UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

SUSTAINABLE DEVELOPMENT GOALS

Carbon Credits for Ethanol Cooking

A Guide for Carbon Credit Project Developers

European Union

COUNCIL ON ETHANOL CLEAN COOKING

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CARBON CREDITS FOR ETHANOL COOKING

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Special thanks go to Rana Ghoneim (Chief of TCS/ECA) for her insightful comments and valuable contributions and suggestions during the development process.

EDITING & GRAPHIC DESIGN: The Typesetter.

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Abbreviations

CA	Corresponding Adjustments
CDM	Clean Development Mechanism
CER	Certified Emissions Reduction
CME	Coordinating/Managing Entity
COP	Conference of Parties
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CPA	Component Project Activity
CPA-DD	Component Project Activity Design Document
DFI	Development Finance Institution
DOE	Designated Operational Entity
EB	CDM Executive Board
ER	Emission Reduction
ERPA	Emission Reduction Purchase Agreement
ESMAP	Energy Sector Management Assistance Programme
ETS	Emissions Trading Scheme
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIPCC	Global Impact Programme for Clean Cooking
GS	Gold Standard
Gt/GT	Gigaton
ICAO	International Civil Aviation Organization
ICVCM	Integrity Council for the Voluntary Carbon Market
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ITMO	Internationally Transferred Mitigation Outcome
KW	Kilowatt
LPG	Liquified Petroleum Gas
LULUCF	Land Use, Land Use Change and Forestry
M	Million
MDB	Multilateral Development Bank
MEF	Market Enabling Framework
MRV	Monitoring, Reporting and Verification
$MtCO_2e$	Million metric tons of CO_2 equivalents
MW	Megawatt
NCMC	National Carbon Monitoring Center, Morogoro, Tanzania
NDB	National Development Bank
NDCs	Nationally Determined Contributions
NGO	Nongovernmental Organization
PDD	Project Design Document
PIN	Project Idea Note
PoA	Programme of Activities
PoA-DD	Programme of Activities Design Document
RBF	Results-based Finance
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDGs	Sustainable Development Goals
SE4ALL	Sustainable Energy for All
SMEs	Small and Micro Enterprises
SSC	Small-scale CDM Project
SUA	Sokoine University of Agriculture
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
VAT	Value-added Tax
VCM	Voluntary Carbon Markets
VCMI	Voluntary Carbon Markets Integrity Initiative
VCS	Verified Carbon Standard
VER	Voluntary/Verified Emission Reduction

Foreword

Achieving **universal access to clean cooking** is a key step towards realizing **Sustainable Development Goal 7 (SDG 7)**, which aims to ensure affordable, reliable, sustainable, and modern energy for all. However, in many developing countries, households still rely on traditional biomass or fossil fuels for cooking, leading to severe health, environmental, and economic consequences. Modern clean cooking solutions are central to addressing these challenges, and among them, **ethanol-based clean cooking** has emerged as a transformative alternative.

Ethanol is a clean-burning, sustainable fuel that improves indoor air quality, reduces greenhouse gas emissions, and can be locally produced from diverse agricultural feedstocks. Its adoption offers a pathway to mitigate deforestation, enhance energy security, and foster economic development. However, scaling ethanol-based cooking solutions has been impeded by barriers such as limited supply chains, insufficient investment, and competition with fossil fuels.

A critical opportunity to overcome these barriers lies in **carbon finance**. By linking the emissions reductions achieved through clean cooking projects to **carbon credits**, stakeholders can access new funding streams to support the development and deployment of ethanol stoves and fuels in scale. The **voluntary carbon markets**, in particular, provide a dynamic platform to channel financial resources into these initiatives, driven by global commitments to reduce carbon emissions.

This document is a comprehensive guide for stakeholders—private sector actors, project developers, policymakers, and investors—on how to design and implement **carbon credit projects for clean cooking**. It outlines a step-by-step approach to navigating voluntary carbon markets, from project design and validation to credit issuance and trading. Moreover, it emphasizes practical strategies for leveraging carbon finance to scale ethanol-based cooking solutions, ensuring projects are both impactful and financially sustainable.

The guide illuminates the potential of carbon finance as a catalytic tool and provides actionable insights for stakeholders committed to driving progress toward SDG 7 and sustainable development. Within this document, stakeholders will find the knowledge and tools necessary to unlock the full potential of carbon credit projects for clean cooking, advancing a future where clean energy solutions are accessible to all. •

Executive Summary

Ethanol is an emerging cooking fuel solution for developing countries. Rectified ethanol, i.e., ethanol that has been cleaned of impurities produced during fermentation, burns very cleanly, with no smoke or soot, or other emissions such as nitrous oxide, thus alleviating the harmful health effects of cooking fires. Rectified ethanol is generally produced in distilleries throughout Africa, India and Southeast Asia. It has shown to be competitive in terms of cost with charcoal and fuelwood in most developing country marketplaces. Unlike other clean cooking fuel options, ethanol can be produced locally in most countries from various available feedstocks. Establishing an ethanol fuel production industry —ideally coupled with the sugar industry or with other agricultural co-products— will allow the introduction of ethanol as a fuel for clean cooking. This will allow countries to move closer to achieving their Nationally Determined Contributions (NDCs) under the Paris Agreement while improving their citizens' health and creating new economic opportunities.

Although there has been interest in ethanol for fuel in African and Southeast Asian countries for many years, and at least since the 1970s when the oil shocks created damaging and costly trade imbalances for many countries, ethanol is still a rarely used fuel, even in those countries heavily dependent on imported fuels. The dominance of petroleum fuels has slowed progress in the development of ethanol as a fuel. Moreover, banks, development agencies and private funds have been deterred from supporting ethanol fuel because of controversy in Europe and the Americas over corn ethanol, oilseed crops and land use change, as well as the orientation of the legacy sugar industry in Africa toward the production of distilled spirits for drinking—a holdover from businesses that took root in colonial days. The key constraints that must be overcome now to accelerate the development of ethanol fuel are access to finance and the creation of concerted, well-organized, government-backed and nurtured development programmes. This whitepaper seeks to examine how carbon finance, as a form of results-based finance, could be integrated into a business development programme, or into individual business plans, to help finance ethanol fuel production and the creation of distribution businesses for ethanol cooking fuel.

