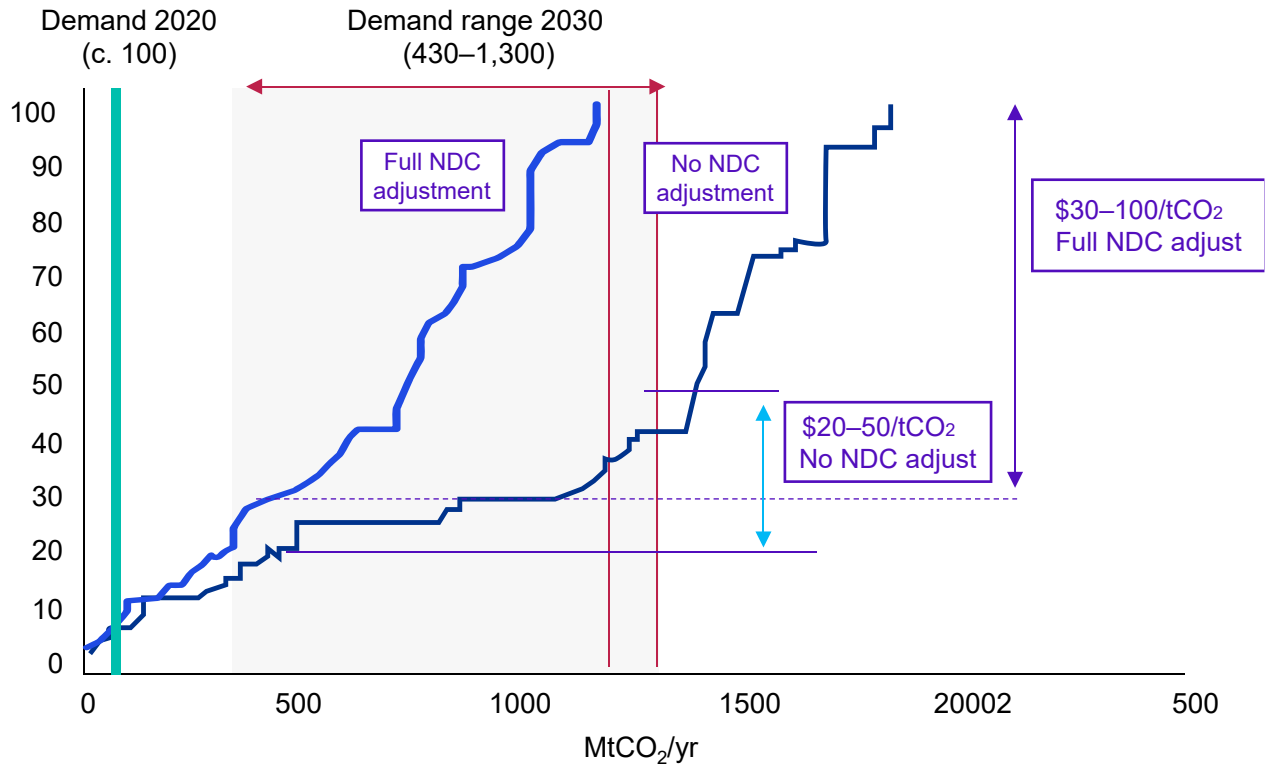
The broad increase in demand for offsets amidst tighter supply will place upwards pressure on prices, benefiting more expensive carbon removal projects. Price forecasting for carbon offsets is not simple: demand and prices vary depending on the 'type' of carbon offset offered and the co-benefits provided. But in general, following basic economic principles, as demand for offsets significantly escalates, prices will rise accordingly, until supply can catch up.

And supply may be a challenge, particularly in the medium-term. Globally, it has been estimated that we will need to remove 10 $GtCO_2$ per year by 2050 and 20 $GtCO_2$ per year by 2100[15]. But anticipated tightening of standards and a focus on higher environmental integrity has created some uncertainty over potential supply. The TSVCM has estimated the 'practical' supply of carbon credits at 8 to 12 $GtCO_2$ per year by 2030, but also indicated that it could be as low as 1 to 5 $GtCO_2$ per year by 2030 due to mobilization challenges.

