Insights Forum™

Unlocking the Full Potential in Carbon Markets:

Pathways to Growth and Sustainability in Asia

GFTN Global Finance & Technology Network + green circle + BCG | SOUTHEAST ASIA Center for Climate & Sustainability

Foreword

As the global urgency to combat climate change intensifies, carbon markets are becoming a critical tool for driving meaningful progress toward net-zero goals. At BCG, we have long believed in the power of bold, scalable solutions to address humanity's greatest challenges. Carbon markets represent a critical opportunity to align innovation, finance, and policy to transform the way we mitigate and remove carbon emissions.

Asia's resources and technological potential position it as a leader in this transformation, from advancing nature-based solutions to pioneering engineered technologies. Singapore's role as a regulatory and financial hub highlights the importance of cross-border collaboration in creating robust, inclusive markets.

This report is a roadmap for action—highlighting the supply, demand, and market structures required to unlock carbon markets' full potential. It also reflects the collective insights from leaders, innovators, and policymakers committed to making climate solutions actionable. By building trust, transparency, and scalability, we can create a thriving ecosystem that delivers economic and environmental benefits.

Rich Lesser
Global Chair, Boston Consulting Group

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1. Carbon Dioxide Removals

Introduction & key design thinking outcomes

The Green Circle Climate Forum, held during the Insights Forum 2024, convened global leaders to address the critical role of durable carbon dioxide removal (CDR) in achieving net-zero emissions.

The Intergovernmental Panel on Climate Change (IPCC) emphasizes that CDR is essential to counterbalance hard-to-abate residual emissions, featuring prominently in all 1.5°C and 2.0°C-aligned scenarios.

Despite the urgency, the current pace of CDR deployment is insufficient. BCG's projections indicate that by 2050, between six and ten gigatons of residual CO_2 emissions will remain unabated globally.

Asia, with its abundant carbon sinks and resources, is poised to play a pivotal role in scaling CDR solutions. Singapore, in particular, has the potential to become a central hub for facilitating global carbon markets.

This report distils key insights from the Forum, outlining strategies to accelerate durable CDR and advance global decarbonization efforts.

Design thinking suggestions

Supply-Side

Scaling Local Carbon Removal Projects

Enhance capacity-building for local stakeholders to support sustainable and scalable carbon removal initiatives. Foster the growth of both nature-based solutions and engineered solutions by addressing barriers such as costs, technical expertise, and feedstock availability.

Standardize High-Quality Credits

Establish unified frameworks for carbon credit evaluation, ensuring credibility and integrating co-benefits like biodiversity and community impact.

Demand-Side

Strengthen Regulatory Mandates and Buyer Coalitions

Governments can consider integrating carbon credits into compliance markets and establish mandates for hard-to-abate sectors. Facilitate long-term offtake agreements and buyer coalitions to provide predictable demand.

Promote Co-Benefits to Drive Market Adoption

Highlight the additional value of credits that deliver biodiversity, social impact, and community welfare benefits. Encourage corporate and public adoption by incentivizing credits that align with SDGs and ESG frameworks.

Market Structures

Build Trading Infrastructure for Liquidity and Transparency

Develop exchange platforms and consistent quality standards to facilitate trading and price discovery for carbon credits. Create mechanisms to address counterparty risks and foster market confidence through rigorous monitoring and verification systems.

Leverage Blended Financing Models to De-Risk Investments

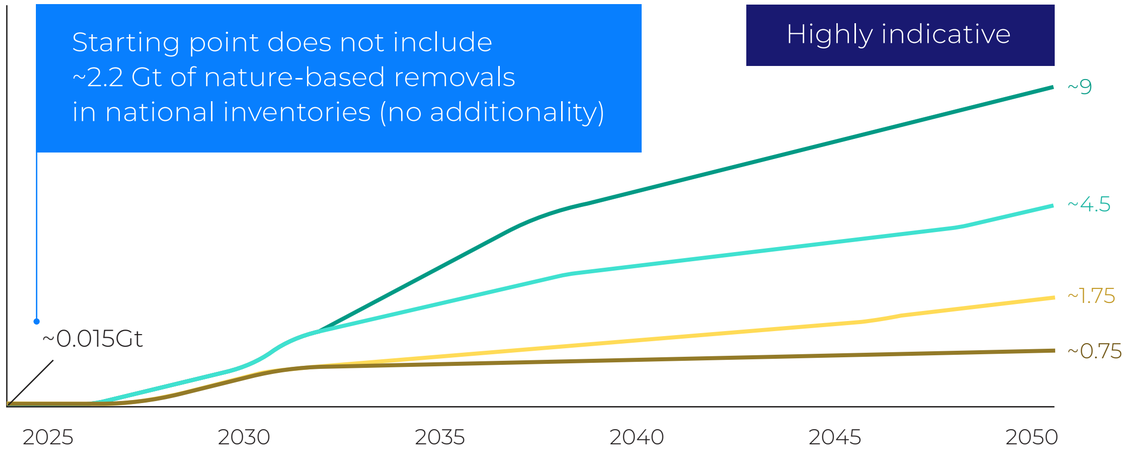
Public and philanthropic funds must absorb early-stage risks, paving the way for private investment.

Singapore as a Global Hub

Singapore's reputation for regulatory excellence positions it to lead the development of a global marketplace for carbon removal credits, furthering collaboration between regions and technologies.