The Kyoto Protocol and the Paris Agreement emphasize financial assistance from industrialized nations to developing and vulnerable countries to implement projects that mitigate climate change, adapt to its impacts, and support sustainable development. These agreements have facilitated the development of carbon markets by promoting the trading of carbon emission rights and derivatives, thereby fostering carbon finance. The Paris Agreement's Article 6 establishes mechanisms for international cooperation in reducing emissions. At COP28 and COP29, significant progress was made in finalizing the rulebook for implementing Article 6, particularly concerning the centralized carbon market under the UN's Article 6.4 mechanism. This mechanism is expected to benefit developing countries through new financial flows and capacity-building support. These advancements have bolstered market momentum for climate finance, driven by "Net Zero" commitments and other corporate climate initiatives. Both the demand and supply sides of carbon markets are responding positively to this momentum, indicating a promising trajectory for global climate action.

Demand for carbon credits, despite some ups and downs, is growing steadily, and is expected to continue to grow in the coming years. Clean-burning, efficient ethanol cookstoves used by households to replace non-renewable biomass and/or fossil fuels are a well-proven emissions reduction programme. Therefore, carbon credits generated from emissions reductions achieved by ethanol cookstoves can play an essential and even catalytic role in upscaling ethanol stove programmes in developing countries—whether by subsidizing stove or fuel prices for new users or assisting in some other way. Current carbon markets, both compliance (mandatory) and voluntary, offer a promising financial opportunity for ethanol fuel and stove businesses, and thus for project developers. Therefore, adding carbon finance to a business or development plan should be carefully considered.

Moving a carbon credit project from conception to the final issuance of offsets takes time and attention to detail. The extended time and resource requirements to develop a carbon finance project have been an enormous challenge for many small-scale projects. To address this challenge, developing a carbon credit strategy for ethanol stove businesses is necessary. This paper reviews approaches that relevant stakeholders can take to lower the burden of developing a carbon finance programme for small projects in selected countries. It examines the Programme of Activities (PoA) approach and applicable methodologies. The PoA provides the organizational and financial framework structure for the on-the-ground activities required to implement projects. Managed by a Coordinating/Managing Entity (CME), it allows the inclusion of as many small ethanol stove projects (Component Project Activities [CPAs]) as possible, and creates the possibility of pre-financing from a carbon developer or early investor under an Emissions Reduction Purchase Agreement (ERPA). •

1. Background

1.1 Clean Cooking Energy

More than 2.5 billion people lack access to clean cooking fuels, relying instead on solid biomass, kerosene or coal as their primary cooking fuel (IEA, 2022). Household air pollution, mostly from cooking smoke, is linked to around 2.5 million premature deaths per year (IEA, 2022). Although there is a gradual decline worldwide in the number of people without access to clean cooking, it has not been enough to outpace population growth in many countries, especially in sub-Saharan Africa. The challenges imposed by the COVID-19 pandemic have increased the number of people without access by 1 per cent between 2019 and 2021, putting many countries further away from reaching universal access to clean cooking (IEA, 2022).

The imperative to provide universal access to reliable and clean energy is increasingly well-recognized (Banerjee et al., 2013). However, constraint in access to finance is perhaps the major limitation to expanding small-scale energy projects in developing countries. Despite the $4.5 billion in annual investment required for the clean cooking sector to reach billions of people by 2030 who still depend on polluting fuels, the investment in the sector remains only in the tens of millions of dollars (CCA, 2022). Carbon markets can provide an additional source of revenue for clean cooking projects by creating a commercial value for greenhouse gas (GHG) emissions reduced by clean energy projects. Carbon markets create a payment platform for projects to access capital and for buyers to purchase emissions reductions. Within this context, carbon finance can be a catalytic opportunity, particularly for projects in least-developed countries.

Carbon finance is a form of results-based finance (RBF), an approach that provides payments for the delivery of pre-specified outputs or outcomes. RBF emerged primarily in the health sector, and is increasingly used by international financial institutions and some donors to support low-carbon energy access programmes (ESMAP, 2013). RBF and carbon finance share many features and procedures, including monitoring and the possibility of long-term support. An important difference, however, is that RBF relies on donor finance, which is at least partly intended to cover the cost of market development, while carbon finance relies on the market for funding (Lambe et al., 2014).

1.2 Carbon Finance

Climate change is becoming more and more severe, causing extreme weather events. A steady increase in the earth's GHG concentration over the past two centuries has been its major cause. The Intergovernmental Panel on Climate Change (IPCC) third assessment report revealed that the world atmospheric temperature is increasing, and most of the warming observed has occurred in the past 50 years. In response to that change, the international community began negotiations to limit anthropogenic GHG emissions. Over time, 191 countries have agreed on a multilateral framework to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UN, 2022).

The Kyoto Protocol was adopted in 1997 in Kyoto, Japan, and entered into force in 2005. The protocol shares objectives to limit GHG emissions to a level that will not be catastrophic to the climate. To meet this objective, the protocol sets commitments for the parties. Annex I parties[1] have a binding commitment to limit their GHG emissions to not exceed the allowable level of emission targets. Annex I parties can add to or subtract from their initial assigned amount, and meet or change their allowable emission targets through emission reduction mechanisms. As countries cap emissions, companies can purchase carbon credits to compensate for the quantity of what they emit beyond their accepted or permitted levels. This allows parties to cancel, acquire or transfer their emission allowances (UNFCCC, 2008).