COP26 negotiations will also influence both demand and supply dynamics; for example, if voluntary offsets can only be applied to projects that are additional to NDC commitments, prices should escalate further (estimated in the range of US$30 to US$100 per tCO_2).

Our prediction? Carbon removal projects will likely command the upper end of these estimates, given the 'quality' of their carbon removal potential.

Global voluntary carbon credit price projections



Average over period 2020-2050 ($/$tCO_2$, 2020 prices). Analysis and visual from Trove Report.

[15] 'Negative emissions technologies and reliable sequestration' (2019) The National Academies of Sciences, Engineering and Medicine.

Green or blue?

Nature-based solutions includea fforestation, restoration of natural carbon sinks (e.g.f orests, wetlands and peatlands), regenerative agriculture and soil carbon sequestration.

On the supply side, **the large majority of carbon removal offsets are 'onshore',** encompassing nature and technology solutions.

'Offshore' carbon projects have been limited, with very few 'blue' offsets verified and sold, and even less relating to carbon removal.

Only 970,000 blue credits (or 970,000 tCO_2e) have been issued by the largest voluntary carbon offset program, a market share of 0.0015%[16].

Technology-based solutions include direct air capture and storage, bioenergy with carbon capture and storage, and accelerated weathering of natural minerals.

Blue carbon ecosystems can be found along every coastline on every continent and can be included in national accounting reported to the United Nations Framework Convention on Climate Change (UNFCCC). Yet only a few countries have included blue carbon contributions in their NDC mitigation actions and priorities[17].

But this is changing. Unlike the Kyoto Protocol, the Paris Agreement formally recognized the role that oceanic ecosystems play in climate regulation and carbon sequestration. The IPCC's special report on the ocean and cryosphere advocated for the conservation and restoration of terrestrial and marine habitats as one of the most effective management measures to climate change mitigation. Blue carbon 'avoidance' projects are being developed under the Reducing Emissions through Deforestation and Forest Degradation (REDD+) program, while the world's largest voluntary carbon offset program has expanded its methodology to include tidal wetland and seagrass restoration.

Blue carbon offsets are uniquely placed to **address specific supply-side issues that arise from the 'onshore' nature** of current carbon removal projects.

01 Efficiency

Onshore carbon removal projects — particularly nature-based — take years to establish and tend to be significantly more expensive than other offsets. Oceanic resources are more efficient at capturing carbon than their terrestrial counterparts, both in terms of sequestration rates but also the time taken to scale to maximum potential. For example, seaweed (theoretically) requires little infrastructure, no fresh water or fertilizer, is fast growing and can sequester up to five times more CO_2 than land-based plants.

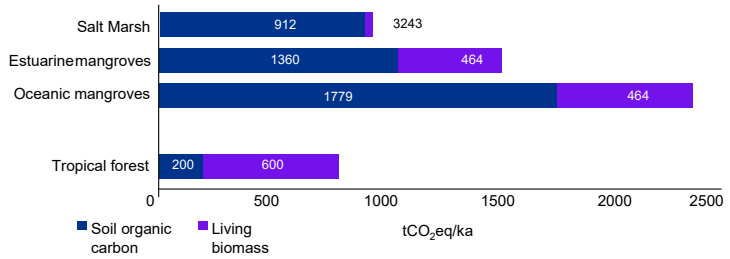
02 Permanence

Blue carbon habitats can sequester carbon underground for centuries to millenia, with largely negligible releases of other GHGs — compared to around 10 to 30 years in terrestrial soils[18]. Marine ecosystems are also resilient; they can cope with highly variable environments, with offset projects potentially less vulnerable to wildfire or storm damage than their terrestrial counterparts.