CDR essential in all climate scenarios

Required global CDR volume under different scenarios ($GtCO_2$ p.a., 2023-50)



Current trajectory
Current trajectory based on current commitments and pledges

Current NDCs & long-term targets
Based on 111 NDCs (2030) and all long-term strategies for 2050 up to Nov. 23 (COP28)[3]

Below 2°C-compatible removal pathway
Median annual CDR deployment in 2050 in IPCC AR6 below 2°C-compatible pathways[2]

1.5°C-compatible removal pathway
Median annual CDR deployment at Net Zero in IPCC AR6 1.5°C-compatible and high overshoot pathways[1]

1. Ruben Prütz et al: Analysis of 83 1.5°C compatible and high overshoot IPCC AR6 WGIII pathways
2. Lamb et al: Analysis of scenarios in categories C1 and C3 of IPCC AR6 scenario database
3. Lamb et al.; Includes assumption that countries without a quantifiable strategy preserve their current levels of conventional CDR on land

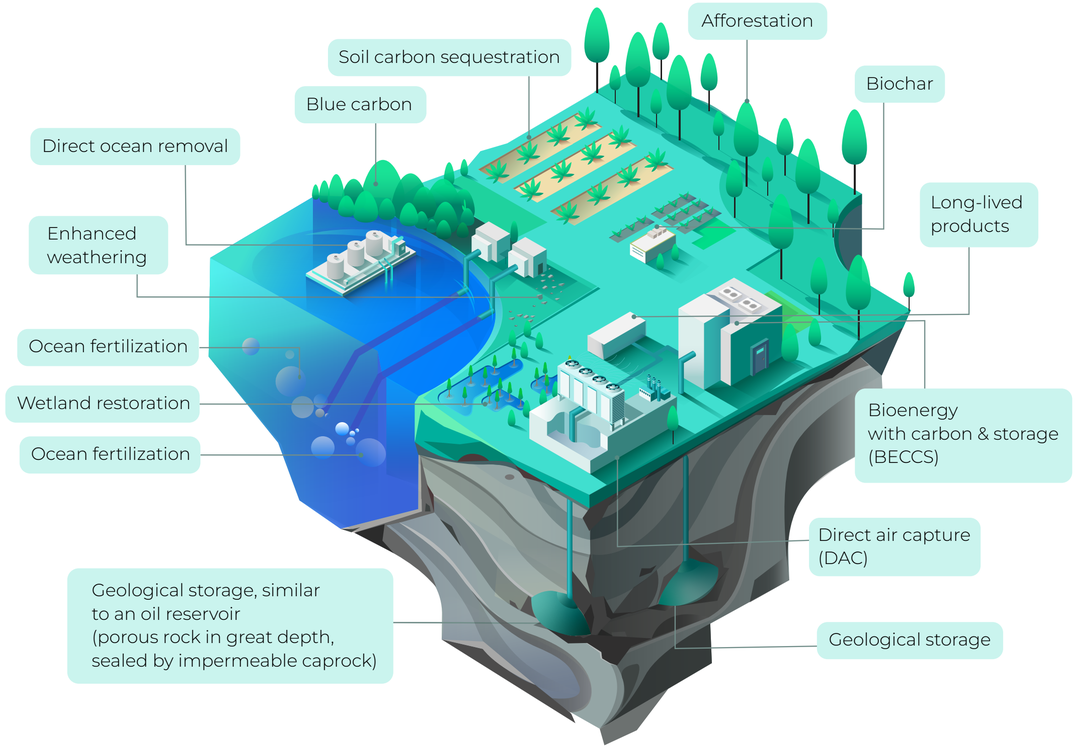
Note: Variance of CDR volumes in IPCC AR6 pathways is very high, indicating diverging beliefs in degree of emission reduction
Source: IPCC AR6 WGIII Chapter 12; Ruben Prütz et al 2023 Environ.
Res. Commun.; William F. Lamb, et al. 2024 Nature Climate Change; IEA Net Zero Roadmap; BCG CDR Market Model

CDR is critical for achieving net-zero emissions, particularly in addressing residual emissions from hard-to-abate sectors. The global carbon market plays a key role in scaling CDR by establishing standards and mechanisms for generating, purchasing, and trading carbon credits. The recent adoption of standards under Article 6 of the Paris Agreement at COP29 highlights efforts to ensure emissions reductions are credible, transparent, and verified.

Carbon markets enable financial flows from emitters to abatement and removal projects through mechanisms like carbon credits, relying on robust infrastructure including standards, accreditation, and risk management.

Compliance markets, nearing $1 trillion in value, are driven by regulatory requirements, while voluntary markets are expanding as companies and individuals aim to reduce their carbon footprints. Nature-based solutions like reforestation are gaining momentum for their sustainability and credibility, while engineered solutions are poised for growth as technology advances.

The carbon removal landscape spans across nature-based, hybrid, & technological solutions



NATURE-BASED SOLUTIONS

Nature-Based Removals

Afforestation, reforestation, improved forest management
Planting forests & restoring existing ones to absorb CO_2 via photosynthesis (incl. durable wood products[1])

Soil carbon sequestration
Implementing agricultural practices that enhance the capacity of soils to hold carbon

Peatland and wetland restoration
Restoring peat- & wetlands to their natural state to enhance their ability to store carbon

Blue carbon management
Conserving & restoring coastal / marine ecosystems, like mangroves, salt marshes, and seagrasses

ENGINEERED SOLUTIONS

Enhanced Natural Processes (hybrid)

Enhanced (rock) weathering
Spreading finely ground silicate rocks over large areas to chemically react with CO_2 and form stable minerals

Biochar carbon removal
Converting biomass residues or other biogenic material into a stable form of carbon, which is used to enhance soils or used in durable products, e.g., asphalt or cement

Ocean / river alkalinity enhancement
Adding minerals to oceans / rivers to increase alkalinity and enhance the water's capacity to absorb CO_2

Ocean fertilization[2]
Adding nutrients to oceans to boost phytoplankton growth (which absorbs CO_2 via photosynthesis)

Technology-Based Removals

DAC (Direct Air Capture)
Capturing CO_2 directly from the atmosphere and storing it underground or using it in durable products[1]

BECCS (Bioenergy with carbon capture and storage)[3]
Producing energy or methane from biomass, capturing & storing CO_2 or using it in durable products[1]

Bio-oil injection
Converting biomass into bio-oil and injecting it into geological underground formations