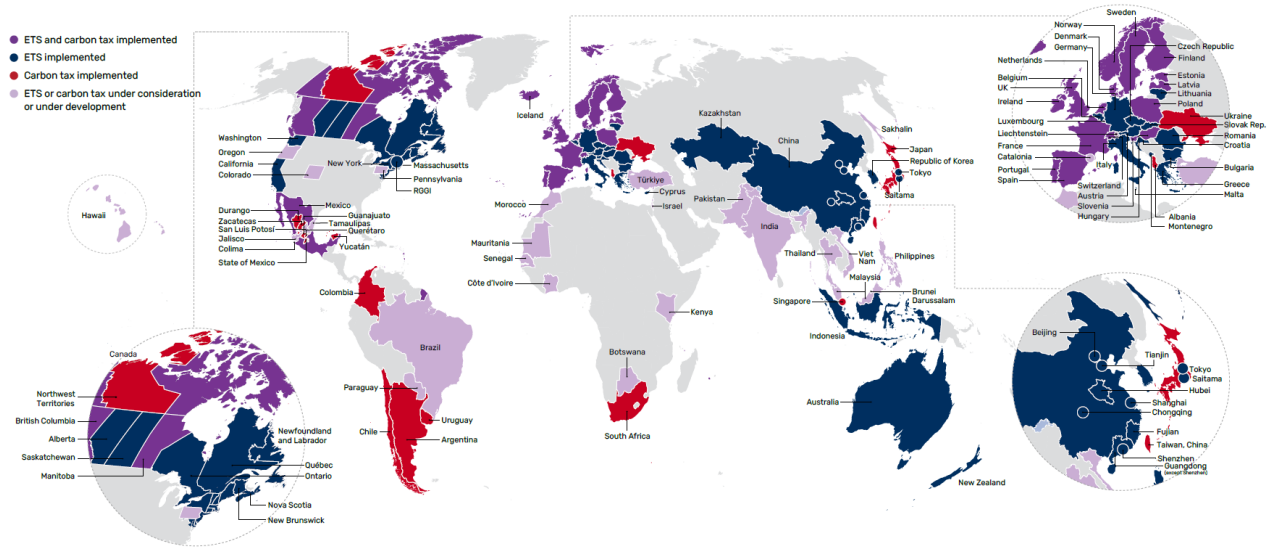
Carbon finance is a local, national or transnational financing that seeks to support mitigation and adaptation actions. The Kyoto Protocol and the Paris Agreement call for financial assistance from industrialized countries to more vulnerable developing countries to implement projects that mitigate climate change and support sustainable development (UNFCCC, 2022). Climate finance promotes the trading of carbon emissions rights and derivatives, which improves the cost of doing business for firms with carbon footprints, encouraging them to reduce GHG emissions (Li and Liu, 2011).

The amount of emissions reduction is measured in carbon credits. A carbon credit (often called a *carbon offset*) is a credit for GHG emissions reduced or removed from the atmosphere by an emission reduction project, which can be used by governments, industries, or individuals to compensate for the emissions they generate elsewhere. One carbon credit is equal to one metric ton of carbon dioxide (tCO_2) or, in some markets, carbon dioxide equivalent gases (CO_2e), and these are bought and sold through international brokers, online retailers, and trading platforms. Since GHG mitigation projects generate credits, this approach can be used to finance carbon reduction schemes among trading partners around the world (Reichel, 2020). Businesses that find it difficult to comply with the carbon emission requirements can purchase carbon credits to offset their emissions by making finance readily available for renewable energy use, forest protection, and reforestation projects around the world (Reichel, 2020).

Globally, a growing number of governments are adopting net zero targets with more ambitious carbon pricing instruments. **Figure 1** below shows the carbon market and carbon tax schemes around the globe. The large circles on the figure represent cooperation initiatives on carbon pricing between sub-national jurisdictions; the small circles represent carbon pricing initiatives in cities.

[1] *Annex I parties include the industrialized countries that were members of the Organization for Economic Co-operation and Development (OECD) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States.*

Figure 1: Carbon pricing map and emissions trading schemes (2021)



Note: Instruments "under development" are where a government is actively working toward the implementation of a carbon pricing instrument and this has been formally confirmed by official government sources.

Source: **World Bank, 2024.**

1.3 Carbon Market

A carbon market is a market where countries can trade carbon credits generated by the reduction or removal of GHG emissions from the atmosphere. Carbon markets assign a cost to producing carbon emissions, to create an incentive to emit fewer emissions, either through efficiencies or offsets. As countries cap emissions, companies can purchase carbon credits to compensate for the quantity of what they emit beyond the accepted or permitted levels. Offsets come from projects that reduce carbon emissions, e.g., switching fuel for cooking from fossil fuel or unsustainably harvested charcoal to renewable ethanol. Thus, clean and efficient cookstove technology powered by renewable energy such as ethanol used to replace non-renewable biomass and/or fossil fuel can result in emission reductions.

For emission reductions to be traded, offsets or removals from carbon finance projects must first be validated by designated independent third-party operational entities (DOEs) and registered to an international carbon standard, where they can be verified and certified as emission reductions/removals. The amount of emission reductions (tons of CO_2e) that are issued are then traded in the carbon market (UNFCCC, 2008). Trading is done in two types of carbon markets: the compliance market and the voluntary market.

1.3.1 Compliance Carbon Markets

Compliance (mandatory) markets are governed by national, regional, or provincial law and compel emission sources (emitters) to meet GHG emissions reduction targets. These carbon markets result from regulations to reduce carbon emissions, and allow regulated entities to obtain and surrender emissions permits (allowances) or offsets to meet predetermined

regulatory targets. Because compliance programme offset credits are generated and traded for regulatory compliance, they typically behave like other commodities priced in the market (Lambe et al., 2014).

An international or government agency sets the rules about what types of offsets are permitted in the market, e.g., EU Emissions Trading Scheme (EU ETS) and Korea ETS. The UNFCCC created the Clean Development Mechanism (CDM) market, which began trading in 2006 to help industrialized countries meet their international commitments (e.g., Kyoto Protocol, Doha Amendment, Paris Agreement, etc.) to reduce climate emissions. The CDM has led to the registration of more than 7,837 carbon offset projects and 365 Programme of Activities in 111 countries (CDM, 2025). To date, more than 2 billion CDM credits, called Certified Emission Reductions (CERs), have been issued by the CDM (CDM, 2025).