Oceanic resources can significantly outperform their terrestrial counterparts in carbon storage. Even accounting for the variability within these coastal ecosystems, sequestration rates are at least 2-4 times greater than mature tropical forests.

Only the top meter of soil is included in the soil carbon estimates. Source: 'Green Payments for Blue Carbon' (2011) Nicholas Institute Report.

Estimates for global average per hectare carbon storage



[16] 'Of a total 630 million tCO_2e that the program has reportedly reduced or removed from the atmosphere. Verified Carbon Standard' (2021) Verra; 'Why the Market for Blue Carbon Credits May Be Poised to Take Off' (2021) Yale Environment 360.
[17] Particularly beyond mangrove ecosystems. For example, Indonesia, Malaysia and the Philippines are among the few ASPAC countries that explicitly have established blue carbon strategies and policies. 'Incorporating blue carbon into Nationally Determined Contributions' (2019) CIFOR.
[18] 'Manual for the Creation of Blue Carbon Projects in Europe and the Mediterranean' (2021) IUCN; 'Terrestrial carbon sequestration' (2011) US EPA.

03 Co-benefits

As mentioned previously, many voluntary offsets offer broader social and environmental 'benefits' alongside carbon reduction. Improved biodiversity related to blue carbon removal projects has the potential to contribute to broader ocean health and climate regulation (such as temperature regulation, sequestration productivity and coastal protection). Unlike forests, which may compete with food supply, blue carbon projects can also enhance food web productivity, as well as food and economic security for developing nations.

04 Capacity and economic competition

Nature-based solutions are currently the most cost-effective and widely available carbon removal options. But onshore projects face greater conflict of use and capacity constraints, particularly when located in primary-producer or densely populated nations.

Onshore solutions, particularly nature-based, are also highly dependent on private sector involvement and the comparative 'opportunity cost' of commercial activities. Governments arguably have greater control over the allocation of oceanic resources, having retained 'ownership', merely 'leasing' them to key economic interests: fishing; aquaculture; shipping; tourism; and ports. This control also helps prevent leakage: where emissions aren't reduced in practice but are displaced elsewhere.

Although socioeconomic considerations need to be balanced, there is significant capacity to expand nature-based carbon removal solutions in sovereign seas. This is particularly the case for small island developing states (SIDS), where oceanic jurisdiction tends to outsize corresponding land mass.

Blue carbon removal offsets could provide an alternate revenue stream for the public and private sector in ocean-based developing nations, particularly in light of potential ITMO arrangements to be discussed at COP26. Offsetting would allow marine restoration to be more commercially competitive with common causes of degradation, and this could be further enhanced through the sale of blue carbon by-products such as animal feed or fuel. This will however, differ on a locational basis and capacity will likely be capped in the face of more lucrative activities such as tourism, ports and shipping.

Untapped blue wealth

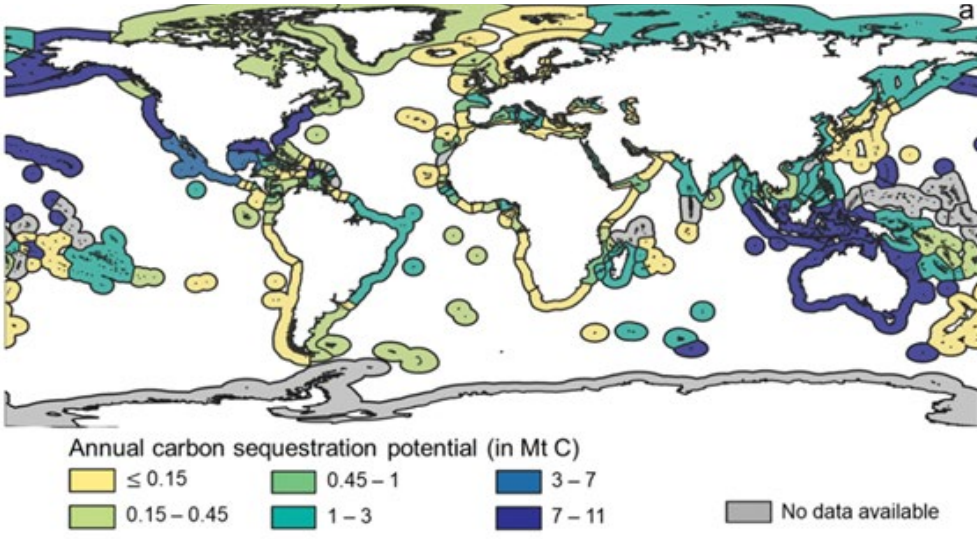
Only 7.6 percent of the oceans globally (roughly 18 percent of sovereign seas and 1 percent of international waters) are protected, compared to 14.9 percent of land[19]. Representing 55 member countries and led by the UK, the Global Ocean Alliance is seeking to grow marine protected areas to 30 percent by 2030, covering both national and international waters.