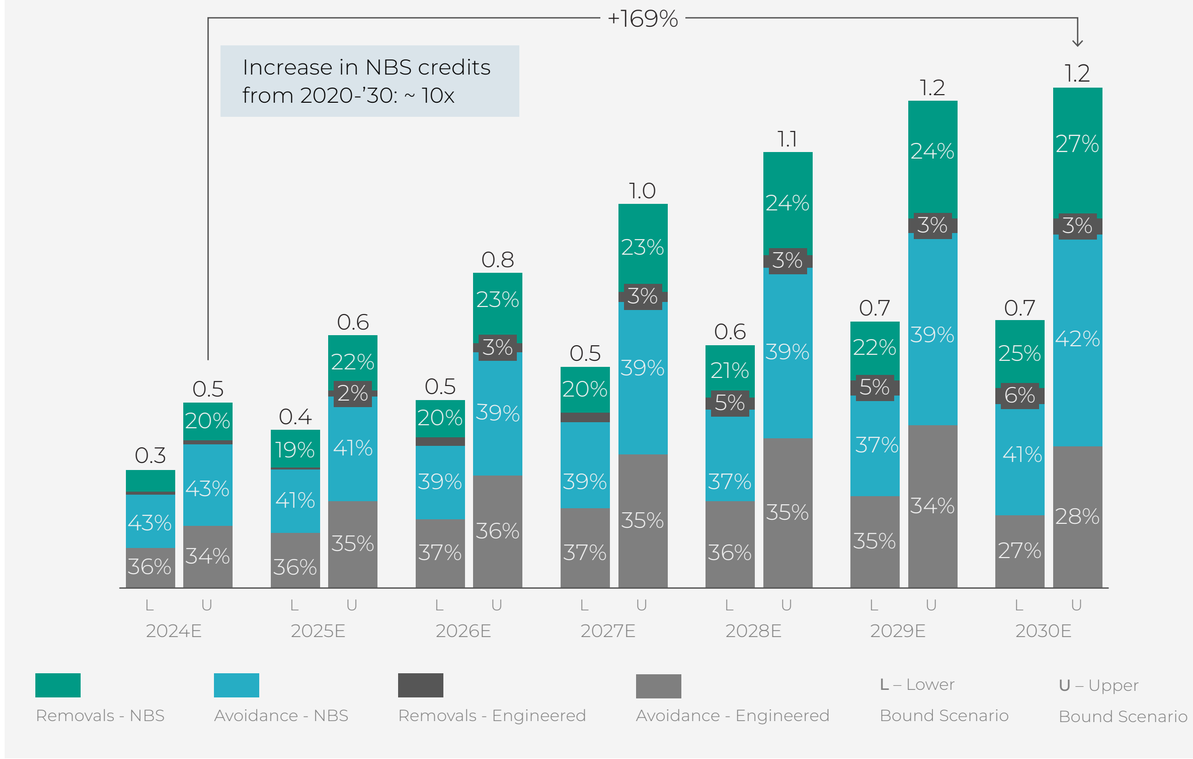
Direct ocean removal[4]
Energy-powered carbon removal directly from ocean using membrane and electrodialysis technology

1. Durable wood products and mineral products considered as separate CDR methods in other reports – subsumed under use phase of respective CDR methods in this report
2. Includes artificial upwelling
3. The currently emerging broader term "Bio-CCS" includes a variety of implementation options not solely related to capturing CO_2 in energy production – in this study, we use BECCS and subsume Waste-to-energy plants (WACCS) with subsequent CCS and biogas producing facilities with CO_2 capturing, liquefaction and storage
4. Includes Direct Ocean Capture and Electrochemical Ocean Removal

Source: Swiss RE, IPCC; Expert interviews; BCG analysis

Removals are likely to gain share of overall market: Nature-based solutions are growing fastest in near-term

Carbon offsets supply ($GtCO_2$-e pa)



1. Actual 2. Sustainable development goals.

Note: Hybrid credits are split equally between respective categories (e.g., Increased Forest Management)

Source: Registries (Gold Standard, ACR, CAR); CORSIA; IMO; IEA; CDP; Company commitments; ICAP; Fraunhofer ISI; BCG analysis

Nature-based solutions (NBS) and engineered solutions are advancing together to drive global carbon removal efforts, with Asia playing a pivotal role in scaling both approaches.

Engineered solutions, such as Direct Air Carbon Capture (DAC) and Bioenergy with Carbon Capture and Storage (BECCS) and enhanced natural process solutions like Biochar Carbon Removal and Enhanced Rock Weathering are gaining traction as technological maturity improves and costs decline. DAC costs, for instance, are currently around $500 per ton of CO_2 removed, with expectations of significant reductions up to $100 per ton as the technology scales. Despite these advances, challenges related to scalability and measurement persist.

Meanwhile, NBS, including afforestation, reforestation, and wetland restoration, are growing at the fastest rate due to their alignment with sustainable development goals, cost efficiency (ranging from $5 to $1000 per ton for projects like afforestation), and widespread acceptance.

Asia accounts for 45% of global carbon credits issued, with NBS expected to deliver a tenfold increase in credit generation by 2030. Engineered solutions are projected to gain traction beyond 2030 as technological hurdles are addressed.

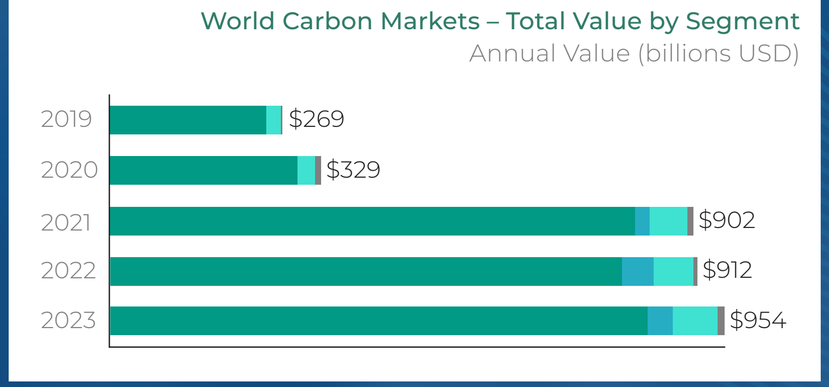
National & state carbon markets are creating a material price for carbon

Globally, emissions trading systems (ETS) and carbon taxes are being implemented across nations, creating a material price for carbon. Asia is positioned as a key supplier of quality carbon credits, reflecting increasing regional efforts in the carbon market landscape.