Carbon credits (offsets) can be used to comply with emission reduction obligations under cap-and-trade systems. There are approved methodologies to quantify the volume of emission reductions achieved for each specific project type. The UN-approved standard for offsets derives from the CDM, which was created under the Kyoto Protocol with a dual purpose: (1) reduce the cost of climate change mitigation by providing flexibility in where GHG emission reductions occur, and (2) promote sustainable development through the transfer of financial resources and sustainable technologies to developing countries (UNFCCC, 2022). CDM credits, CERs, were used to meet obligations under the Kyoto Protocol or national or regional cap-and-trade systems. The CDM was the only programme that could issue carbon credits from developing countries to be used for compliance in developed countries. Primary demand for CERs comes from corporations that have emission reduction obligations under the EU ETS and from a handful of European governments (Lambe et al., 2014). The CDM is now being transformed to Article 6 based on the 2015 Paris Conference of the Parties (COP21) agreement.

1.3.2 The Voluntary Carbon Market

The voluntary carbon market refers to all purchases of carbon offsets not driven by an existing regulatory or compliance obligation. Voluntary markets serve businesses, organizations and individuals seeking to offset their GHG emissions even though they are not required to. Demand is driven primarily by companies motivated by corporate social responsibility, a desire to show leadership in their industry or public opinion. There has been a growing interest in funding projects that deliver developmental, environmental and social benefits, along with emission reductions (World Bank, 2021). Offsets sold on the voluntary carbon markets typically follow rules prescribed by one of the voluntary standards bodies. There are several different voluntary standards for carbon offsets. These include The Gold Standard, the American Carbon Registry, the Verified Carbon Standard, the Climate Action Reserve, and Plan Vivo.

Although the voluntary market represents a special opportunity for pro-poor energy projects, both markets provide advantages and limitations arising from the attributes or characteristics of their system, such as their market participants, flexibility in applying methodologies, stringency of accounting, and carbon credit prices.

1.4 Demand for Carbon Credits

COP26 marked a significant milestone with the completion of the rulebook for implementing what negotiators adopted in the Paris Agreement, particularly the framework for Article 6. This article provides mechanisms for international cooperation in reducing emissions by building on and modernizing elements of the CDM. Subsequent climate conferences, including COP29, have advanced the operationalization of Article 6 by clarifying rules for carbon markets and increasing transparency in emissions trading systems. Market momentum continues to grow, driven by Net Zero commitments, ambitious corporate climate pledges, and increased engagement from both the public and private sectors. As countries and companies align their climate strategies with global goals, both the demand and supply sides of carbon markets are expanding. The current market dynamics are promising for project developers to participate in the carbon markets.

Momentum has been building for more robust carbon markets, driven by Net Zero[2] pledges, energy compacts[3] and other corporate and civic climate commitments (World Bank, 2024). The demand for carbon credits to fulfill these pledges is growing and is expected to continue rising in the coming years (World Bank, 2024). Financial actors—such as banks, private funds, investment companies, and brokers—are becoming increasingly involved in the carbon markets, which is likely to improve liquidity. Further, the development of more standardized products for voluntary credits reflects a growing interest in the market.

The voluntary carbon market has experienced significant growth in recent years, but it has somewhat slowed down lately. In 2021, the volume of carbon credits traded increased to 516 million $MtCO_2e$, more than doubling from 2020 (Congressional Research Service, 2024). However, in 2022, the market saw a decline, with transaction volumes dropping by about 50% to 254 million $MtCO_2e$ (Congressional Research Service, 2024). In 2023, the voluntary carbon market experienced a significant downturn, with total transactions plummeting by 56% to 111 million $MtCO_2e$ (Ecosystem Marketplace, 2024). This downturn was primarily driven by a substantial decrease in transactions related to renewable energy and forestry and land-use projects, which had previously accounted for a significant portion of credit transactions (Ecosystem Marketplace, 2024).

Despite the overall market contraction, certain project categories demonstrated resilience. Notably, projects focusing on soil carbon sequestration and blue carbon initiatives, such as mangrove restoration, continued to attract interest and investment (Ecosystem Marketplace, 2024). These projects are increasingly recognized for their potential to deliver high-quality carbon credits with co-benefits, including biodiversity conservation and enhanced resilience to climate change (World Bank, 2024).

The price of carbon has doubled since the end of 2020 (carboncredits.com, 2022). In the past five years, the voluntary market has taken dominance over the CDM (compliance market).

Several carbon pricing instruments allow entities to use carbon credits to meet their obligations, especially those in East Asia and North America. However, these only accounted for 18 $MtCO_2e$ in 2020 (World Bank, 2021). Despite fluctuations, the voluntary carbon market has seen significant growth over the past few years, with its value increasing from just $520 million in 2020 to $2 billion in 2021. By 31 August 2021, voluntary carbon markets had posted $748.2 million in sales for 239.3 million credits, reflecting a 58% increase in value (up from $472.9 million) and a 27% growth in credit volume over 2020 (up from 188.2 million credits transacted) (Ecosystem Marketplace, 2021). In 2022, the voluntary carbon market experienced a 51% decrease in transaction volume compared to 2021 (Ecosystem Marketplace, 2024). However, the average price per credit increased by 82%, rising from $4.04 per ton in 2021 to $7.37 in 2022. This price increase allowed the overall market value to remain relatively stable at just under $2 billion (Ecosystem Marketplace, 2024). In 2023, the market contracted further, with a 56% year-on-year decline in transaction volume (Ecosystem Marketplace, 2024). The total reported transaction value was $723 million (Ecosystem Marketplace, 2024). Factors contributing to this decline included negative media coverage on the integrity of carbon credits and a pause in purchasing as buyers awaited guidance from integrity initiatives.[4]

The rising demand from corporations is the driving force for the increased carbon credit demand. As of October 2020, 1,565 companies across all continents