Australia topped recent research as the most 'wealthy' in blue carbon — estimated at US$25 billion annually, with a net contribution of US$22 billion per year to the rest of the world[20].

The research also estimated that blue carbon sequestration exceeds emissions for a number of small developing nations.

The potential introduction of ITMOs under Article 6 would mean that these governments could partner with landlocked countries on blue carbon removal projects — offering a potentially lucrative revenue stream while helping developed countries achieve their climate targets.

Average annual blue carbon sequestration potential



Shading indicates size of the potential. Visual and analysis by Nature Climate Change.

[19] UN World Database on Marine Protected Areas.
[20] 'The blue carbon wealth of nations' (2021) Nature Climate Change.

Blue carbon removal

Blue carbon removal solutions tend to focus on coastal and shallow water ecosystems, however is expanding to include deep water biological and geological sequestration and storage.

Mangrove forests

Estimated carbon stock: 738.9 Mg C / hectare
Sequestration rate: 179.6 g C / sq. m / year

Occurring in intertidal zones of tropical and subtropical countries, mangrove forest restoration and revegetation is the most common and 'shovel ready' type of blue carbon offsetting project to date, reflecting its inclusion in 'onshore' carbon offsetting methodologies and verification processes[21].

Example projects include reforestation and restoration projects in Tanzania, Kenya, Mozambique, Gambia, Senegal, Guinea Biassaau and Guinea. Private companies have also announced similar projects in partnership with conservation agencies, although few have focused on restoration and carbon removal (rather than avoidance)[22].

Seagrass meadows[24]

Estimated carbon stock: 51 ± 7 Mg C / hectare
Sequestration rate: 23.2 ± 3.2 g C / sq. m / year[24]

Seagrass can be found in all continental coastal waters but is one of the most threatened ecosystems: nearly 30% has already been lost globally. These meadows only occupy 0.1% of the ocean's surface but store up to 18% of the carbon sequestered by the ocean — twice the amount of carbon per hectare as terrestrial soils.

Whilst the potential of seagrass is well-recognized, progress has been limited to date as the first fully 'offshore' carbon removal solution. However, certification standards are expanding to explicitly extend to the afforestation, reforestation and conservation of seagrass meadows. A US-based seagrass restoration project was the first in the world to apply for carbon offset certification earlier this year.

Tidal and salt marshes[23]

Estimated carbon stock: 53.8 to 94.9 Mg C / hectare
Sequestration rate: 146 ± 102 g C / sq. m / year

These ecosystems occur in sheltered coastlines across Europe, America, Australia, and the northern parts of South America and Africa. Tidal marshes are highly efficient at carbon removal: organic carbon is accumulated in the soil at rates up to 55 times faster than tropical rainforests and are stored for millennial timescales. Excluding co-benefits such as coastal protection and enhanced biodiversity, the annual sequestration of 1.4 million hectares of tidal marshes in Australia alone (representing a quarter of global salt marshes) has been valued at US$ 28 million per annum.