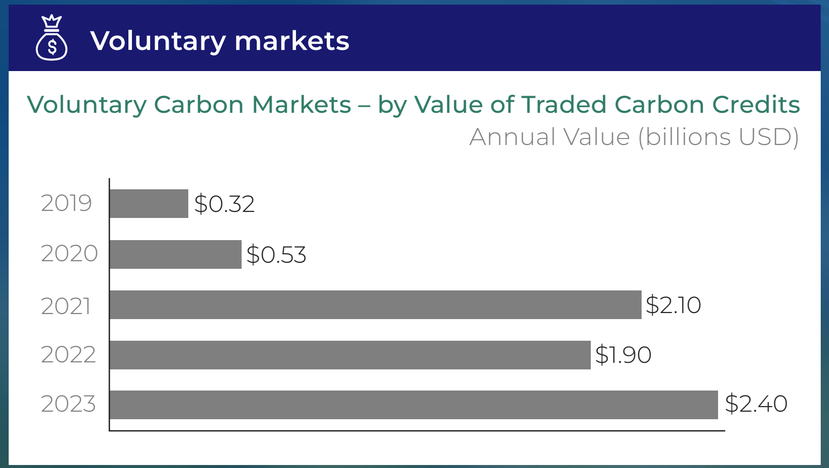
However, as of December 2024, voluntary markets face challenges of oversupply, although retirements of credits are showing signs of recovery. Industry coalitions and sector-specific commitments are emerging trends likely to enhance market demand and standardization.

Singapore has emerged as a leader in the region's carbon ecosystem, exemplified by its bilateral collaborations with 19 countries announced at COP29. These agreements aim to facilitate cross-border carbon credit trading while maintaining rigorous standards for transparency & sustainability. Singapore's Climate Impact X (CIX) supports this role by providing a platform for high-quality voluntary carbon credit trading, with the potential to handle credits from DAC and BECCS as they mature.

Compliance markets



Voluntary markets



1. ETS also under consideration in Colombia, Mexico, Ukraine

Sources: World Bank (2024), LSEG Carbon Market year in review 2023, BCG Analysis, WRI

National & local carbon markets are creating a material price for carbon

ETS and carbon tax implemented or scheduled

- Suriname
- Portugal
- Spain
- France
- Switzerland
- Iceland
- Ireland
- United Kingdom
- Netherlands
- Denmark
- Norway
- Sweden
- Finland
- Poland
- Estonia
- Latvia
- Svalbard
- British Columbia
- Manitoba
- Nunavut
- Yukon
- Baja California Sur
- Baja California
- Sonora
- Chihuahua
- Coahuila
- Quintana Roo
- Campeche
- Tobasco
- Chiapas
- Veracruz
- Oaxaca

ETS implemented or scheduled implementation

- Belgium
- Germany
- Czechia
- Austria
- Slovakia
- Hungary
- Slovenia
- Croatia
- Italy
- Greece
- Bulgaria
- Romania
- Lithuania
- Kazakhstan
- Mainland China
- South Korea
- Indonesia
- Papua New Guinea
- Australia
- New Zealand
- Washington
- California
- Alberta
- Saskatchewan
- Ontario
- Quebec
- Newfoundland and Labrador
- Prince Edward Island
- Nova Scotia
- Maine
- Vermont
- New Hampshire
- Massachusetts
- New York
- Ottawa
- Toronto
- Pennsylvania

Carbon tax implemented or scheduled[1]

- Colombia
- Uruguay
- Argentina
- Chile
- South Africa
- Albania
- Ukraine
- Japan
- Northwest Territories
- Yucatan

ETS or carbon tax under consideration

- Oregon
- Wyoming
- Brazil
- Paraguay
- Mauritania
- Morocco
- Senegal
- Côte d'Ivoire
- Kenya
- Botswana
- Turkey
- Pakistan
- India
- Bangladesh
- Bhutan
- Thailand
- Vietnam
- Malaysia
- Philippines
- Jalisco
- Colima

1. ETS also under consideration in Colombia, Mexico, Ukraine, **Source:** World Bank (2024), BCG Analysis, WRI

Article 6 provides countries with a suite of options to cooperate on emissions reductions targets & engage in cross-border carbon trade

	Article 6.2	Article 6.4	Article 6.8
DESCRIPTION	**Market-based mechanism** that allows for decentralized bilateral or multilateral trades between countries, governed by countries with guidance from UNFCCC	Mechanism that allows **for market and non-market based trades** between countries and companies, governed by UN Article 6.4 Supervisory Body[1]	UNFCCC-facilitated mechanism to support **non-market based** approaches (inter alia finance, technology transfer, capacity building), where no trading of emissions is involved
CARBON CREDIT UNIT	**Internationally Transferred Mitigation Outcomes** (ITMOs). All ITMOs must be authorized for a corresponding adjustment and avoid double counting	**Article 6.4 Emissions reductions units (A6.4ERs)** A6.4ERs can either be ITMOs or "mitigation contribution" units, depending on authorization	**No carbon credit unit exists under Article 6.8.** as it focuses on non-market mechanisms
OBJECTIVES	Enables **host country** on track to exceed its NDC target to trade ITMOS in exchange for investments and / or capacity building The **buyer country** purchases ITMOS to meet its own NDC targets	Enables **host countries** to sell credits under standardized, approved methods The **buyer countries** and **the private sector** can purchase these units to meet NDC targets OR other purposes (i.e., voluntary carbon markets)	Connects countries **seeking mitigation support** and **those offering support / technical** to efficiently deploy funds and technology support without expectation of trading units
CURRENT STATUS	**Operational,** with final reporting, monitoring, and transparency mechanisms clarified at COP29	**In development;** project standards and governance rules agreed upon at COP29 after 10 years of negotiation; Supervisory Body to launch work on methodologies, registry in 2025	A work program for non-market approaches was established at COP29, but implementation mechanisms are still **under development**

Countries have the option to a.) Import cost-effective / high-quality carbon credits to achieve NDC[2] and / or b.) Export extra carbon credits to capture proceeds

1. (also known as Paris Agreement Crediting Mechanism (PACM) 2. Nationally determined contribution

Source: UNFCCC, The Nature Conservancy; BCG analysis

3 emerging trends will help accelerate the flow of capital into carbon removal activities

