The Role of Carbon Markets in Transitions

A Report by the International Energy Forum

March 2024

INTERNATIONAL ENERGY FORUM

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About the International Energy Forum

The International Energy Forum (IEF) is the world's largest international organization of energy ministers from 72 countries and includes both producing and consuming nations. The IEF has a broad mandate to examine all energy issues, including oil and gas, clean and renewable energy, sustainability, energy transitions and new technologies, data transparency, and energy access. Through the Forum and its associated events, officials, industry executives, and other experts engage in a dialogue of increasing importance to global energy security and sustainability.

Acknowledgement

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Table of Contents

Abbreviations

BECCS	Bioenergy with Carbon Capture and Storage
CBAM	Carbon Border Adjustment Mechanism
CCE	Circular Carbon Economy
CCS	Carbon Capture and Storage
CCTS	Carbon Credit Trading Scheme
CCU	Carbon Capture and Utilization
CCUS	Carbon Capture Utilization and Storage
CDM	Clean Development Mechanism
CO_2	Carbon Dioxide
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DAC	Direct Air Capture
DACS	Direct Air Capture and Storage
DNA	Designated National Authority
EOR	Enhanced Oil Recovery
ESG	Environmental, Social, and Governance
ETS	Emissions Trading System
EU-ETS	European Union - Emissions Trading System
GCC	Global Carbon Council
GCOM	Greenhouse Gas Crediting and Offsetting Mechanism
GCP	Green Credit Program
GHG	Greenhouse Gases
ICAO	International Civil Aviation Organization
ICVCM	The Integrity Council for the Voluntary Carbon Market
IEA	International Energy Agency
IMF	International Monetry Fund
IPCC	The Intergovernmental Panel on Climate Change
ITMOs	Internationally Transferred Mitigation Outcomes
MENA	Middle East and North Africa
NDC	Nationally Determined Contributions
OECD	Organization for Economic Cooperation and Development
RVCMC	Regional Voluntary Carbon Market Company
SDGs	Sustainable Development Goals
TCAF	Transformative Carbon Asset Facility
UICCA	UAE Independent Climate Change Accelerator
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary Carbon Market
VCMI	Voluntary Carbon Markets Integrity Initiative
WTO	World Trade Organization

Key findings

- **Unlocking the potential of the evolving carbon markets is a game-changer for climate action**. These markets effectively lower the costs associated with carbon removal by connecting local (small or large scale) project owners capable of removing carbon, potentially at a lower cost, with international buyers eager to offset their emissions. The promotion of cross-border trade in carbon credits between nations will bolster net-zero carbon balances, consequently boosting both supply and demand.

- **Evolving carbon markets offer a promising avenue to complement and potentially supplant transboundary carbon levy mechanisms**. By fostering global collaboration, these markets facilitate cost reduction and promote the alignment of regulatory frameworks, resulting in more cohesive and predictable climate and energy policies across regions. This convergence contributes to enhanced market liquidity and global stability, ultimately advancing the collective effort towards addressing climate change.

- **Carbon markets have significant potential for attracting investments in Circular Carbon Economy (CCE) solutions**. Projects supported through Article 6 of the Paris Agreement or other initiatives such as J-Credits by Japan are injecting new funding into various project categories, encompassing energy efficiency, solar, hydro, agriculture, transportation, and, more recently, endeavors focused on financing CCUS projects. CCE solutions represent promising and effective technologies for reducing emissions and price volatility, while strengthening energy security.

- **Governments need to shape evolving carbon markets into a win-win scenario for both consumers and producers**. Given the recent growth of carbon markets in many countries and the absence of specific guidelines, currently, it is imperative for governments to ensure that targeted emission reductions do not lead to undue social and economic harms. Fortifying the global framework governing these markets and streamlining the movement of credits like Internationally Transferred Mitigation Outcomes (ITMOs) will enable mutual reinforcing carbon market designs.

- **Voluntary Carbon Markets (VCM) represent an initial step in addressing both national and international climate challenges**. The VCM has the potential to strengthen global energy and climate policy coherence. Through participation in voluntary markets, the country gains insights into best practices. Management and designated staff will become more attuned to the strengths and weaknesses of these markets in different contexts. Countries and businesses may transition into compliance markets or use voluntary carbon markets for equivalent effect depending on performance and circumstances.

- **Carbon market revenues serve as a supplementary source of climate finance.** The exchange of carbon credits can diminish the dependence on national public support schemes for industries to reduce carbon emissions, ensuring the economic viability of GHG emission reduction projects. Revenues generated from carbon markets will deliver co-benefits in addressing Sustainable Development Goals (SDGs) bridging global divides and transcend the scope of climate-related objectives alone.

- **Carbon market incentives can help scale CCE solutions and reduce clean hydrogen deployment costs.** Scaling investments in CCUS will progressively advance technologies and lower capture and storage costs. This will also help to decrease costs associated with clean hydrogen production and other clean technologies that rely on CCUS.

- **Fragmented markets lead to increased costs, hurdles, and reduced transparency.** Leveraging open and well-functioning global markets to facilitate affordable and just transitions through IEF consumer-producer dialogue reduces GHG emissions, energy market risk and amplifies sustainable development benefits. This involves stakeholder dialogue on the evolution of carbon markets, energy investment and trade as well as carbon market data transparency requirements.

- **Enhanced digitalization and coding enable better carbon market data transparency.** Digitalization is crucial for ensuring robust accounting of Carbon Dioxide (CO_2) emissions. Digitalization can help to better quantify, measure, report and verify carbon market data and boost investor confidence. Scaling up digitalization across all CCS and other engineering-based activities improves transparency and precision. As carbon markets and CCE solutions scale, countries and organizations must adopt appropriate methodologies to enhance carbon market data transparency.

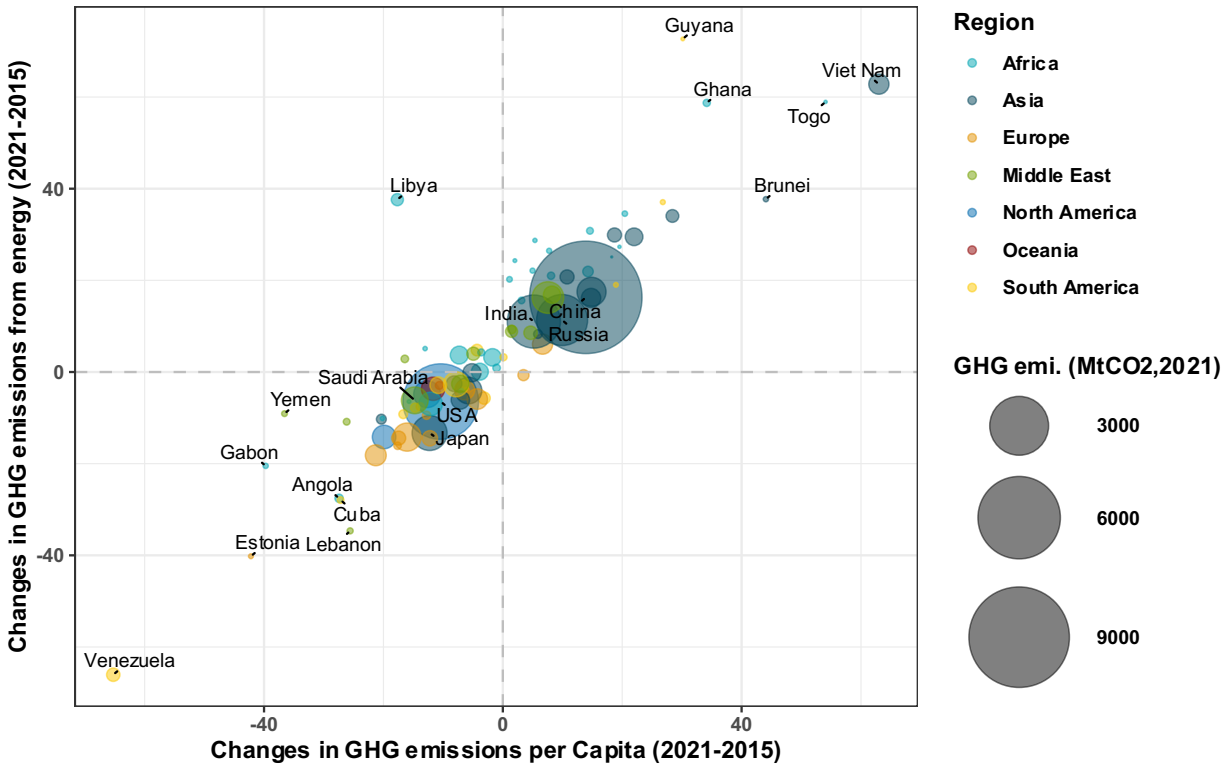
- **Carbon Capture and Utilization (CCU), when incentivized by carbon market mechanisms, can diminish material emission footprints.** Innovative approaches to carbon utilization have the capacity to facilitate material transitions with low-carbon intensity materials. Material transitions require substantial resources for research and development, carbon markets can provide an additional incentive for investment in such projects.