Geological carbon storage[25]

Carbon storage potential can be enhanced through manipulation of soil and sediments, such as the creation of the necessary (and natural) hydrological or salinity conditions. Adding alkalinity (such as silicate minerals or carbonate) can help store carbon as dissolved solid minerals and increase the productivity of the natural carbon cycle of the oceans.

Similarly, researchers are proposing to capture CO_2 from seawater and transform it into solid minerals. Others have developed technology to remove CO_2 from the ocean surface and store it underground.

Biological carbon cycles

Hybrid geological storage opportunities mirror oceanic carbon removal by both marine plants and animals. For example, marine organisms such as shellfish can remove CO_2 and store as solid minerals. Enhancement of the ocean's (natural) biological pump is similarly being explored.

However, some other forms of ocean-based carbon sequestration, such as oyster and seaweed farming, tend to be utilized for more lucrative carbon reduction and avoidance purposes, rather than carbon removal. For example, seaweed can be used as a low-carbon protein, animal feed (which also reduces the release of methane), as a biofuel, in cosmetics, fashion, pharmaceuticals and as a plastic replacement.

[21] Where a country has defined 'forests' as including mangroves. Carbon removal and storage rates: 'Global Significance of Mangrove Blue Carbon in Climate Change Mitigation' (2020) Sci.
[22] Apple has created a USD200 million fund for mangrove carbon credits that aims to remove at least 1 million tCO_2e annually.
[23] 'Canadian estimate. 'Carbon Stocks and Accumulation Rates in Salt Marshes of the Pacific Coast of Canada' (2018) Biogeosciences; 'A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habits in sequestering CO_2' (2011) Frontiers in Ecology and the Environment; 'Carbon sequestration by Australian tide marshes' (2017) Scientific Reports.
[24] 'What is Blue Carbon (2021)' US National Oceanic and Atmospheric Administration; Frontiers in Ecology and the Environment. Contribution of Seagrass Blue Carbon Toward Carbon Neutral Policies in a Touristic and Environmentally-Friendly Island' (2020) Frontiers in Marine Science.
[25] 'Could the ocean hold the key to reducing carbon dioxide in the atmosphere?' (2021) UCLA; 'Unlocking Blue Carbon Offsets' (2021) Cleantech Group.

Private or public?

Blue carbon projects have the potential to become a more efficient, scaleable and economically attractive option than their terrestrial counterparts.

Private sector investment will be essential to ensuring the blue carbon market reaches its full environmental and economic potential. **But by nature, offshore carbon removal solutions will be highly dependent on governments.** The right policy frameworks are required to accelerate the development of blue offsets for both compliance and voluntary markets.

01 Ambition

Like the ocean itself, the biggest barrier to blue carbon removal to date is that it is unmapped, unobserved and unexplored. In the past, standards and approaches to blue carbon removal were comparatively uncertain or inconsistent. However, in recent years, as our understanding of methodologies and side effects have progressed, the bigger challenge has stemmed from a lack of awareness of blue carbon solutions.

Governments with coastlines have an obligation to explicitly include these ecosystems in GHG inventories. **Inclusion of blue carbon mitigation strategies and policies as part of NDCs will drive market awareness, signals and investment.** This will also support continued conservation and efforts to address less sustainable activities undertaken by maritime industries — and avoid any unintended consequences from a shift away from carbon avoidance towards carbon removal solutions.

The Philippines has established a Blue Carbon Steering Committee and Technical Working Group. Australia has included coastal wetlands in its commitment to lower CO_2 emissions to 28 percent below 2005 levels by 2030;

BHP recently committed US$2.4 million to a research program that, in part, will measure and quantify coastal blue carbon potential that could be implemented through Australia's Emissions Reduction Fund.

02 Regulation

The second biggest barrier to blue carbon offsets is measurability and integrity. Sequestration and storage can differ significantly between locations and over time. Exogenous and endogenous factors influence the uptake of carbon within these ecosystems, including: habitat type; plant species; nutrient supply; sediment; climactic conditions; and water depth.