Buyer Coalitions

Corporate coalitions bring capital and provide a level of trust among a number of respected corporates

*Coalitions of corporate buyers, such as **Lead Coalition, NextGen, Frontier, and Symbiosis,** bring larger pools of capital to meet aspirational commitments, often focusing on long-dated methodologies and driving collective impact in achieving sustainability goals.*

Industry Coalitions

Industry specific commitments will increase demand across all competitors in a given market and establish agreed standards

*Airlines have committed to holding emission growth flat, with the **Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)** playing a critical role in driving material future demand for high-quality credits.*

Govts. Linking Credits into Compliance Markets

Increased volumes of credits in compliance schemes provide higher price realization and government oversight

*Governments, including **California, Canada, and Singapore** are allowing use of removal and avoidance credits to meet some obligations.*

Generating high-quality credits through verified abatement & removals

Asia is uniquely positioned to lead the carbon credit origination, particularly in NBS, thanks to its rich natural carbon sinks, abundant agricultural waste, and cost-effective labor. However, the supply side faces hurdles such as fragmentation among small producers and scaling difficulties. For biochar, a key NBS component, high initial costs, feedstock scarcity, and a lack of technical expertise among farmers hinder widespread adoption, while uncertified biochar credits add to market hesitancy. Blue carbon, another promising NBS category involving coastal ecosystems like mangroves and seagrasses, provides exceptional co-benefits such as biodiversity enhancement and shoreline protection. Though less mature than other NBS solutions due to challenges in verification, measurement accuracy, and site availability, blue carbon represents an untapped opportunity for growth in the sector.

DAC, a leading engineered solution, offers unmatched permanence and precise measurability by storing carbon in geological formations for millennia. However, high costs, scalability issues, and the need for renewable energy limit its immediate impact.

The absence of standardized quality benchmarks and robust verification mechanisms undermines trust in carbon credit claims, while regulatory uncertainty complicates investment decisions. Despite these challenges, the future of carbon removal solutions is promising. Investments in robust quality standards, maturing regulatory clarity, and innovative financing models are **paving the way for a more scalable and trusted market.** As these solutions mature, they promise not only to address the climate crisis but also to deliver significant co-benefits, fostering biodiversity, community welfare, and economic growth.

Design thinking outcomes

What would it take to create an integrated ecosystem in Asia where nature-based and engineered solutions coexist and complement each other in the carbon markets?

Develop Comprehensive Standards

Establish robust, technology-agnostic frameworks to assess and compare the quality of carbon credits across NBS and engineered solutions. Standards should also incorporate non-emission ESG benefits like biodiversity.

Foster Fungibility and Trust

Make carbon removal credits fungible across jurisdictions and pathways. Introduce rigorous third-party verification to ensure market trust and encourage adoption.

Enable Ecosystem Collaboration

Facilitate an integrated ecosystem where NBS & engineering solutions coexist and complement each other. Singapore could lead by leveraging its strengths in finance, policy, and technological innovation.

Promote Long-term Demand Certainty

Encourage buyer coalitions and government-backed offtake guarantees to stabilize demand and de-risk investments. Transparent and predictable pricing models can further incentivize scaling.

Engage Local Communities

Provide technical training and resources to local stakeholders to increase project sustainability and social impact. Address opportunity costs to optimize biomass utilization.

View on demand side for high-quality carbon credits ecosystem in Asia

Historically, internal carbon prices in Asia have been lower than in Europe or the U.S., but this is changing, driven by forward-looking companies across APAC. The region's heavy reliance on manufacturing, which is increasingly integrating carbon credits into supply chains, positions it as a significant market for high-quality carbon removal solutions. However, demand for carbon credits remains fragile, as end-customers and investors express uncertainty about the credibility and long-term value of offsets. While employees and governments are pushing sustainability agendas, stronger regulatory mandates are needed to build momentum and ensure long-term adoption.

One critical challenge is the lack of demand, which discourages investment in carbon removal projects. Offtake agreements that provide predictable demand —covering volumes, timeframes, and pricing—can help reducing the risks for developers and attract investors. Government-led initiatives, such as national funds or compliance markets, can further stimulate demand by providing stable frameworks and incentives for companies. For example, the aviation sector in major aviation hubs could accelerate adoption by equating carbon removal credits with sustainable aviation fuel, setting a benchmark for other industries.

As the market matures, a shift toward treating carbon credits as investable financial assets is crucial. Establishing robust infrastructure for trading, ensuring transparency in standards and monitoring, and fostering trust will make credits more attractive to both corporates and financial institutions. With innovative policies, patient capital, and clear demand signals, Asia is poised to lead the way in creating a thriving market for carbon credits, driving global decarbonization and achieving meaningful climate impact.

Design thinking outcomes

How might we catalyze the demand for high-quality carbon credits?

Strengthen Regulatory Mandates

Governments could establish clear and robust regulatory frameworks that mandate the adoption of carbon credits, particularly in hard-to-abate sectors. Policies such as integrating carbon credits into compliance markets or recognizing them as equivalents to abatement alternatives can drive demand and incentivize corporate participation.

Facilitate Long-term Offtake Agreements

Encourage buyer coalitions and government-backed funds to create offtake agreements that guarantee stable demand for carbon credits. These agreements could specify volumes, timeframes, and pricing to reduce risk for project developers and attract private investment.

Build Market Infrastructure for Trading and Trust

Develop robust infrastructure to support the trading of carbon credits as financial assets. This includes setting transparent quality standards, ensuring reliable monitoring and verification systems, and creating exchange platforms to enable liquidity and price discovery.

Enhance Stakeholder Engagement

Increase pull from key stakeholders —customers, employees, and investors—by promoting awareness of the benefits of carbon credits. Governments can play a role by encouraging public-private partnerships and offering incentives for companies that integrate sustainable practices into their operations.

Incentivize Biodiversity and Co-benefits

Highlight the additional value of credits that deliver biodiversity and community welfare benefits, particularly from NBS. Such differentiation can drive higher market demand and increase the overall value of carbon credits, ensuring they are viewed not just as compliance tools but as impactful investments.