1. Introduction

Given the increasing efforts by governments to explore strategies addressing climate change, the world continues to demand more innovative technologies and mechanisms to achieve nations' climate targets and sustainable development goals. However, despite the proliferation of all these mitigation strategies, there has been a more than 3% increase in energy-related emissions since the Paris Agreement, as reported by the IEA[1] (see figure 1). The relative decrease in greenhouse gas emissions from developed countries post the Paris Agreement was followed by an increase in emissions from emerging economies. Despite this rise in emissions from developing non-OECD countries, per capita emissions are still less than half of those in developed OECD countries. Given the increasing population growth accompanied by a growing need to lift people from poverty and overcome inequality in the next decades, it is crucial to enable policymakers to take climate mitigation actions without restricting economic and social prospects, especially in emerging economies in Asia and Africa.

[1] IEA (2023), GHG Emissions from Energy

Figure 1: Shifts in GHG emissions following the Paris Agreement



Source IEF & IEA

Therefore, innovative, and all-inclusive solutions are essential to bridge the gap between, for example, countries' climate targets and the actual emission trends driven by socio-economic growth under existing policies and technologies. Evolving carbon markets present effective solutions and can be leveraged internationally through the carbon market mechanism outlined in Article 6 of the Paris Agreement. However, it remains underutilized due to a lack of guidance on certain key provisions.

In carbon markets, which operate as trading systems facilitating the exchange of carbon credits, entities have a mechanism to offset their greenhouse gas emissions. Each tradable carbon credit represents one tonne of carbon dioxide. Participants, encompassing both companies and individuals, can procure these credits from entities actively involved in emission reduction activities. This system brings efficiency by enabling the trade of emission rights and encourages incentive-based approaches that are both effective and cost-efficient. When designed well, carbon markets facilitate the transfer of capital and technologies to the most impactful emission reduction activities, achieving important co-benefits by bridging divisions and fostering more inclusive sustainable development between OECD and non-OECD economies.

The financial resources generated from the purchases of carbon credits, aimed at offsetting emissions for other nations, can assist emerging countries in investing in clean energy technologies and harnessing nature-based and demand-side emission reductions. These incentives also support countries in achieving their Nationally Determined Contributions (NDC) targets in the long run by building the required regulatory framework and human capacities.

Over the past few years, the Voluntary Carbon Markets (VCM) have garnered significant attention and discussions as well, alongside compliance markets. Voluntary Carbon Markets are a crucial tool for nations that have not yet implemented emission trading systems. The COP28 presidency considered carbon markets to play a pivotal role in both offsetting large emissions from hydrocarbons in the short term and delivering investment in CO_2 removals in the longer term (additional insights from COP28 regarding carbon markets can be found in the following chapter). This aligns with what producers and consumers pursue within the context of the G20 Circular Carbon Economy (2020) and the Carbon Management Challenge announced at the Major Economies Forum in April 2023, and later launched at COP28 in December 2023 with the support of the IEF.

The Taskforce on Scaling Voluntary Carbon Markets report estimated that investment mobilized from Voluntary Carbon Markets needs to be increased 15-fold to meet the goal of sequestering or removing 2 Gt of emissions by 2030[2]. The authors of the report suggested that more investments should be shifted toward carbon removal technologies to address the long-term reduction. Furthermore, Article 6.4[3] of Paris Agreement (see Box 1) was also in the forefront of the Bonn Climate Change Conference in June 2023 (and previously at COP26 in Glasgow). The Article 6.4 Advisory Body conducted multiple meetings before COP28 to provide updates on recommendations concerning methodologies and removals. The Advisory Body was tasked with establishing rules for a new multilateral and/or international carbon market.

The transition from the earlier Clean Development Mechanism (CDM), introduced two decades ago by Article 12 of the Kyoto Protocol, to Article 6.4 of the Paris Agreement stemmed from various failures encountered by the CDM. These included 1) the lack of demand; 2) the lack of proving additionality[4]; 3) a drop in carbon credit prices to less than $5, impeding new project generation[5]; 4) major emitters, such as the US and China, not being signatories to the Kyoto Protocol; and 5) issues of double-counting and environmental integrity[6]. Hence, over the past decade, collective efforts by national and intergovernmental bodies have been directed towards establishing a robust foundation for Article 6.4 of the Paris Agreement, aiming to address the past shortcomings of the CDM.

[2] Taskforce on Scaling Voluntary Carbon Markets report (2021), Institute of International Finance.
[3] UNCCC. (2015). *Paris Agreement - Article 6*. Retrieved from ttps://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf#page=9
[4] Wara M (2008) Measuring the clean development mechanism's performance and potential. UCLA law review. University of California, Los Angeles. School Law 55(6)
[5] see https://www.economist.com/finance-and-economics/2012/09/15/complete-disaster-in-the-making
[6] Aldy J. E., and Zachery M. Halem (2022). The Evolving Role of Greenhouse Gas Emission Offsets in Combating Climate Change. Faculty Research Working Paper Series, Harvard Kennedy School, Harvard University.

Box 1: Article 6.4 of the Paris Agreement

In 2015, Article 6 of the Paris Agreement introduced a multilateral mechanism that allows governments and companies to trade their emission reductions with different countries and counterparts. The provisions of this Article were ratified during the COP26 climate summit in Glasgow, establishing the regulations governing carbon markets. The mechanism, for example, states:

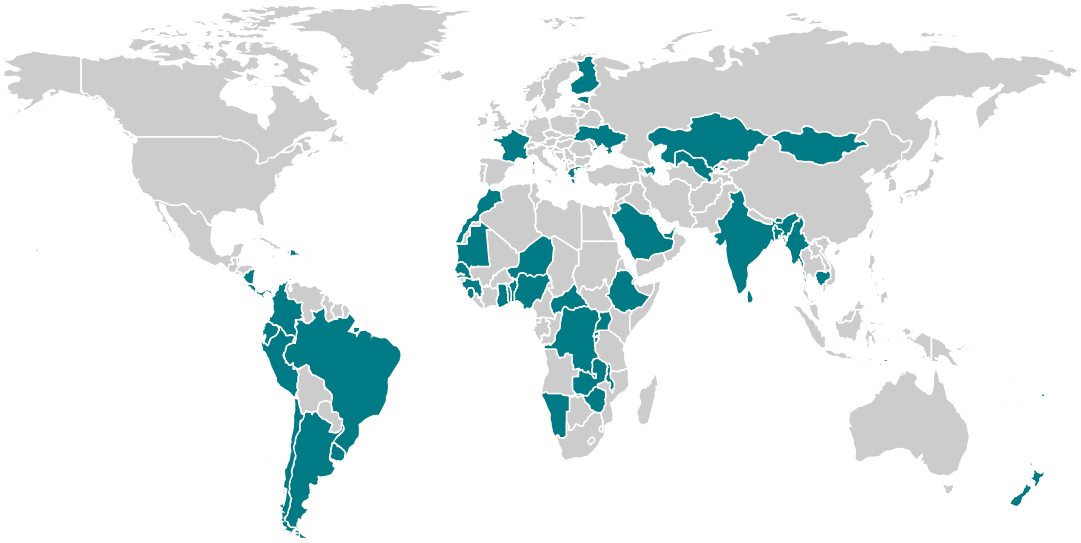
"*A mechanism to contribute to the mitigation of greenhouse gas emissions and support sustainable development is hereby established under the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Agreement for use by Parties on a voluntary basis. It shall be supervised by a body designated by the Conference of the Parties serving as the meeting of the Parties to this Agreement and shall aim:*

- *To promote the mitigation of greenhouse gas emissions while fostering sustainable development;*
- *To incentivize and facilitate participation in the mitigation of greenhouse gas emissions by public and private entities authorized by a Party;*
- *To contribute to the reduction of emission levels in the host Party, which will benefit from mitigation activities resulting in emission reductions that can also be used by another Party to fulfil its nationally determined contribution; and*
- *To deliver an overall mitigation in global emissions*"

Such a mechanism provides national and private sector industries with incentives to expand their carbon management activities, at a lower cost, while achieving their business and environmental goals.

One of the initial prerequisites for countries to participate in carbon market activities on a global scale is the establishment of a Designated National Authority (DNA). The DNA is the organization granted the responsibility by a country to authorize and approve participation in Clean Development Mechanism (CDM) projects as well as Article 6 of the Paris Agreement and certify carbon credits. As of December 2023, 65 countries have established DNAs, see Figure 2. Creating these national authorities represents an advanced step in cooperating and participating in international agreements related to carbon crediting.

Figure 2: Global mapping of Designated National Authorities for Article 6 of the Paris Agreement.



Source: IEF and UNEP

Producer-consumer dialogues and cooperation on carbon markets, along with the trading of carbon credits between nations, can help leverage global markets to incentivize investment, knowledge transfer in clean technologies, and facilitate transition for all stakeholders. This includes scaling trade and investment in promising but often overlooked clean policy and technology pathways, such as those provided by the Circular Carbon Economy (CCE). The CCE entails capturing emissions directly from sources or the atmosphere and storing them permanently or reusing them in industrial products and processes, thereby achieving a sustainable reduction in emissions. In the build up to COP28, IEF dialogue participants emphasized the necessity for increased collaboration among producers and consumers to advance Circular Carbon Economy solutions. This can be achieved by leveraging carbon markets and enhancing data transparency through improved emissions accounting[7]. The increased participation of more nations in global carbon markets will enhance market liquidity and stability by better balancing supply and demand for carbon offsets, provided carbon market data transparency improves.