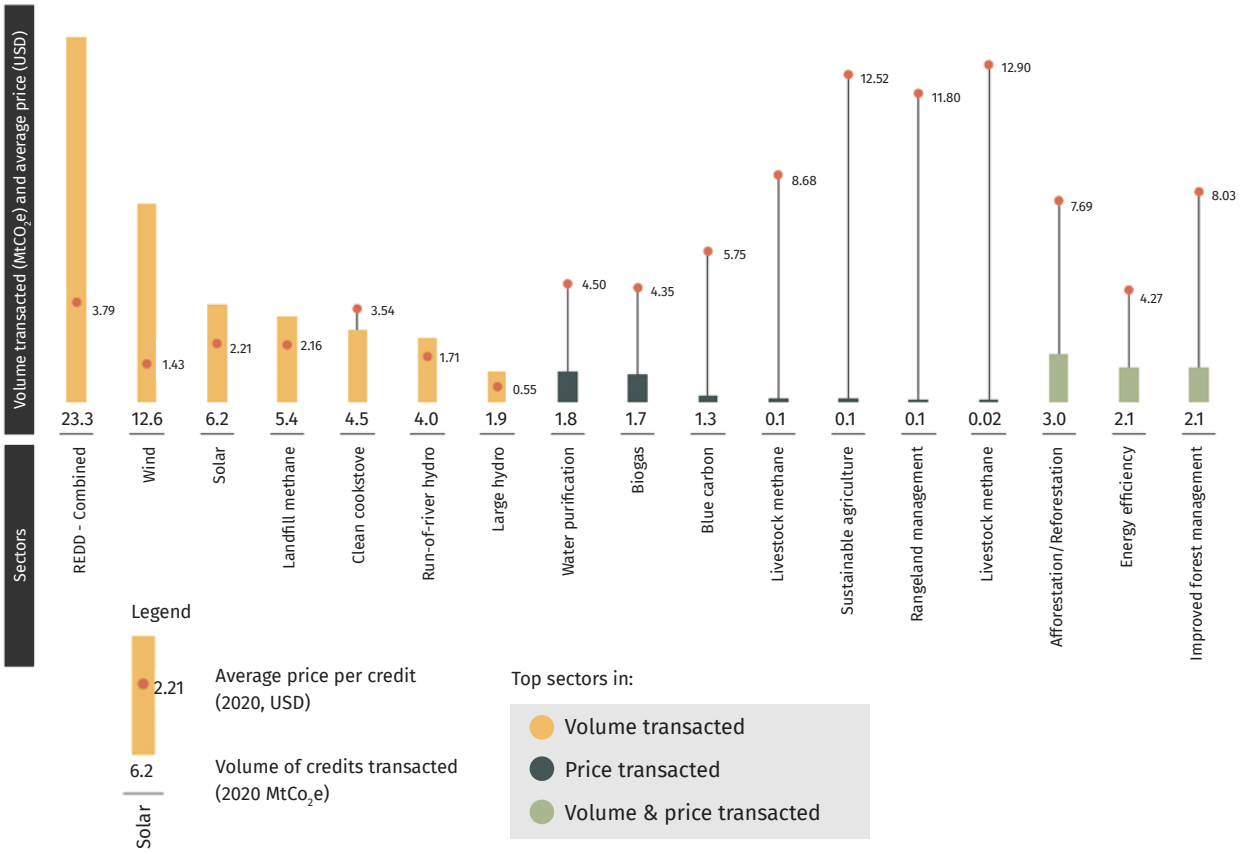
[2] *UN Coalition for Net Zero defines net zero as: "put simply, it means cutting greenhouse gas emissions to as close to zero as possible, with any remaining emissions re-absorbed from the atmosphere, by oceans and forests for instance." (https://www.un.org/en/climatechange/net-zero-coalition).*

[3] *Energy compacts are voluntary commitments to specific actions to accelerate progress on energy access, renewable energy and energy efficiency (https://www.un.org/en/energycompacts).*

[4] *For an overview of organizations and efforts dedicated to ensuring the integrity of carbon credits, see the Integrity Council for the Voluntary Carbon Market (ICVCM) https://icvcm.org/, the Voluntary Carbon Markets Integrity Initiative (VCMI) https://vcmintegrity.org/, and the Carbon Credit Quality Initiative (CCQI) https://carboncreditquality.org/.*

encompassing tech giants, oil majors, consumer brands, airlines, and others had adopted commitments to reduce their emissions to net zero (World Bank, 2021). About half of these companies have indicated their intent to rely at least partially on carbon offsetting to achieve their targets, with few companies having entirely ruled out the possibility of offsetting (World Bank, 2021). Shell alone has announced that it intends to purchase 120 million carbon credits per year by 2030, more than the entire size of the voluntary carbon market in 2019 (World Bank, 2021). For some companies, especially those serving consumer markets, the possibility of establishing a clear correlation between their local environmental impact and crediting projects is attractive, and there is willingness to pay a higher price than the average in the market (World Bank, 2021).

***Figure 2:* Volumes and prices transacted per sector (2019)**



***Source:* World Bank, 2021.**

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) was expected to create large demand, estimated to be 3 $GtCO_2e$ between 2020 and 2035 (World Bank, 2021). However, this demand has not materialized, and the International Civil Aviation Organization (ICAO) Council adjusted the plan's baseline considering the COVID-19 pandemic (World Bank, 2021). The plan required countries to purchase or retire carbon credits to offset the GHG emissions growth of their airlines relative to a 2019–2020 baseline. Following the impact of the COVID-19 pandemic on the airline industry in 2020, the ICAO Council decided to set the carbon neutral growth baseline for international aviation during CORSIA's pilot phase, 2021 to 2023, at 2019 emissions levels (World Bank, 2021). This was intended to reduce the possibility of CORSIA-driven demand for offsets coming from the air travel recovery rather than from industry growth.

Table 1: **Voluntary credit buyers and projects purchased by region**

Buyer Region	Project Region	Volume ($MtCO_2e$)		Share of Regional Credits from Global Sources		Price ($)	
		2018	2019	2018	2019	2018	2019
Europe	Global	38.58	23.5			3.26	3.32
	In Europe	0.71	0.2	1.9%	0.9%	6.94	10.19
North America	Global	8.50	12.2			3.23	3.01
	In North America	5.56	9.4	65%	77%	3.04	3.41
Oceania	Global	1.82	0.7			3.69	7.87
	In Oceania	0.55	0.3	30%	43%	15.84	13.44

Note: "Buyers" refers to the private sector, governments, NGOs and other institutions. "Global" includes projects located in the buyer region.