Climate change is also impacting the potential of these ecosystems, but not always in a clear way. For example, plants can be more productive in higher CO_2 levels and warmer temperatures, but this can also increase decay rates, making it difficult to isolate the 'additive' nature of interventions.

It is only comparatively recently that attempts have been made to quantify the carbon storage potential of a broad range of marine habitats. Although robust methodologies to monitor and measure blue carbon sequestration and storage exist, there is no globally accepted method, and few relate specifically to blue carbon or encompass the full breadth of its potential[26].

Carbon accounting frameworks need to be updated to better facilitate the inclusion of blue carbon removal solutions. Governments can support further research and the development of relevant methodologies for blue offset certification. Greater fungibility in blue offset solutions — presuming rigorous certification processes — between voluntary and compliance markets should also encourage their use.

03 Asset management

Most blue carbon projects are undertaken in sovereign waters, meaning companies are highly dependent on the public sector to undertake exploratory projects. **As the primary 'blue asset owner', governments can help develop blue carbon removal** by setting aside protected areas and creating clear criteria to incentivize licensing or lease arrangements for these activities.

Any potential social and economic impacts on local communities should be taken into consideration — including the upside. Governments have an opportunity to create downstream benefits relating to blue carbon opportunities, including for existing industries such as sustainable fishing.

Innovative models to insure these assets will also be important, particularly to protect nature-based solutions against the risk of loss from climate-related events.

Of course, nearly two-thirds of the oceans lie beyond national jurisdiction — representing 95 percent of the world's total habitat. The full potential of blue carbon

[26] Existing methodologies in the voluntary carbon offset market include (but are not limited to): CDM's AR-AM0014 "Afforestation and reforestation of degraded mangrove habitats"; CDM's AR-AMS0003 "Simplified baseline and monitoring methodology for small scale CDM afforestation and reforestation project activities implemented on wetlands"; Gold Standard's "Afforestation/Reforestation (A/R) GHG Emissions Reduction & Sequestration Methodology"; VCS's VM0033 "Tidal Wetland and Seagrass Restoration"; VCS's VM0007 "REDD+ Methodology Framework (REDD+MF)"; VCS's "VM0024 Methodology for Coastal Wetland Creation".

removal projects has not been — and is unlikely to be - fully explored. The few international frameworks governing the oceans do not contemplate the concept of carbon removal, although at the time of writing, a new treaty under the UN Convention on the Law of the Seas (UNCLOS) was in the final stages of negotiation.

It will establish a global framework to conserve and manage biodiversity in areas beyond national jurisdiction, as part of a push to designate 30% of the oceans as protected habitats by 2030. Although it remains unlikely that some blue carbon potential (such as the role of whales) will ever be truly a viable offset option, this is an encouraging step forwards in the sustainable management of a global common, and in the longer-term, may help enable transnational, nature-based carbon removal projects in the high seas.

04 Capacity building

What works well in one climatic zone may not be as effective in another. The application of these methodologies will also rely on relevant technical infrastructure and expertise, which creates a further challenge particularly for developing nations that may not have regional carbon storage and sequestration data.

Governments can play a key role in the development of collaborative platforms and alliances to share knowledge and rapidly promote the development of the blue carbon industry. For example, the creation of regional partnerships, particularly between SIDS, could allow for the mapping of blue carbon and collection of data, such as the Pacific Blue Carbon Initiative funded by Australia.

As already noted, nature-based blue carbon removal in particular offers a significant opportunity to create jobs for local communities, particularly in developing nations. Governments could provide funding and support to upskill local communities in blue carbon management as an economic development mechanism. Being a market maker for these emerging industries would reinforce the broader agenda of many governments, as they support their economies to emerge from the COVID-19 pandemic with new and sustainable avenues to prosperity.

05 Financing

As with many marine activities, the biodiversity impact of technology-based solutions (and the unintended consequences of nature-based solutions) on fragile ecosystems must be understood before scaling solutions. Blue carbon would benefit from: core research in marine biology and ecosystems; applied research to develop carbon removal solutions; innovation for commercial benefit; and production and full-scale roll-out.