This report aims to focus on how carbon markets' incentives can facilitate implementation of Circular Carbon Economy solutions. The objective of the report is also to present a comprehensive worldwide outlook on carbon markets, emphasizing the importance of establishing an integrated carbon market that reduces trade and investment barriers between producing and consuming countries. It delves into the contribution of carbon markets to investments in Carbon Capture and Storage technologies and the cross-border trade of carbon dioxide. Additionally, it explores the relationship between the evolution of carbon markets and other measures, such as Carbon Border Adjustment Mechanisms.

[7] See for instance IEF (2023). *Shaping a Living Roadmap for Energy Transition*, A report by the International Energy Forum and S&P Global Commodity Insights. IEF (2024). CCUS Regulatory and Policy Landscape: A Global and MENA Perspective.

These mechanisms are anticipated to exert diverse impacts on emissions reduction and just transitions and influence the functioning of energy and carbon markets at regional and global level.

Moreover, the report discusses the technical challenges that emerging carbon markets may confront and offers an overview of how these markets can accelerate worldwide reductions in CO_2 emissions, enhance the liquidity and stability of the global energy sector, and contribute to the attainment of climate and sustainable development goals for all stakeholders.

2. Carbon Markets: Shaping the path for just transitions?

Key takeaways from COP28

COP28 in the United Arab Emirates witnessed a historic agreement by approximately 200 countries to transition away from fossil fuels. The shift from fossil fuels will occur “in a just, orderly, and equitable manner”, while concurrently “accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science”[8].

The COP28 discussions also marked a significant milestone by incorporating numerous discussions, initiatives, and collaborations centered around carbon markets. Noteworthy statements from key figures include the UN Climate Change Executive Secretary emphasizing that "*no developing country wishing to use voluntary carbon markets should be left behind.*[9]*"* The World Bank President advocated for compensating developing countries for the climate benefits they provide, stating that the discussion concerning carbon credits was delayed due to "the intellectual arguments,[10]" surrounding it, while the US Special Climate Envoy expressed firm belief in the power of carbon markets to drive climate ambition and action[11].

Several initiatives and collaborations emerged during COP28, including:

- A joint statement on a High-Level Roundtable to unlock high-integrity Carbon Markets, featuring key figures such as COP28 President Dr. Sultan Al-Jaber, UNFCCC Executive Secretary Simon Stiell, World Bank Group President Ajay Banga, and others[12].
- The launch of the World Bank engagement roadmap for carbon markets[13].
- Agreeing to emphasize the importance of establishing high-integrity carbon markets, a key element of the UAE Leaders’ declaration on a global climate finance Framework[14].

[8] The UAE Consensus; https://prod-cd-cdn.azureedge.net/-/media/Project/COP28/COP28_The-UAE-Consensus_Brochure_19122023.pdf?rev=8415d617d79845d1a7fb99c3b77c0e87
[9] https://unfccc.int/news/un-climate-change-executive-secretary-speech-at-voluntary-carbon-market-roundtable-on-margins-of
[10] https://www.ft.com/content/c0c6a401-5a15-4446-b4a5-d441193862e6
[11] https://www.bloomberg.com/news/articles/2023-12-08/cop28-carbon-market-push-tries-to-fix-scandal-tainted-credits
[12] See https://www.worldbank.org/en/topic/climatechange/brief/statement-on-high-level-roundtable-on-unlocking-high-integrity-carbon-markets
[13] https://thedocs.worldbank.org/en/doc/12facd8b391a1eafa5dd53e7ddc5eeb5-0020012023/original/COP28-World-Bank-Engagement-Roadmap-for-Carbon-Markets.pdf
[14] https://www.cop28.com/en/climate_finance_framework

- The Article 6.4 Advisory Body and the Integrity Council for Voluntary Carbon Markets (ICVCM) have established a more detailed guardrail to ensure high-integrity credit supply and demand in the voluntary market, along with providing granular guidance for carbon credits.
- Efforts by non-profit organizations (VCMI, Science Based Target initiatives, GHG Protocol, and the ICVCM) to establish an integrity framework offering consistent guidance on decarbonization.
- The CORSIA initiative, managed by the International Civil Aviation Organization (ICAO), approving standards from various organizations (Verra, Gold Standard, Climate Action Reserve, American Carbon Registry, Architecture for REDD+ Transactions and Global Carbon Council) and announcing collaboration to establish consistent standards on quantification, verification, permanence, and removal.
- The Environmental Defense Fund has introduced an innovative tool to aid companies in reducing their aviation footprints. This tool supports the purchase of Sustainable Aviation Fuel certificates[15].
- The Article 6.4 Advisory Body conducted multiple meetings before COP28 to elaborate recommendations concerning methodologies and removals. However, Parties in the final statement failed to reach agreement on these recommendations.
- The COP28 talks failed to reach an agreement on new rules for carbon offsetting, impeding the launch of a centralized UN system for countries and companies to trade carbon emissions offsets. The topic will be revisited at the next COP in hopes of achieving a consensus.

To counteract greenwashing and enhance integrity in the Voluntary Carbon Markets, seven European countries (Netherlands, Germany, France, Spain, Finland, Belgium, and Austria) have also jointly proposed recommendations. The primary objective of this collaboration is to ensure that the generated credits are of high quality and originate from a fully transparent environment. Six recommendations, primarily directed at companies purchasing carbon credits, have been formulated to assist in meeting climate targets. These recommendations include:

1. Publicly disclose all direct and indirect emissions, maintaining a clear vision and roadmap aligned with the organization's climate target in accordance with the Paris Agreement.
2. Prioritize emission reductions across the value chain, ensuring that purchased credits align with the organization's climate roadmap but are not considered essential.
3. Provide detailed information to substantiate claims related to the use of carbon credits.
4. Clearly indicate whether the produced credits are directed toward the organization's climate goals or contribute to global climate mitigation goals by reducing emissions in the host country.
5. Ensure that purchased credits adhere to the main Core Principles of VCM, including real, additional, permanent removal, and prevention of possible leakage.
6. Ensure that such purchases extend beyond environmental goals, encompassing social benefits, decent job creation, and a commitment to avoiding human rights violations, with investments aligned with the SDGs.

[15] See https://www.safcregistry.org/

Mapping carbon markets and transboundary mechanisms

Carbon markets can be classified into two main types: mandatory compliance schemes and voluntary markets. Mandatory carbon markets, illustrated by the European Emission Trading System and the associated Carbon Border Mechanism, employ a market-based approach to mitigate carbon emissions and tackle issues such as "carbon leakage." In contrast, voluntary carbon markets revolve around the optional trading of carbon credits, often known as offsets. Companies drive the growth of voluntary carbon markets by willingly purchasing carbon offsets as part of their commitment to achieving net-zero goals.

The voluntary carbon market may represent an initial step toward the compliance market, where participation becomes mandatory. While involvement in the voluntary market remains optional, its performance in reducing emissions may be comparable to or preferable over compliance markets, depending on context. Voluntary carbon markets can serve as the foundation for generating investments to support projects aimed at reducing and removing CO_2 emissions and fostering sustainable development, both on a small and large scale. The growth of voluntary carbon markets outpaces that of compliance markets and is the main driver behind the implementation of more bilateral cooperations under Article 6 of the Paris Agreement[16]. Additionally, carbon markets, in general, enhance transparency through public-private partnerships[17].

[16] World Bank (2023). *State and Trends of Carbon Pricing 2023*. International Bank for Reconstruction and Development, the World Bank.
[17] Bose, A., Cohen, J., Fattouh, B., Johnson, O., & Spilker, G. (2021). Voluntary makets for carbon offsets: Evolution and lessons for the LNG market. *The Oxford Institiute for Energy Studies*.

Carbon markets can play a pivotal role in mitigating a substantial portion of CO_2 emissions and their global greenhouse gas equivalents. The evolution of Emission Trading Systems (ETSs) has also encouraged businesses and governments to shift their focus from emission reduction to emission removal[18]. The initial international dialogue on carbon markets began with the Kyoto Protocol in 1997, particularly in Article 12, which established the Clean Development Mechanism[19]. This mechanism allows countries to earn credits for, for instance, afforestation and reforestation projects that generate certificates for emission reductions. Subsequently, numerous countries (mostly OECD) have developed their own ETSs, including the European Union Emissions Trading System (EU-ETS) in 2005 (See Box 2), New Zealand in 2010, South Korea in 2015, among others. In 1990, the United States established a trading system aimed at reducing the emission of sulfur dioxide (SO2) into the atmosphere as part of the Clean Air Act Amendments. This was the world's first cap-and-trade system in terms of its scale. Carbon markets have also evolved in non-OECD countries at national, regional, and sub-national level with China boasting the world's largest ETS (see below).