Key success factors of carbon markets

The success of carbon markets hinges on **creating trust, ensuring liquidity,** and **fostering scalability.** Building trust involves three pillars: confidence in the science of carbon removal, clarity in legal frameworks governing the quality of credits, and robust accounting practices for integrating credits into company assets.

Trust in Science

Accurate carbon removal monitoring and verification ensure the credibility of claims, with independent audits providing transparency.

Lifecycle assessments help quantify emissions and removal processes, establishing confidence in diverse methods.

Trust in Legal Frameworks

Clear standards for carbon credit quality outline the roles and responsibilities of all parties, ensuring consistency and reliability.

Harmonized cross-border rules allow carbon credits to be traded and recognized internationally, enhancing market access.

Trust in Accounting and Asset Integration

Standardized accounting practices help companies transparently value and report carbon credits in financial statements.

Independent verification of credit usage reassures investors and stakeholders of their legitimacy and impact.

The lack of liquidity in current markets limits price discovery and investor participation. Making carbon credits investable and tradeable assets, with infrastructure like exchange markets and consistent standards, is key to scaling the market. Offtake agreements play a critical role in mitigating risk for developers and attracting capital. Aggregating smaller offtakes into sizable commitments ensures demand certainty, which is vital for long-term investment in carbon removal projects. Financing challenges, particularly for capital-intensive projects, require innovative solutions such as blended finance, which combines public, philanthropic, and private capital to de-risk investments and encourage market participation. The establishment of clear demand signals and quality standards is more important than upfront financing, as clarity ensures consistent and predictable growth in the market.

Design thinking outcomes

How can finance play a catalytic role to accelerate carbon removals?

Build Trust in Market Mechanisms

Develop robust verification systems and legal frameworks that clearly define the quality of carbon credits and the responsibilities of stakeholders. This will establish confidence in the market and attract a wider range of investors.

Enable Liquidity Through Tradeable Credits

Establish exchange platforms where carbon credits can be freely traded, regardless of buyer or investor type. This liquidity will allow for better price discovery and foster broader participation from financial institutions, including hedge funds and speculators.

Aggregate Offtakes for Demand Stability

Create mechanisms to aggregate smaller offtake agreements into sizable contracts. This ensures stable demand for carbon credits, reduces risk for developers, and provides the long-term cash flows needed to secure large-scale investments.

Innovate Financing Models

Utilize blended finance to mitigate early-stage risks for carbon removal projects. Public and philanthropic funds can absorb upfront costs and make these projects attractive to private investors, particularly for nascent or capital-intensive solutions.

Ensure Market Transparency and Predictability

Provide clear and accessible data on market demand, the number of projects, and buyer commitments. Transparency helps align stakeholders, builds investor confidence, and ensures that projects scale to meet both environmental and economic goals.

Solution case studies

Innovative solutions are at the heart of scaling carbon removal efforts to meet the urgent demands of the climate crisis. The following case studies highlight pioneering approaches that address critical challenges in carbon markets, from enhancing the credibility and scalability of nature-based solutions to driving cost efficiencies in engineered technologies. These examples showcase how diverse stakeholders—entrepreneurs, local communities, and global organizations—are forging impactful strategies to overcome barriers and unlock opportunities.

As the carbon market evolves, these projects serve as inspiring examples of innovation in action, setting a precedent for what can be achieved when ambition meets execution. Together, they provide a blueprint for scaling carbon removal efforts while delivering co-benefits like biodiversity, economic growth, and community empowerment.

climeworks

By removing CO_2, Climeworks transforms a global responsibility into an economic amplifier.

CHALLENGE

2024 will break another record in being the hottest year on record. Global warming must be limited to 1.5°C. To maximize our chances of success, the world needs to reach net-zero emissions by 2050. This can only be achieved by reducing emissions and, as well as removing unavoidable and historic CO2 emissions.

SOLUTION

Climeworks provides holistic carbon removal solutions built on the expertise of their gold standard direct air capture so that companies can achieve their net-zero targets. For individuals, the company offers a self-service to remove their CO_2 footprint. With their own direct air capture technology in two commercial plants, Climeworks captures CO_2 from the air and with partners stores it permanently underground – the most reliable and durable way to remove carbon from the atmosphere.

IMPACT

Direct air capture technology is one of the key technological solutions to fight the climate crisis. It can scale, is permanent and has no geographical limits. Only with emission reductions and removals will the world suffer less negative impacts on intensity and frequency of extreme weather events, resources, ecosystems, biodiversity, health, or food security.

"At Climeworks we dare to reclaim control of our climate future. We're on a journey to scale our carbon removal technology to gigaton capacity, to protect our planet, the only home we have."

- Christoph Gebald,
Co-CEO and Co-Founder Climeworks

www.climeworks.com

MACROCARBON

Macrocarbon helps to defossilize the chemical and aviation industry by producing sustainable hydrocarbons from macroalgae cultivated in the open ocean.

CHALLENGE

To substitute fossil feedstocks for the chemical industry and fossil fuels for the aviation industry, we need millions of tons of renewable carbon-rich biomass. Land-based biomass requires space, freshwater, and fertilizer to grow, and agricultural waste is limited.

SOLUTION

Macrocarbon is growing macroalgae in the open ocean at scale to produce biomass at scale in a cost-effective way. The macroalgal biomass is then processed with advanced pyrolysis (gasification). The gas is then transformed to liquid hydrocarbons such as bionaphtha and sustainable aviation fuel (SAF) through Fischer Tropsch technology. The solid outputs sequester carbon permanently in the form of carbon black and biochar that can be used to create carbon negative materials

IMPACT

Open ocean aquafarms enhance biodiversity and reduce ocean acidification. 88% of the carbon sequestered by the macroalgae while it grows ends up in valuable products. Macrocarbon's impact is 12.000 tons of CO_2 equivalents per km^2 of aquafarm per year, and there is enough space in the ocean to bring this approach to Gt scale.

"We are called to be architects of our future, not its victims. The future belongs to those who act, and we are determined to break the walls to defossilize our industry at scale using the power of macroalgae in the ocean."