Source: **World Bank, 2021.**

1.5 Carbon Credits Supply

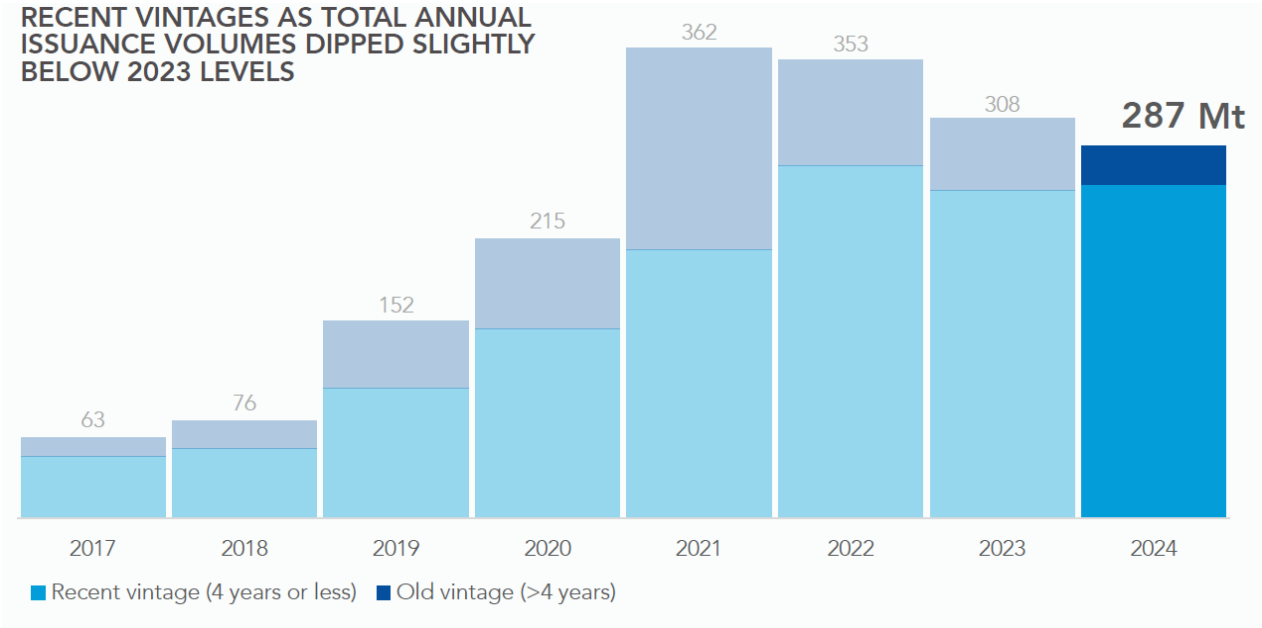
Carbon credit markets continue to grow with both registered projects and issued credits, which have increased substantially in the past five years. While growth has been observed across all types of crediting mechanisms, independent standards (Verra, Gold Standard, etc.) have taken the majority. Despite the COVID-19 pandemic and economic downturn, the number of registered projects increased by 11 per cent, from 16,854 in 2019 to 18,664 in 2020 (World Bank, 2021). The number of credits issued also increased by 10 per cent over the same period, bringing the total number of credits issued since inception by CDM and voluntary registries to about 3.9 billion tCO_2e (VERRA, 2025) (Gold Standard Registry, 2025) (CDM, 2025) (Ecosystem Marketplace Reports, 2025). This is equivalent to what 180 billion trees could absorb in one year, or around 7.8 per cent of annual global GHG emissions.

The annual supply numbers, however, are far below the levels seen at the peak of market supply in 2012 before the end of the first compliance period of the Kyoto Protocol, with issuance and project registration numbers five times higher than today's volume. CDM issued over 1 billion Certified Emission Reductions in 2012 alone, compared to significantly lower issuance volumes in recent years (CDM, 2025). Over the past years, the market has been impacted by regulatory uncertainty and continues to face criticism for failing to uphold integrity, which has resulted in decreased trading volumes and lower valuations across many project types (ClimateFocus, 2025).

The crediting market is now dominated by activity from independent crediting standards programmes. In 2022, over 70% of the credits issued came from independent standards such as Verra's Verified Carbon Standard (VCS) and the Gold Standard, reflecting a significant increase in market share compared to previous years (Ecosystem Marketplace, 2023). Credits issued by these standards grew by 20 per cent from 2021, driven by rising corporate demand for high-quality offsets (Refinitiv, 2023). Corporations represented over 90 per cent of the rise in voluntary market transactions, with leading sectors including consumer goods, financial institutions, and technology companies (Ecosystem Marketplace, 2023). Domestic crediting mechanisms also played a key role, accounting for 80 per cent of newly registered projects in 2022. The issuance of credits in domestic crediting programmes increased by 15 per cent, with significant contributions from the California Compliance Offset Programme and the Australia Emissions Reduction Fund (ICAP, 2023).

The proportion of recently issued vintages reached a record high in 2024, accounting for 90 per cent of all carbon credits issued that year (ClimateFocus, 2025). This milestone coincided with a slight decrease in total issuance volumes compared to the previous year, with 2024 volumes at 287 Mt compared to 308 Mt in 2023 (ClimateFocus, 2025). The demand for newer vintages is expected to remain strong as buyers increasingly prioritize credits aligned with current market standards and evolving best practices (ClimateFocus, 2025). This shift is likely to gain further momentum with the Integrity Council for the Voluntary Carbon Market (ICVCM)'s Core Carbon Principles labeling process, which evaluates methodology versions and has begun excluding older versions of certain methodologies (ClimateFocus, 2025).