Box 2: The EU - Emissions Trading Systems (EU-ETS)

In 2005, the European Union introduced a cap-and-trade emissions trading system. The EU-ETS covers all EU member countries, including Iceland, Liechtenstein, and Norway, totaling more than 11,000 installations. The EU ETS consists of four phases:

- Phase 1 (2005-2007): During this period, the EU established the market and determined the price of EU emission allowances tradable under the ETS. This phase also involved setting up the necessary infrastructure for monitoring, reporting, and verification. Sectors included in this phase were power generators and energy-intensive industries.
- Phase 2 (2008-2012): During this period, the EU reduced the number of EU emission allowances by 6.5% compared to the 2005 limit.
- Phase 3 (2013-2020): This phase treated the EU as a single EU-wide cap on emissions rather than individual national caps. It also included more industries, and 300 million allowances were set aside in a New Entrants Reserve to fund the deployment of renewable energy technologies and Carbon Capture, Utilization, and Storage (CCUS).
- Phase 4 (2021-2028): During this period, the number of emission allowances will be reduced by 2.2% each year, starting from 2021.

To accelerate the emissions reduction, at the end of last year (December 2022) the EU agreed to establish a new upstream trading system (ETS2) that covers e.g. energy used in buildings and road transport. The launch of this trading system is expected in 2027-2028.

Below is a selection of some recently developed markets and trading systems:

[18] Lee, H., & Mayer, A. (2020). *The Future of Carbon Offset Markets: current trends and emerging challenges.* Boston: Belfer Center for Science and International Affairs, Harvard Kennedy School, Harvard University.
[19] UNFCCC. (1997). *Kyoto Protocol to the United Nations Framework Convention on Climate Change*.

Saudi Arabia voluntary carbon market

At the end of 2022, Saudi Arabia's Public Investment Fund, in collaboration with Tadawul Group[20] established the Regional Voluntary Carbon Market Company (RVCMC). The primary objective of this company is to create incentives for projects aimed at addressing climate issues and thereby expedite efforts to achieve mitigation outcomes. Since its inception, the company has successfully conducted two auctions, selling 3.6 million tonnes of carbon credits to domestic companies, including Saudi Aramco, NEOM, SABIC, and others.

As part of these efforts, the Kingdom also launched the Greenhouse Gas Crediting and Offsetting Mechanism (GCOM) program during the 2023 MENA Climate Week. This initiative assists companies in crediting and offsetting carbon credits.

China

The Emission Trading System (ETS) in China was initially established in 2017 and underwent a recent update, becoming operational in 2021. The China ETS stands as the world's largest ETS in terms of volume, covering more than 4 billion tCO_2 and representing 40% of Chinese emissions. Guidelines regarding the regulations and policies for these emissions have been outlined through a comprehensive survey conducted by the Ministry of Ecology and Environment, in collaboration with the ICF Climate Center and the Environmental Defense Fund (EDF).

Carbon market in the UAE

The UAE carbon market, also known as the Carbon Alliance, has recently been introduced (mid-2023) with the goal of advancing the development of the carbon market ecosystem within the UAE. This Alliance consists of numerous domestic and international member entities, including the UAE Independent Climate Change Accelerator (UICCA), AirCarbon Exchange, First Abu Dhabi Bank, Mubadala Investment Company (Mubadala), among others. The collaborative endeavors of these institutions in the UAE underscore the significance of carbon markets in achieving net-zero goals. The alliance aims to strengthen the interconnected efforts between the private and public sectors, simultaneously contributing to the formulation of government strategies for greenhouse gas emission reduction.

India’s carbon market

In 2023, two climate programs were inaugurated as part of the Lifestyle for Environment (LiFE) initiative: the Carbon Credit Trading Scheme (CCTS) and the Green Credit Program (GCP). These programs are designed to establish the framework for India's carbon market and encourage active participation from industries and businesses. The targeted industries encompass sectors such as thermal power plants, cement, steel, aluminum, and fertilizers.

India has also introduced a comprehensive draft guidance on compliance with carbon credit trading, aiming to create a regulatory framework for the trading of carbon credits. The implementation of CCTS

[20] The Saudi Tadawul Group is the parent company of Saudi Exchange, a dedicated stock exchange business, the Securities Clearing Center Company (Muqassa), the Securities Depository Center Company (Edaa) and Wamid – the innovation arm of the Group

and GCP is expected to facilitate the generation of certificates for tradeable carbon credits produced within India through domestic projects.

Indonesia voluntary carbon market

In 2023, Indonesia introduced its first emission trading system. The primary objective is to collaborate and amplify efforts to expand the number of climate projects generating carbon credits, actively participating in global initiatives to combat climate change. Indonesia is a significant stakeholder in the context of climate change and sustainable development, as one of the largest global producers of carbon dioxide and home to the world's third-largest rainforest area.

Trading within this market will commence on a voluntary basis, allowing industries and businesses to join at their discretion. The government also has plans to transition towards compliance, including the distribution of allowances.

Zimbabwe carbon market

Zimbabwe stands as one of the leading global producers of carbon credits, with an impressive delivery of over 4 million carbon credits in 2022. In 2023, the United Arab Emirates (UAE) demonstrated its commitment to environmental initiatives by allocating US$1.5 billion for investments in Zimbabwe. This funding is designated for supporting forest protection and rehabilitation projects. Kariba is one of Zimbabwe's largest initiatives, covering vast hectares of forest.

In a strategic move to attract further investment, Zimbabwe implemented a pivotal legal amendment in mid-2023. This amendment reduced the environmental levy, applicable to both the government and local communities, from 70% to 30% of the revenues generated from carbon credits.

Transboundary mechanisms

Dialogues surrounding Emission Trading Systems (ETS) have evolved significantly in the European Union (EU) over the past few years, giving rise to the CBAM (see Box 3), which entered into force on October 1, 2023. This mechanism accounts for emission costs within the EU's territorial borders and imposes charges on emissions embedded in imported goods from producing countries. Its purpose is to maintain the EU's industrial competitiveness, prevent so-called "carbon leakage", and reduce global emissions by incentivizing trade partners to implement equivalent measures to reduce emissions.

The introduction of the EU CBAM has sparked controversy due to its far-reaching implications for trade, particularly with economies whose exports rely on carbon-intensive industries. Various dimensions and implications intersect with this mechanism, including trade agreements, trade relationships, concerns about inflation, the interaction between carbon markets and the socio-economic impacts of the transition to a net-zero climate resilient economy, among others.

Box 3: The EU - Carbon Border Adjustment Mechanism (CBAM)

CBAM is a new mechanism introduced by the EU that imposes charges on emissions embedded in goods entering its territory. CBAM came into effect on October 1, 2023, for a transitional period that extends until the end of 2025. This transitional period is considered a learning phase for importers, producers, and authorities to understand the extent of emissions embedded in imported goods. Starting from October 1, 2023, importers are required to submit their first emission reports no later than the end of January 2024. Initially, CBAM covers the sectors of iron and steel, electricity, hydrogen, cement, fertilizers, and aluminum. The sector list may expand by the end of the transitional period to include indirect emissions, such as those associated with the electricity used in cement production. CBAM sets an important new precedent in energy and climate policies of leading OECD countries that may prompt challenges under World Trade Organization (WTO), and or lead other countries to take equivalent or retaliatory measures, that will challenge the functioning of world markets.

Many International Energy Forum members, including for example Japan[21], India[22], and the US[23], have expressed concerns about the CBAM. They contend that it adversely impacts investment and trade relationships between producers and consumers, raising questions about data availability and the extent of monitoring, reporting, and verification requirements that CBAM imposes. The impact of this mechanism varies significantly depending on a country's exports in sectors subject to CBAM and their relationships with the EU.

Transboundary mechanisms affect the cost of imported goods, and influence the cost of living for consumers, especially for products with a high carbon footprint. Sectors directly impacted by CBAM include construction, energy, and food. Conversely, this also affects the economic prospects of suppliers in different countries and contributes to inflationary pressures. Each country has its unique

[21] Japan Business Council in Brussels (2023). *JBCE'S Position on the Reporting Obligations During the Transitional Period of CBAM*. Retrieved from https://www.jbce.org/images/JBCE_Position_on_CBAM_IR_V04_Clean_version.pdf
[22] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1975349
[23] https://www.ft.com/content/3d00d3c8-202d-4765-b0ae-e2b212bbca98

starting point; a policy effective in the EU may not necessarily be suitable for implementation in other regions.

According to the UN Comtrade[24] exports data, the impact on some MENA countries might have reached approximately 10% of total goods exports to the EU. Other countries also have a significant impact from CBAM; for example, 20% of Mozambique's total exports are aluminum to the EU, which is directly impacted by CBAM[25].

Similarly, with the recent decline in carbon prices in the UK to less than half of EU levels, producers from the UK need to pay the difference to comply with the EU CBAM[26]. In December 2023, and in less than 3 months since the EU CBAM entered into force, the UK introduced its version of the Carbon Border Adjustment Mechanism (CBAM)[27].

With the evolution of carbon markets and transboundary mechanisms, carbon crediting and offsetting have become feasible across nations. This is further facilitated by the global acceptance of Article 6.2 of the Paris Agreement, encouraging inter-country collaborations in carbon trading. However, if other countries and regions implement similar transboundary measures in response, this may raise regulatory uncertainty and transaction costs for all stakeholders, hindering trade and investment flows. On the other hand, the coherent and transparent development of carbon markets could help unlock the means to achieve climate and sustainable development goals as cost-effective, equitable, and swiftly as possible on a global scale.