- Mar Fernandez and Jason Cole, Co-CEOs Macrocarbon inspired by Buckminster Fuller and Rafael Laguna de la Vera

www.macrocarbon.world

Arukah unlocks gigaton-scale carbon removal in the Global South with a 50% revenue sharing model to smallholder farmers, operationalised with digital MRV and payments.

CHALLENGE

By 2030, the annual demand for durable CDR is estimated to range from approximately 40 to 200 million metric tons (Mt) of CO_2, translating into a market opportunity of $10 billion to $40 billion (BCG). The challenge is not only in unlocking the supply pipeline, but also in achieving a cost-effective portfolio at scale.

SOLUTION

Arukah works with smallholder farmers in the Global South to convert agricultural waste into biochar-based fertilizer, sequestering carbon in the process. Their revenue sharing model incentivizes sustainable long-term participation by directing climate income to local communities.

IMPACT

By providing end to end traceability and transparent real-time data to financiers, we unlock financing at scale.

"Arukah was established during the pandemic amid predictions that up to 100 million people in Asia could fall below $2 a day, most of whom are farmers. Arukah aims to help them earn more – at scale...

We have identified an opportunity to use carbon markets to finance farmers to process agricultural waste sustainably. While often overlooked, farmers are essential partners in the global climate transition."

- Joanna Yeo,
Founder and CEO of Arukah Capital

www.arukah.finance

Puro.earth helps to build the carbon removal industry by certifying CO_2 Removal Suppliers to power the net-negative economy.

CHALLENGE

To achieve net-zero, deep decarbonization of each sector's economic activities needs to be paired with carbon removal services to neutralize residual emissions. This CDR services sector needs to be scaled exponentially.

SOLUTION

Puro.earth is the world's leading crediting platform for engineered carbon removal, and maintains a high-integrity, transparent standard to certify CDR companies operating in all the major, established methods.

IMPACT

Puro.earth certified CDR companies are collectively approaching megaton level carbon removal capacity by mid-decade, setting the foundation for the multi-billion ton per year (gigaton) capacity needed to enable net-zero by mid century. CDR is the net-negative economy.

"Carbon removal is a critical service just like the utilities sector. Net-zero is only feasible by pairing this new utility – the net-negative economy – with the greener activities of every other sector in the economy."

- Alvin Lee,
Head of Asia-Pacific, Puro.earth

www.puro.earth

Terraformation

Terraformation is a native forest restoration company dedicated to addressing climate change by rapidly expanding the number of large-scale biodiverse forest projects.

CHALLENGE

Forests are one of the best ways to address climate change, potentially storing over 30% of the world's excess carbon. However, globally, there is a lack of forestry teams with the necessary capacity to plant native forests on the scale the world needs. To scale, they also need capital. Currently, $200 billion flows into nature-based solutions, but the world needs three times the amount by 2030 to meet climate commitments.

SOLUTION

Terraformation is on a mission to rapidly scale up the restoration of native, biodiverse forests by providing solutions that address both sides of this dilemma. Through their Seed to Carbon Forest Accelerator, forestry teams gain expertise in forestry science, native species, community engagement, and carbon markets. They provide software tools, training, and access to capital to help the teams build biodiverse forests for future generations. For investors, their programs and technology deliver a portfolio of high-quality, certified carbon projects that meet investor due diligence criteria.

IMPACT

Over 14 teams entered the Seed to Carbon Forrest Accelerator from all over the world in Africa, LATAM, and APAC, incl. two mangrove restoration projects. Up to 12 more teams to be onboarded by the end of 2024, supporting the restoration of nearly 25,000 ha of biodiverse forests, offering economic benefits to the local communities that steward the forests.

"Investing in forests is more than funding a project—it's seeding a future. Native, biodiverse reforestation doesn't just capture carbon. It restores ecosystems, supports communities, and builds resilience against climate challenges."

- Huey Lin,
Special Advisor to Terraformation

www.terraformation.com

U.S. Department of ENERGY

DOE's Carbon Negative Shot has set a target of secure, gigaton-scalable CDR across multiple pathways for under $100 / net metric ton CO_2-equivalent by 2032.

CHALLENGE

The U.S. net-zero strategy calls for greater than 100 million tons of CO_2 removal (CDR) each year by 2050, requiring international collaboration to elevate CDR in international climate policy discussions; to build capacity and develop effective regulatory environments in emerging markets; to leverage global capabilities, share knowledge, and fill funding gaps; to promote development of rigorous and consistent carbon accounting regimes and cross-border transport standards; and to catalyze concessionary finance to enable innovation and deployment globally.

SOLUTION

DOE is investing $3.5 billion for regional DAC hubs; $100 million for Carbon Negative Shot pilots; and $35 million in CDR advance purchase commitments under the world's first national government CDR credit purchase initiative. DOE also launched the Voluntary CDR Purchasing Challenge, calling on organizations to purchase high-quality, durable CDR credits. Collectively, these efforts will develop the CDR infrastructure, credit quality standards, and market mechanisms to effectively scale private sector demand.

IMPACT

Private sector purchases have the potential to catalyze CDR innovation, paving the way for removals to be available in the quantities required to meet both corporate net-zero and global climate goals in the coming decades. Several companies have already announced that they will match DOE's $35 million commitment with deals for nature-based CDR and DAC credits.

"To avoid the worst impacts of climate change, the CDR industry needs rapid, global ramp-up. But ramping up the CDR industry will require concerted effort across key areas, including investing in first-of-a-kind demonstrations; creating market demand; and engaging local communities early and often on CDR."

- U.S. Department of Energy

www.energy.gov

Why Singapore has a role to play

Heterogenous region as an epicenter of credit issuance

Despite accounting for majority of credit issuance, Asia is a highly heterogeneous region with diverse countries and regulatory environments but lacks a unified orchestrator, common frameworks, and a centralized marketplace.

Singapore's position as a business and financial hub

Singapore, as the regional headquarters for numerous multinational companies and financial institutions, can serve as a key bridge to connect private entities (e.g., potential buyers and industry coalitions) with investors and financiers across the carbon removal and trading ecosystem.

Opportunity to spearhead and shape the market

Singapore can lead efforts to shape the region's carbon market by driving the development of robust frameworks, fostering collaboration among governments and industries, and leveraging its expertise in governance and finance to ensure credibility and high-impact carbon removal initiatives tailored to the region’s needs.