All of these stages have different risk, capital and development needs. Although blue carbon is distinct in many ways from onshore solutions, there are parallel learnings that can be applied in the oceanic context. There is a high first-mover price for quality carbon removal, and most offshore projects are at an even earlier stage than onshore options — few projects are at a commercial stage, with only a few providers in the market.

The current market value of the carbon sequestered is unlikely to fund the development of a restoration project on its own — and there is the risk that necessary policy frameworks will not mature in the short time we have left to take radical action.

Blended finance may be required to kickstart the blue carbon market. In recognition that capital is needed for research and pilot testing, early-stage investors tend to include charities and governments funding research for high-quality nature-based solutions. For example, the Namibia Infrastructure Development and Investment Fund invested in a series of kelp farms off the coast.

The sale on voluntary carbon markets to ensure valuation of 'co-benefits' (beyond carbon removal) can also make these projects more commercially attractive. Similarly, the creation of dual revenue streams — for example, by investing in seagrass both to generate carbon offsets but also to transform the waste into bioethanol — could improve returns until offset prices escalate.

One Planet, one Economy

Blue carbon offsets are not the panacea to climate change mitigation, nor will they ever displace the need for zero-carbon technologies that don't just rely on the natural environment. There is even the potential that a continued reliance on offsets — even those relating to carbon removal — could have the unintended effect of providing political coverage to governments to continue to delay or avoid reducing their own emissions.

But the scientific reality is such that we must progress multiple approaches at speed and scale to achieve global reduction ambitions. And the **blue carbon wealth of many countries remains an untapped and highly valuable resource in the fight against climate change** — and will only become more important in coming years as the capabilities and capacity of terrestrial solutions stall. To access this wealth, governments need to lead on the development of the blue carbon market — and quickly.

How KPMG can help

KPMG firms have deep experience in supporting organizations to establish their blue economy strategy. KPMG professionals can help organizations integrate blue economy considerations within their corporate and climate strategies. We assist organizations with identifying and accessing funding for blue economy related investments and projects, aligning and reporting against the evolving TNFD, supporting and developing energy transition to integrate blue energy sources, and supporting ways to protect and promote the social aspects of the blue economy. Our coastal and marine sector specific service offering provides expertise in climate scenario planning and assessment with additional focus on the management of fresh-water assets and infrastructure. This includes additional support with the planning and collection, monitoring, and interpretation of water use using propriety data analytics.

About the KPMG and Eurasia Group Alliance

KPMG International has formed an alliance with Eurasia Group, one of the world's leading global political risk research and consulting firms, to develop solutions that help businesses deal with geopolitical challenges. Through our alliance, KPMG professionals can bring the political insights of Eurasia Group's analysts across 100+ countries and territories together with KPMG firms' nuts and bolts understanding of your business covering the macro to the most granular of analysis.

Authors/contributors

Josh Hasdell
Senior Manager
KPMG in Canada

Sarah Nelson
Associate Director,
Climate Risk and Strategy
KPMG in the UK

Orlaith Delargy
Associate Director
KPMG in Ireland

Carolin Leeshaa
Natural Capital & Biodiversity
Global Lead
KPMG International

Shari Friedman
Managing Director, Climate and Sustainability
Eurasia Group

Contacts

Mike Hayes
Climate Change and Decarbonization Leader, Global Head of Renewable Energy
KPMG International

David Greenhall
Global Managing Director
KPMG International

Rob Fisher
Partner
KPMG in the US

Simon Nicholas
Partner
KPMG Crown Dependencies

Michael Quigley
Manager
KPMG in the UK

Some or all of the services described herein may not be permissible for KPMG audit clients and their affiliates or related entities.

kpmg.com/socialmedia

Designed by Evalueserve.

Publication name: The (blue) wealth of nations

Publication number: 138797B-G

Publication date: June 2023