3. Carbon Markets Role in Circular Carbon Economy Investment

The Intergovernmental Panel on Climate Change (IPCC) defines Carbon Dioxide Removal as follows: "*Anthropogenic activities removing carbon dioxide (CO_2) from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical CO_2 sinks and Direct Air Carbon Dioxide Capture and Storage but excludes natural CO_2 uptake not directly caused by human activities*." Countries are actively developing diverse methodologies for measuring, monitoring, and validating the removal of carbon from the atmosphere.

Why the Circular Carbon Economy (CCE) matters

Nearly all mitigation scenarios involve a combination of options and solutions aimed at reducing the global average temperature to levels below 2 or 1.5 degrees Celsius. Both nature- and engineering-based solutions are pivotal in effectively curtailing a substantial portion of CO_2 emissions. Nature-based solutions, such as afforestation, improved plantation, and coastal restoration, are crucial for naturally removing an appropriate amount of CO_2 from the atmosphere. For example, trees can capture carbon dioxide and emit oxygen throughout their entire life cycle. However, planting more

[24] https://comtrade.un.org/
[25] Magacho, G., Espagne, E., & Godin, A. (2022). *Impacts of CBAM on EU trade partners: consequences for developing countries.* Paris: Agence Française de Développement.
[26] Futures Trading Exchange for Crude Oil, Energy, Interest Rates, & Softs | ICE Futures Europe
[27] https://www.gov.uk/government/consultations/addressing-carbon-leakage-risk-to-support-decarbonisation/outcome/factsheet-uk-carbon-border-adjustment-mechanism

trees is not sufficient to capture the huge amount of CO_2 in the air. It is also essential to note that the carbon captured by trees is not permanently eliminated. In cases of bushfires or when trees are cut down for firewood, the stored carbon is released back into the atmosphere. Moreover, certain tree plantation initiatives have not met their intended objectives, as the mass planting of trees often necessitates a significant amount of water.

The engineering-based solutions of the Circular Carbon Economy can complement efforts in nature-based solutions and enable the reduction of carbon emissions with greater data accuracy and accounting reliability. The Circular Carbon Economy framework received endorsement from G20 leaders in Riyadh in 2020, and more recently, it gained further support during the G7 ministerial meeting in 2023. The technologies encompassed by the Circular Carbon Economy (CCE) include, for example, Carbon Capture, Utilization, and Storage (CCUS), Direct Air Capture with Storage (DACS), Bioenergy and CCS (BECCS), among others. These technologies have demonstrated significant effectiveness in capturing CO_2 emissions directly at their sources and can address legacy emissions by reducing CO_2 levels in the atmosphere. Developed countries have been utilizing these technologies for decades and have rolled out various new policies and strategies including substantial funding schemes to stimulate investment in the wider deployment of CCUS, DACCS, and BECCS.

Various Carbon Capture and Utilization (CCU) technologies are currently under development to recycle and store CO_2 across a range of production processes, including construction materials and chemicals. Material transitioning represents an innovative solution that can revolutionize our architecture and infrastructure, taking a significant step towards reducing material carbon footprints. Carbon fiber, for instance, shows promise as it not only utilizes captured emissions, effectively removing them, but also enables substitutions for materials that can be conserved for future generations. However, the adoption of such innovative manufacturing processes necessitates investments in Research, Development and Deployment to mitigate the current high costs associated with production by scaling solutions[28]. These technologies have the potential to attract investment from carbon markets towards the various GHG emission mitigation options material transitions can offer.

Another notable application of carbon utilization is in the production of e-fuel. Carbon dioxide captured can be combined with green hydrogen to generate e-fuel, which can be seamlessly integrated into existing automotive, shipping, and aviation industries. The primary advantage of e-fuel lies in its carbon-neutral nature, when post-combustion emissions are offset by the captured emissions utilized in production. However, challenges lie in the elevated costs associated with each stage of production, including the production of green hydrogen, capturing, and transporting carbon dioxide, and manufacturing e-fuel, each of which demands energy inputs. The widespread adoption of such innovative solutions hinges on substantial investments to render the technology cost-effective and competitive. Redirecting carbon market resources towards these low-carbon technologies would not only reduce costs but also emissions, paving the way for a more sustainable future.

Although, pending breakthroughs, conventional wisdom sees CCU making only a marginal contribution compared to CCS, CCUS has the potential to significantly reduce the costs of

[28] https://www.csiro.au/-/media/Services/Futures/21-00285_SER-FUT_REPORT_CO2UtilisationRoadmap_WEB_210810.pdf

decarbonization, safeguard numerous jobs and industries, and create new skilled job opportunities simultaneously. The progressive evolution of CCUS technologies and broader policy support for Circular Carbon Economy (CCE) in general has made it both more feasible and cost-effective for countries to support their industries in adopting this technology.

Table 1 illustrates the effectiveness of CCUS technology in addressing all 10 Core Principles developed by the Integrity Council for Voluntary Carbon Markets (ICVCM), where additional information about these principles will be presented in the next section. The anticipated carbon credits generated through CCUS are poised to significantly contribute to the global reduction of carbon emissions. The incentives provided by carbon markets for CCUS are expected to facilitate the broader deployment of this technology and a further reduction in associated costs.

Table 1: Testing CCUS as crediting projects under Article 6 and the 10 ICVCM Core Principles

Effective governance	The positive contribution of CCUS technology to a firm's annual Environmental, Social, and Governance (ESG) performance is inherently linked to effective governance, ensuring that the implementation and operation of carbon capture and storage align with environmental and sustainability goals, and regulatory compliance, including ESG. Effective governance frameworks help guide responsible practices in reducing CO_2 emissions, fostering transparency, accountability, and long-term environmental benefits.
Tracking	The range of CCUS technologies and operations continually evolves, advancing tracking and maintenance practices. This evolution can simultaneously increase scrutiny and audit measures.
Transparency	Recent methodologies for removal developed by intergovernmental bodies and non-profit organizations enhance transparency concerning CCUS technology. They also ensure the environmental integrity of carbon issuance.
Third party validation,	Emission reductions resulting from CCUS will undergo scrutiny by multiple government agencies and other third-party entities.
Additionality	The technology designed to capture emissions directly from sources or the atmosphere necessitates incentives and investments for project deployment. Without these incentives, such projects will not come to fruition. As various organizations are developing current methodologies for Carbon Capture, Utilization, and Storage (CCUS) removal, efforts to enhance methodological coherence and predictability will enhance investor confidence in this technology, consequently scaling up its deployment. It is important to note that the incentives and resources used to initiate projects in host countries constitute an additional aspect and are not included in a country's Nationally Determined Contributions, to avoid double counting.
Permanence removal or avoided	Many countries, firms, and international organizations, including the Intergovernmental Panel on Climate Change (IPCC), have tested,

	and validated this technology. Additionally, rigorous scrutiny and verification are conducted throughout the capturing operations, transportation of CO_2, injection of CO_2 underground, and post-implementation to ensure safe operations, including affirmation that no leakages can occur from the stored CO_2 and that adequate detection and emergency measures are in place.
Robust quantification	Emission reduction quantification has been well-implemented in all CCUS technologies, including Direct Air Capture (DAC), Bioenergy with Carbon Capture and Storage (BECCS), and at each stage of the process—capturing, transportation through pipelines, and injection of the captured CO_2. Robust quantification of CO_2 has already been addressed during the earlier use of this technology through Enhanced Oil Recovery (EOR). The accounting of emission reductions by CCUS technology must be effective and trustworthy, with accurate statistics that correspond with empirical test and real-world data.
No double counting	Emission reductions from Carbon Capture, Utilization, and Storage (CCUS) activities are documented in various reports, including, for example, the firm's sustainability report and annual ESG reporting. When utilized to offset emissions for other countries or firms under Article 6 or other mechanisms, emission credits are generated, preventing double counting with the host country through its Nationally Determined Contributions (NDCs). Additionally, the emission reduction is accounted for in multiple locations, including the CCUS operator, the hard-to-abate firm utilizing the CCUS activities, the balance sheet of the utilizing firm, and among other relevant entities. Moreover, in general, both the seller and buyer countries involved in the transfer of ITMOs must adhere to reporting requirements under the Paris Agreement to prevent double counting.
Sustainable development benefits	With the latest development of CCUS activities to accommodate new sectors, the benefits extend beyond environmental aspects, to generating revenues and creating decent employment and other sustainable development opportunities.
Contribution toward net zero transition	Millions of tons of carbon dioxide have already been stored in saline liquefiers or deep underground, and this number is expected to grow exponentially as many countries express increasingly ambitious plans to reach Net Zero targets. CCUS projects are either under development or anticipated to be deployed in the coming years. CCUS capacity must increase from the mega to giga tonnes of CO_2 stored to meet agreed-upon net zero climate targets.

In addition, increased investments in CCS will have an indirect positive impact on other energy sectors, such as hydrogen production with CCS. This will reduce the cost of producing clean hydrogen, as CCS processes currently account for a significant portion of the total cost.