Thank you for paving the way to unlock the potential of carbon removals

Green Circle Climate Forum participating organizations

Amazon, Arukah Capital, BCG, CaptureNow, Carbon Removal Partners, Climeworks, Climate Impact X, Engie, Golden Agri-Resources, GFTN, Gprnt, U.S. Department of Energy, Isometrics, Microsoft, NUS, Puro.Earth, Standard Chartered, Stanford University, STX, Terraformation, UBS

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About GFTN

Global Finance & Technology Network (GFTN) is a not-for-profit organisation established by the Monetary Authority of Singapore (MAS) in 2024 to harness technology and foster innovation for more efficient, resilient, and inclusive financial ecosystems through global partnerships. GFTN organises convening forums, offers advisory services on innovation ecosystems, provides access to transformative digital platforms, and invests in technology startups with the potential for growth and positive social impact through its venture fund. For more information, visit www.gftn.co

About Gprnt

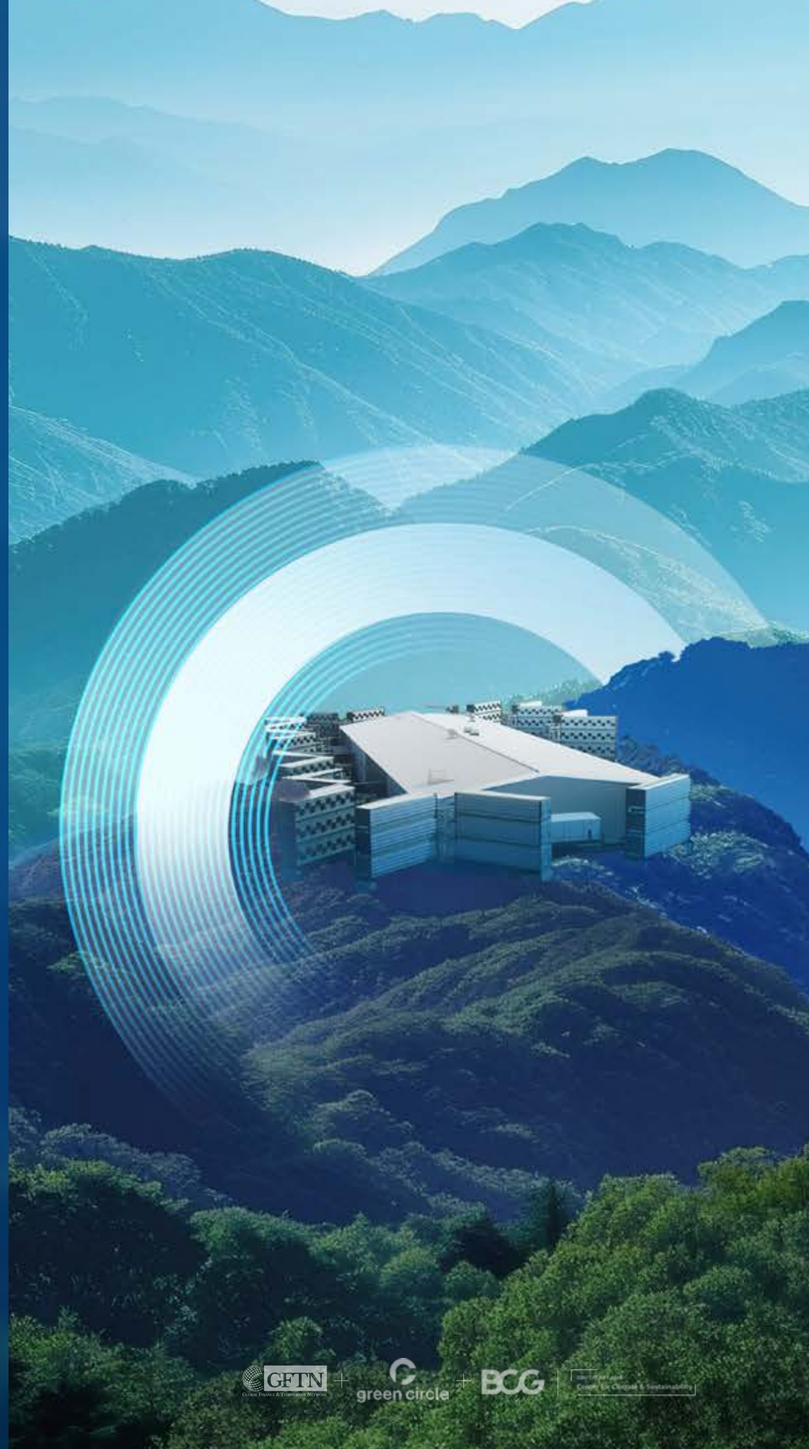
Gprnt (pronounced "greenprint") began in 2020 as Project Greenprint, an initiative by the Monetary Authority of Singapore (MAS) to streamline sustainability data and drive capital towards sustainable projects. In 2023, Gprnt was launched as an independent entity, backed by public and private stakeholders, to meet global ESG reporting needs.

Today, Gprnt offers the Gprnt.ai platform, which helps SMEs, corporates, financial institutions, and governments to collect, measure, and act on sustainability data. We also run Green Circle, an ecosystem of forums, tools, and programs to provide these same stakeholders with the knowledge, solution and collaboration needed to execute on their transition agenda.

About Boston Consulting Group

Boston Consulting Group partners with leaders in business and society to tackle their most important challenges and capture their greatest opportunities. BCG was the pioneer in business strategy when it was founded in 1963. Today, we work closely with clients to embrace a transformational approach aimed at benefiting all stakeholders—empowering organizations to grow, build sustainable competitive advantage, and drive positive societal impact.

Our diverse, global teams bring deep industry and functional expertise and a range of perspectives that question the status quo and spark change. BCG delivers solutions through leading-edge management consulting, technology and design, and corporate and digital ventures. We work in a uniquely collaborative model across the firm and throughout all levels of the client organization, fueled by the goal of helping our clients thrive and enabling them to make the world a better place.

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