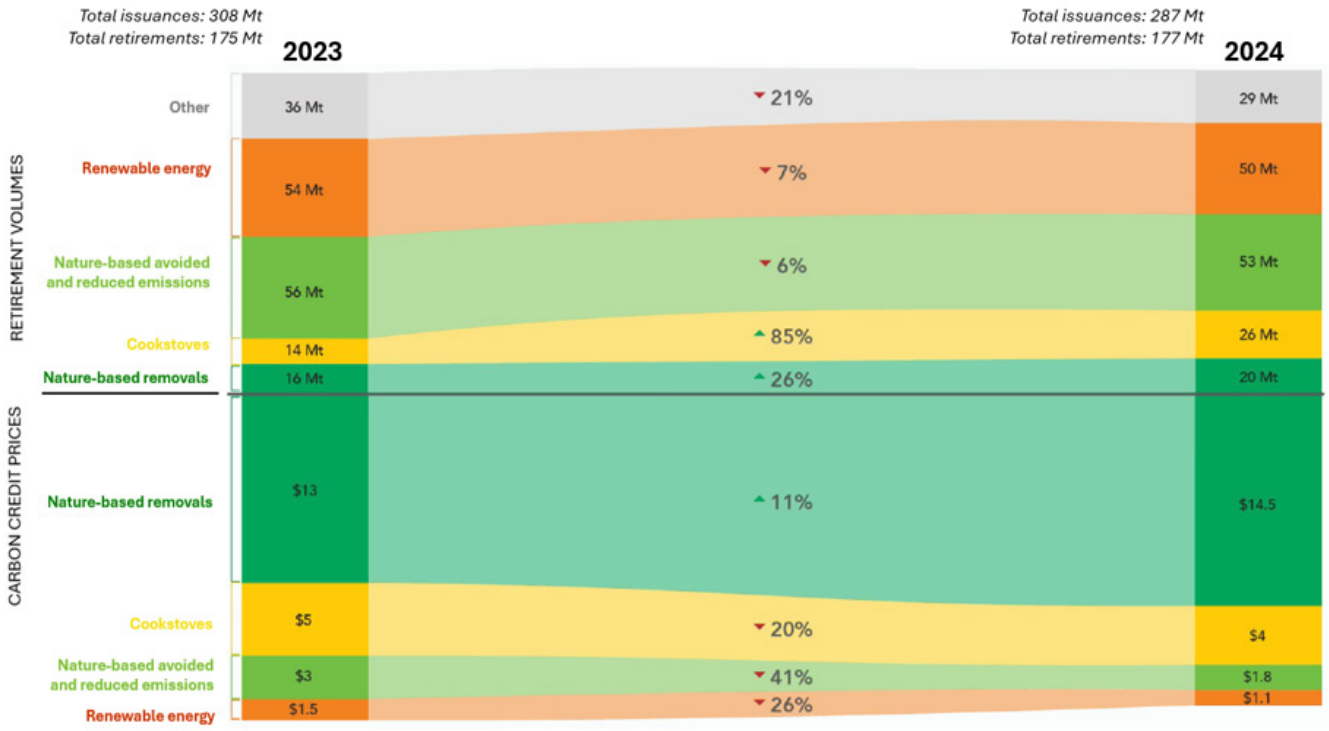
Figure 3: **Credit issuance and number of projects registered by mechanism**



Source: **ClimateFocus, 2025.**

As the world sets its sights on achieving net zero emissions, the move toward net zero has triggered fresh discussion about the role of carbon offsetting in achieving real and long-lasting decarbonization. Despite the positive contribution carbon offsets may provide, there is increasing debate over their role in achieving reduced emissions. Some argue that offsets do not encourage businesses to reduce their emissions because the opportunity to use offsets provides an alternative to the harder work of reducing emissions. Purchasing low-cost offsets that someone else has struggled to produce provides a too easy and cheap solution for the largest polluters. By requiring businesses to reduce rather than offset, businesses are forced to make the investments and be innovative to be cleaner, rather than simply following business as usual.

Figure 4: Credits issued, registered activities, 2023 – 2024 prices and sectors covered by crediting mechanisms



Carbon prices are based on average carbon prices transacted on leading exchanges across selected project categories as of end of 2023 (left-hand side) and the end of 2024 (right-hand side).

Source: **ClimateFocus, 2025.**

While collaborative initiatives by the UNFCCC, UNEP, EU and governments are beginning to forge consensus on some aspects of this debate, voluntary markets will likely continue to see diverging standards and approaches (World Bank, 2021). To meet Paris Agreement's goals, global emissions must be reduced to an absolute minimum by 2050, with residual emissions addressed through removals by offsets. This effort requires drastic emissions[5] cuts across all sectors and regions. However, offsetting can contribute by mobilizing finance and lowering overall mitigation costs. ●

[5] *Emissions are expected to be reduced to an absolute minimum by 2050. However, there will be emissions remaining that will not be able to be removed, considered as residual emissions. Residual emissions are expected to be removed by mechanisms like carbon capture and storage, not offsets.*

2. Present and Future Outlook of the Carbon Market

The carbon market has an inherent risk, as it depends on the actions of politicians and policymakers obliged to juggle competing interests. Industry lobby groups may push back on the rising price of carbon, or politicians' constituents may complain about rising prices blamed on carbon allowance costs (Ecosystem Marketplace, 2021). However, recent political actions have generally been more positive and supportive than for the development of the carbon market. Despite the likelihood of temporary setbacks, it is expected that this progress will continue.

In November 2021, more than 190 nations took another step forward in addressing the challenge of climate change at the 26th Conference of the Parties (COP26). The result was the Glasgow Climate Pact, which led to a positive climate response. More than 150 countries submitted improved national plans (Nationally Determined Contributions, NDCs) on cutting emissions to the United Nations. The conference also produced various bilateral and multilateral initiatives targeting emissions of methane, deforestation, coal, and transport.