Carbon markets revenue: Financing climate mitigation

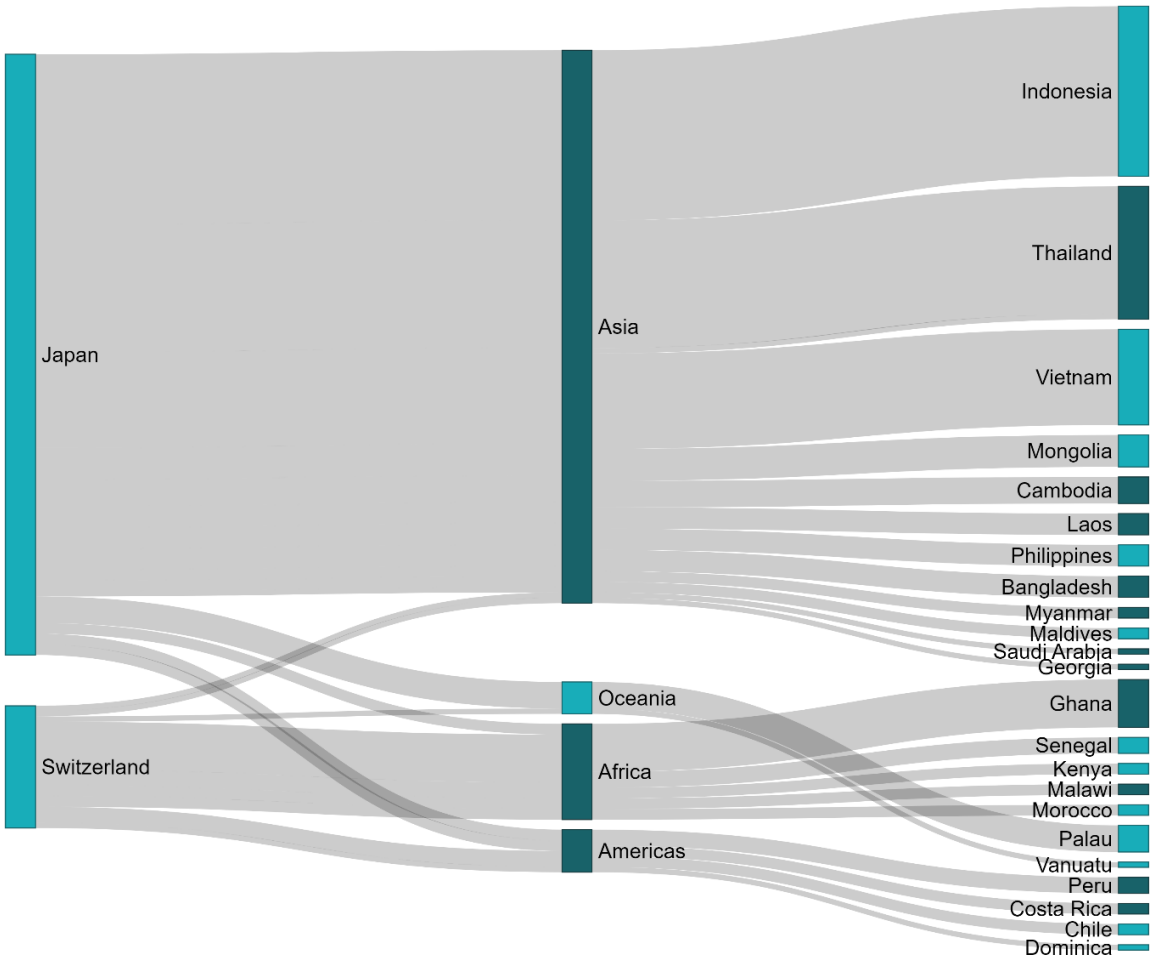
Carbon markets represent a new stream of funds that will be part of climate finance, which already includes various financial instruments such as grants, bonds, and guarantees. The financial resources in carbon markets stem from the sale of carbon credits, enabling countries to offset their emissions through the mitigation efforts of other nations. The revenues generated from carbon credits serve as an additional income source to bolster climate mitigation activities. They can amplify the efficacy of blended finance that combines concessional financing from development, philanthropic sources, and financing from private sector sources at market rates. Such a merger allows diverse stakeholders to join forces in fulfilling various public and private sector goals. Revenue streams from carbon markets can help to reduce financial market hurdles and other obstacles, ultimately leading to more substantial mitigation outcomes.

International organizations and non-governmental institutions play a crucial role in formulating, guiding, and assessing the impact of carbon markets. For instance, the World Bank's Transformative Carbon Asset Facility (TCAF), established in 2017, assists countries in enhancing their climate ambitions. Contributing to these objectives, the World Bank's Carbon Partnership Facility also plays a pivotal role. Moreover, the Integrity Council for the Voluntary Carbon Market has formulated Core Carbon Principles, concentrating on governance, emission impacts, and sustainable development, encompassing ten associated principles: 1. effective governance, 2. tracking, 3. transparency, 4. third-party validation, 5. additionality, 6. Permanence of removal or avoidance, 7. robust quantification, 8. no double counting, 9. sustainable development benefits, and 10. contribution toward a net-zero transition. These principles integrate numerous inputs from various organizations in this field, striving to create a robust global benchmark framework for carbon markets. Furthermore, the Green Climate Fund supports capacity-building activities to prepare for the implementation of carbon markets and Article 6 of the Paris Agreement operating as part of the United Nations Framework Convention on Climate Change (UNFCCC).

Carbon market diplomacy: Bilateral cooperations under the Paris Agreement

There is a rapid growth of bilateral cooperations under Article 6.2 of the Paris Agreement. As of January 2024, there have been 78 bilateral agreements, encompassing a total of 138 projects (See Figure 3). Japan is taking a leading role in this endeavor, participating in more than 100 projects across 27 countries. On the other hand, Switzerland, is involved in over 20 projects, with more than half of them located in Africa. Several other countries, including Australia, Singapore, South Korea, and Sweden, have signed bilateral agreements with countries in Africa, Latin America, Asia, and Oceania, even though actual projects have not yet been deployed. Over 50% of the 136 projects have been established in the past two years. Given that the mechanism of this market is new and evolving, global alignment and ultimate standardization of emissions accounting, crediting, validation, and verification processes is imperative. This process will help enhance investor trust, ensure the additionality of emission reductions, and form the bedrock of carbon market transparency. The usefulness of Article 6.2 stems from the provision that bilateral cooperation only necessitates approval from the involved parties/countries, irrespective of any disparities in their respective guidelines.

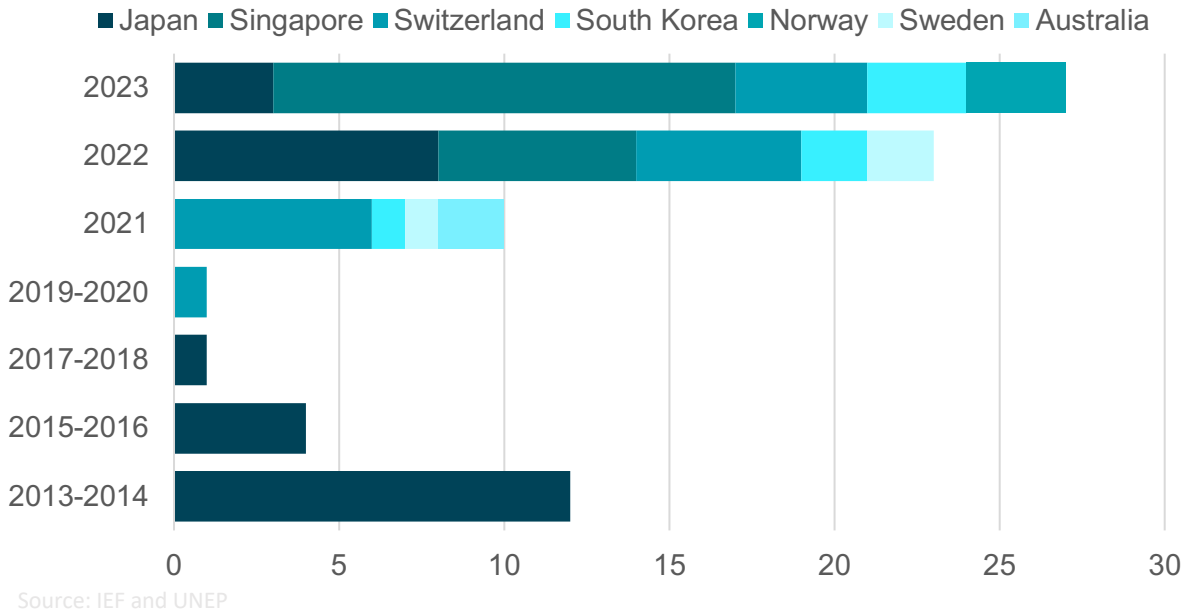
Figure 3: Bilateral Agreements between countries purchasing carbon credits (left) and those selling them (right), under Article 6.2 of the Paris Agreement.



Source: IEF & UNEP. Notes: The width of the figure represents the number of projects within this framework. Countries like Australia, Sweden, Singapore, and South Korea have signed bilateral agreements with other nations under this framework, although actual projects have not yet been initiated.

The number of bilateral agreements has exponentially increased with over 50% of all agreements signed in the past two years, as illustrated in Figure 4. This trend is anticipated to continue rising, driven by countries' ambitions to curb emissions using diverse technologies and mechanisms. Moreover, the increased clarity surrounding credit issuance and methodology, particularly within the framework of newly emerging carbon markets, further fuels this expansion.

Figure 4: Number of bilateral agreements over the years, under Article 6.2 of the Paris Agreement and the CDM.



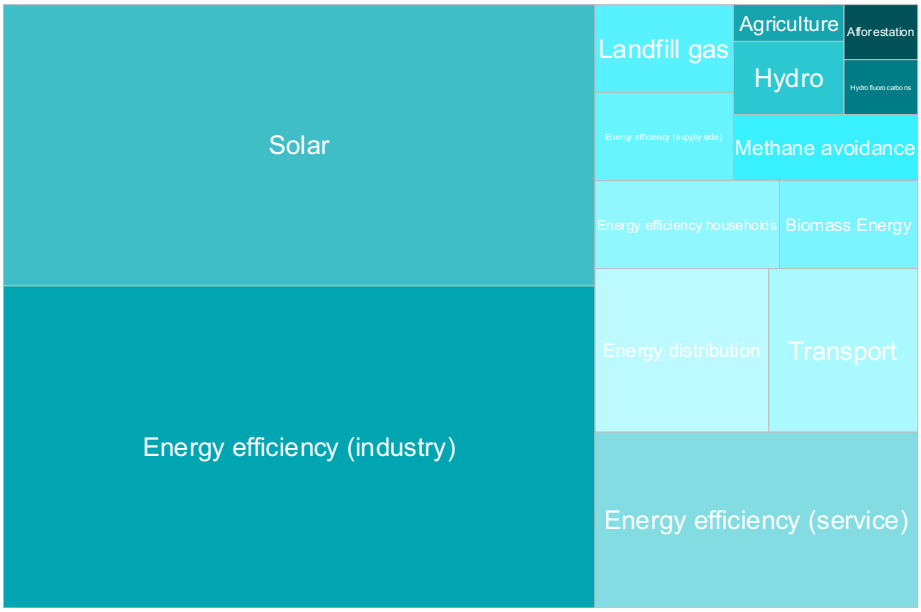
Source: IEF and UNEP

Note: A biannual presentation has been conducted due to the absence of bilateral agreements signed in certain initial years of the targeted period.

Energy efficiency is the prominent credited activity that has been approved under Article 6.2 of the Paris Agreement (see Figure 5), accounting for over 50% of all activities. It is essential to ensure that these activities permanently remove CO_2 emissions to have a meaningful impact on climate change. The Circular Carbon Economy offers promising solutions, such as CCUS, for the permanent removal of CO_2 emissions that thus far are not covered by this carbon market mechanism.

Recent estimates from McKinsey indicate that worldwide investments of $100-$150 billion are required for CCUS to meet global climate goals. The current growth of evolving carbon markets can play a crucial role in attracting the necessary investments. Inclusion of CCE/CCUS based emission mitigation outcomes within the framework that evolving carbon markets provide will accelerate global greenhouse gas emission reductions, increase the liquidity and stability of global carbon and energy markets, and deliver on sustainable development goals.

Figure 5: Project activities under Article 6.2 bilateral agreements.

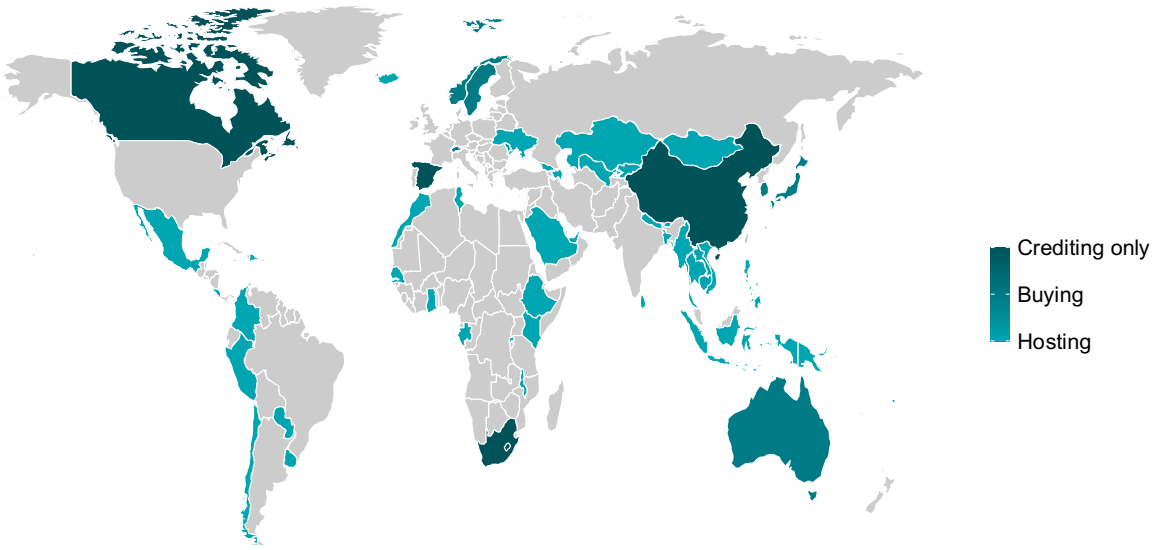


Source: IEF & UNEP

Carbon trading offers distinct advantages particularly in encouraging the participation of developing countries. It facilitates mobilizing capital and technology, thereby supporting these nations in achieving their net zero carbon targets and sustainable development goals. The private sector, driven by incentives from carbon markets, can identify and implement cost-effective carbon reduction opportunities worldwide. This approach promotes sustainable development in host countries by allowing them to engage in new economic activities and host emission-reducing projects. An inclusive global carbon market, allocating carbon allowances to developing countries, becomes a more effective and participation-efficient strategy compared to direct financial payments or sustainable financing alone.

Increasing participation is essential to drive the markets and boost the demand for carbon credits, particularly from the EU, UK, and the USA. A global overview of countries involved in the Article 6.2 mechanism indicates limited engagement from developed nations, as shown in Figure 6. Urgent attention is needed to focus on the implementation of Article 6 through domestic legislation, carbon credit purchasing strategies, and market infrastructure.

Figure 6: Global mapping of Article 6 participation and carbon crediting mechanisms.



Source: IEF, UNEP and World Bank. Note: *Hosting* countries refer to those hosting GHG emission reduction projects generated under Article 6.2 of the Paris Agreement; *Buying* countries are those purchasing carbon credits under the Paris Agreement derived from these projects, and *Crediting* countries are those with established crediting mechanisms in their countries but are not yet participating in the global mechanisms i.e. South Africa Crediting Mechanism and Spain FES-CO_2 Program. While some countries are presented as hosts of the climate projects, they can also be classified as buying countries. For example, Saudi Arabia's VCM organized two auctions in the past couple of years (2022 and 2023), selling approximately 3.6 million tonnes of carbon credits to domestic firms. The data presented here is at the national level and subnational authorities are not mentioned i.e., California Compliance offset Mechanism.

Carbon markets security: Building resilience for energy markets and environmental sustainability

One of the primary lessons learned from the recent pandemic and rising geopolitical tensions is the importance of enhancing resilience and leveraging diverse energy sources and physical and financial energy market options. Global energy security and market stability are closely intertwined with efforts to mitigate climate change, as evidenced by supply chain vulnerabilities and escalating cost of living crisis, which has sharpened global divisions.

The mandate of the International Energy Forum (IEF) to strengthen global energy security, market stability, and accelerate orderly and just transitions through producer-consumer dialogue relies on a deepened understanding of the complex interactions between energy security, market stability, climate and sustainable development goals. This involves exploring new policies and technological solutions that foster greater resilience and inclusion. Enhanced dialogue on evolving carbon markets and corresponding mechanisms will foster a more orderly and equitable energy transition. Above all, carbon market may help to attract new investments for a broader range of climate mitigation outcomes, including Circular Carbon Economy solutions, and facilitate bridging global divides through the financial flows directed to the global south.

4. Carbon Market Transparency: Better data for better abatement

The evolving carbon markets have spurred the growth of verification bodies and non-profit organizations, providing guidance, frameworks, and methodologies. Among well-known organizations are Verra, Global Carbon Council (GCC), I-Renewable Energy Certificate Standard, American Carbon Registry, Gold Standard, and others. Additionally, the Article 6.4 Advisory Body develops methodologies and guidance for carbon markets. However, clear, cohesive, and consistent guidance on carbon markets is still lacking. Measuring procedures vary from one methodology to another which hampers comparability and erodes investor confidence.

Asymmetry in methodologies and standards

The lack of consistency in methodology presents challenges when comparing the mitigation outcomes achieved by various countries and industries employing similar mitigation options. This complicates the assessment of carbon market uptake and investment in CCUS and other clean technologies on a global scale. Divergent methodologies drive up costs and impose significant expenses to align project proponents with different approaches. This complexity creates obstacles for project sponsors and owners, heightening risks, and constraining opportunities for scaling. Greater clarity and harmonization are imperative to facilitate cross-country comparisons. Additionally, the absence of benchmarking methodology or guidance from accredited institutions exacerbates the issue. Therefore, it is crucial for GHG emission reduction activities covered by carbon markets to be monitored and reported in a manner that enables comparisons with similar activities across methodologies and jurisdictions.

Technical challenges

The transition toward achieving emission reductions and universal energy access will inevitably incur additional costs and risks, particularly when global markets face undue barriers to trade and investment. Such barriers diminish economic incentives for the efficient allocation of capital and resources, resulting in suboptimal outcomes in international markets, which can disproportionately affect vulnerable stakeholders. Many emerging economies already encounter limitations in accessing climate finance and resources necessary for affordable and equitable transitions. Beyond financial constraints, stakeholders in carbon markets may also confront challenges in the following areas:

Market transparency and accountability

The vast majority of medium to large firms have implemented accounting, measurement, validation, and monitoring of GHG emissions throughout the production process and value chains. However, in countries where climate policies are less developed, this is still not a common practice. Accelerating emission reporting in alignment with evolving carbon markets is a challenging task that requires systematic capacity building and skills. Challenges may arise due to constraints on human resources, institutional capacity, and infrastructure. Integrating global markets can help address these challenges by reducing accounting hurdles and mitigating the risk of double counting.

Structural transformation

To fulfill their environmental commitments, countries and firms must modify their operations to reduce carbon emissions while simultaneously maintaining competitiveness. This can result in two scenarios: some countries/firms may successfully invest in cleaner technologies and practices, potentially yielding positive socio-economic impacts like job creation and technological innovation. However, emerging countries may find it more challenging to catch up in this regard, potentially leading to a

decline in exports of products with high carbon footprints. The structural transformation of the global economy from cost competitiveness to carbon competitiveness could adversely impact employment, industrial competitiveness, overall economic performance, and widen global divides when left unaddressed. Orderly and just transitions will increasingly depend on how these new carbon market metrics are measured and valued in national markets and by trade and investment partners. Creating a fair, transparent and predictable playing field for carbon competitiveness is crucial to achieve climate targets and foster inclusive and sustainable economic growth globally.

Capacity building

With the introduction of carbon markets by emerging economies, there is a need to build skills and knowledge. Countries hosting environmental projects should enhance their capacity in collecting and harmonizing carbon market and related environmental statistics and develop robust frameworks and guidelines to attract investments. Carbon Capture and Storage (CCS) facilities may also require specific technical expertise in terms of operations, maintenance, and post-injection assurance. Developing these knowledge and data networks will not only benefit carbon market initiatives but also help countries save costs toward achieving their Nationally Determined Contributions (NDC) targets.

Stakeholders need to work towards a comprehensive and collectively shared understanding of the accounting framework of Article 6 and project requirements to address these issues effectively and ensure carbon markets deliver on their promise. Demand for capacity-building training and education of human resources in measuring, monitoring, reporting techniques and validating other skills will grow as carbon markets evolve. This includes tools and skills to reliably quantify and estimate GHG emissions associated with global trade and investment flows and entire value chains, as Carbon Border Adjustment Mechanism enter effect.

Enhancing digitalization and coding requirements

Digitalization plays a crucial role in ensuring high-quality accounting while reducing time and effort. The digitalization of carbon markets enhances robustness and trust among investors. Scaling up digitalization across all phases of Carbon Capture and Storage (CCS) activities will improve transparency and accuracy. In addition, as carbon markets and CCS experience expanded growth in monetary volume, usage, and trade, it becomes imperative for countries and organizations to institute relevant codes for identifying these activities within the broader economy. This involves creating new codes and standards aligned with the International Standard Industrial Classification, National Accounts, and Extended Balance of Payment Services Classification.

Fragmentation in world trade: an example of trade hurdles

Energy markets and the world economy more broadly have undergone significant changes due to globalization, demographic growth, and the emergence of new energy technologies. For example, leaders from the World Trade Organization (WTO) and the International Monetary Fund (IMF), have warned that dividing the world into blocs would lead to a global decline in GDP ranging from 0.2-7 %[29]. Governments have warned that imposing fees and adding more restrictions could sometimes yield positive outcomes to overcome socks, but it could result in greater economic instability and rising

[29] https://www.imf.org/-/media/Files/Publications/Fandd/Article/2023/June/md-ngozi-okonjo-iweala.ashx

inflation if protectionist measures adopted under the guise of national energy security, economic competitiveness, and climate or environmental goals become more entrenched[30].

In general, the increase in international trade and investment flows raises various environmental governance questions, including the embodiment of carbon or GHG emissions associated with the energy matrices from which imported goods and services originate. The OECD, for example, has developed a set of indicators that provide statistics on emissions associated with international trade and investment flows[31]. For instance, production- and consumption-based indicators provide estimates of the origin of CO_2 emissions produced by each country and the emissions embodied in final demand, essentially illustrating the comparison between CO_2 production and CO_2 consumption[32].This also relates to where and how emissions are measured or to which country they are attributed and where these goods and services are produced or consumed. For example, the demand-based perspective encompasses not only emissions related to activities within a country but also emissions associated with imported goods and services. This includes, for instance, CO_2 emissions embodied in steel production in the exporting country, which are subsequently imported for use in the car industry in the EU. How carbon content is measured and to which countries these are allocated makes a huge difference.

The complexities of tracing supply chain origins and related GHG emissions illustrate the challenges in managing carbon content and GHG emissions data. Even with fully transparency, issues regarding their appropriate allocation persist. For instance, Mozal, an aluminum producer in Mozambique, primarily exporting to the EU automotive industry, accounted for approximately 6% of Mozambique's aluminum exports to the Netherlands in 2021[33]. This is one of the sectors targeted by the EU Carbon Boarder Adjustment Mechanism (EU CBAM). Mozal's aluminum production relies on bauxite and alumina from Australia, and a portion of the electricity used in production comes from South Africa[34]. The critical question is whether the final products exported to the EU should include the emissions associated with the imported inputs used in production? If the emissions contribution of the final products to the EU is minimal due to these factors, it becomes challenging to compare Mozal with companies whose activities are mostly confined within their own operations. Thus, if a significant proportion of the final products are composed of imported inputs, gathering information from various companies with varying climate rules and emissions reporting standards becomes necessary. This complexity raises numerous questions along the supply chain. So, depending on a firm's position in the entire value chain, emissions accounting can vary significantly, and there is considerable room for interpretation regarding how these emissions are allocated.

The absence of readily available comparable and reliable data, along with a lack of globally shared methodologies on how GHG emissions are allocated along global value chains, leads to the necessity of making numerous assumptions when constructing these indicators (particularly in the context of

[30] https://www.atlanticcouncil.org/news/transcripts/dutch-deputy-prime-minister-sigrid-kaag-on-how-the-eu-can-use-geoeconomic-tools-to-assert-itself-on-the-international-stage/
[31] See http://oe.cd/io-co2
[32] OECD. (2021). *Carbon dioxide emissions embodied in international trade*. Retrieved from https://www.oecd.org/industry/ind/carbondioxideemissionsembodiedininternationaltrade.htm
[33] See https://oec.world/en/profile/country/moz
[34] Mozal's Annual Report (2023). https://www.south32.net/docs/default-source/annual-reporting-suite/2023/sustainable-development-report-2023.pdf?sfvrsn=2e57d4d2_2

OECD indicators mentioned above) and estimates, even if solely for research purposes[35]. Various data and methodological challenges arise for producers and consumers that must be addressed.

5. Conclusions

Evolving carbon markets help to reduce costs and align regulatory frameworks towards more cohesive and predictable climate and energy policies among producers and consumers. The introduction of national Voluntary Carbon Markets (VCMs) is one step towards addressing both national and global climate change goals, especially for countries that have yet to implement emission trading systems. With the introduction of VCM, companies can build on their own capacity in gathering emission statistics. Individuals and businesses benefit from participating in these markets by reducing their own emissions, supporting net-zero targets, and meeting sustainability objectives while increasing options to access climate finance.

Carbon markets can play a pivotal role in attracting sustainable investments toward Circular Carbon Economy solutions. This will have multiple implications; for the environment, contributing to a reduction in global carbon and material footprints; for the economy, by generating revenues and income; and for sustainable development and inclusion, for instance, by creating employment and growth opportunities.

Several challenges, including issues related to human capital, climate finance, and industrial adaptation, have been identified as obstacles to achieving sustainable development goals and climate net-zero targets. Any policy aimed at strengthening efforts in evolving carbon markets needs to ensure that they are designed as win-win solutions for both producers and consumers.

The IEF can serve as a hub to evaluate diverse carbon market methodologies of IEF member countries, facilitating the sharing of knowledge and data to foster the global evolution of these markets in a cohesive and reliable manner. This approach aims to avoid trade and investment hurdles while promoting orderly and just transitions.

[35] Wiebe, K. and N. Yamano (2016), "Estimating CO2 Emissions Embodied in Final Demand and Trade Using the OECD ICIO 2015: Methodology and Results", OECD Science, Technology and Industry Working Papers, No. 2016/05, OECD Publishing, Paris, https://doi.org/10.1787/5jlrcm216xkl-en.

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