The CDM produced significant contributions to global efforts to address climate change. As of October 2021, it was responsible for over 2.17 billion certified emission reductions issued, of which over 301 million had been voluntarily cancelled (retired) either in national registries or in the CDM registry (COP, 2021). Because of CDM's significance, COP26 addressed the issue of deciding how to restructure international carbon credit trading under Article 6 of the Paris Agreement, while COP29 led to the completion of the rulebook for implementing what negotiators had adopted during the Paris Agreement. Article 6 is central to the agreement because it guides the international community on how countries should cooperate to generate GHG reductions cost-effectively and lead to more ambitious NDCs. The mechanism established by Article 6, paragraph 4, of the Paris Agreement, referred to as the "Article 6.4 mechanism", is expected to replace the CDM. A newly formed Supervisory Body was created to oversee the new carbon crediting mechanism.

COP29 delegates thus approved regulations to govern the registration and creation of tradable emissions reductions. In the Paris Agreement, emission reductions that pass from one country's GHG inventory to another are called "Internationally Transferred Mitigation Outcomes (ITMOs)". Like all carbon credits, ITMOs are created by projects that either reduce emissions or remove gasses in one place, with the payments coming from another place. They become ITMOs when those places are in different countries and the reduction is transferred from one country's national GHG inventory to the other. The Article 6 rulebook requires Corresponding Adjustments (CAs) when an ITMO is passed from one country to another. A CA means that the host country, or the country where the carbon project is located, must first authorize the transfer and then adjust its GHG inventory to reflect that the emission reduction achieved inside its borders is being credited to another country. The buying country then adjusts its GHG inventory by the same amount.

The Voluntary Carbon Market (VCM) encompasses all transactions of carbon offsets that are not purchased to surrender them into an active regulated carbon market. It includes offsets that are purchased with the intent to re-sell or retire to meet net zero, carbon neutral, or other climate claims. However, the Article 6 rulebook does not refer to voluntary markets. VERs do not have to be entered into a national inventory because they are not created to meet a legal requirement. A host country can, if it chooses, apply a CA to VERs that leave its border, but this is not required.

Article 6.2 states the following: "Parties shall, where engaging on a voluntary basis in cooperative approaches that involve the use of internationally transferred mitigation outcomes towards nationally

determined contributions, promote sustainable development and ensure environmental integrity and transparency, including in governance, and shall apply robust accounting to ensure, inter alia, the avoidance of double counting, consistent with guidance adopted by the Conference of the Parties serving as the meeting of the Parties to this Agreement." The paragraph does not create a trading system itself, but instead provides a framework within which countries can create their own systems in ways that are consistent with UN rules and comparable to each other.

Article 6.4 establishes a centralized hub to replace the CDM, and states the following:

> 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:
>
> 1. To promote the mitigation of greenhouse gas emissions while fostering sustainable development;
> 2. To incentivize and facilitate participation in the mitigation of greenhouse gas emissions by public and private entities authorized by a Party;
> 3. 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
> 4. To deliver an overall mitigation of global emissions.

Switzerland signed the first Article 6-specific bilateral agreements with Peru and Ghana in 2020, followed by agreements with other countries, to establish mitigation outcome purchase agreements (FOEN, 2022). Similarly, Singapore and the Japanese Joint Crediting Mechanism are at the forefront of developing ITMO agreements. Under this mechanism, several bilateral and commercial agreements with countries and project developers have been signed, and activities are generating carbon credits that could be eligible as ITMOs once Article 6 becomes operational (World Bank, 2021).

The specific details for the operationalization of Article 6 are still to be determined in a subsequent work programme, even though the fundamental rules are already agreed upon. Market participants are getting ready for the transition of CDM activities to Article 6 and requesting guidance on how to get authorization for the international transfer of mitigation outcomes. Momentum is building both on the demand and supply side of the carbon markets. The current market dynamics are promising for project developers to participate in carbon markets. As a result, it is believed that ethanol cookstove project implementers could benefit highly from carbon markets if they engage early and make their projects ready for the Article 6 market mechanism. •

3. Biofuel Strategy: Ethanol Production and its Use as Cooking Fuel

3.1 Ethanol Production

Ethanol is a renewable biofuel produced via the fermentation and distillation of sugar and starch crops, such as corn, wheat sugarcane, and cellulosic feedstocks. Due to its ease of transformation into alcohol, corn became the dominant feedstock for ethanol production, followed by sugarcane. The global demand for ethanol was increasing dramatically before the COVID-19 pandemic, and it is again growing today. Ethanol is a widely produced global commodity although many developing countries still produce very little of it and do not use it as fuel.

Any biological feedstock with reasonable amounts of sugar or starch can be used to produce ethanol. Bioethanol production through the fermentation of sugars extracted from sugar-rich crops, such as sugarcane, sugar beet and sweet sorghum, and starchy crops, such as grain sorghum and cassava, is a technically mature commercial process. Ethanol can also be produced from lignocellulosic materials such as cassava peels, sugarcane and sorghum bagasse, wheat straw, corn stover and corn cobs. But ethanol produced from lignocellulosic materials, where cellulose is broken down physically and/or chemically to fermentable sugars, requires more energy, process time and costly equipment, with more inputs such as chemicals, nutrients, enzymes and water.

Biofuels have been separated into "first," "second," "third" and even "fourth" generation biofuels. "Advanced" biofuels are defined as biofuels that do not use feedstocks meant for human consumption or are produced from waste products and residues. Advanced biofuels have also been defined as biofuels that do not produce undesirable land use change and achieve a lifecycle reduction in GHG emissions of at least 50 per cent compared with fossil fuels. Ethanol from sugar and starch crops, used to replace petroleum fuels or non-replaced forest biomass, can achieve these objectives provided the methods of growing and processing these materials are designed and managed correctly. The simplicity and economy of producing ethanol from sugar and starch feedstocks, and the ability to do this on a small or micro scale, are attributes that are well suited to what farmers and businesses in developing countries can most easily achieve. The concept of "advanced" biofuels relates mostly to large-scale ethanol production in countries like Brazil, the U.S. and EU nations. Inevitably, however, these concepts will be applied to any ethanol production, including micro-distilleries in developing countries.

Ethanol from sugar and starches is the simplest, easiest and most economical ethanol to make. In most developing countries, sugar and starch feedstocks are abundant, and often wasted or of low value. Sceptics of biofuels assume that ethanol from lignocellulosic feedstocks is preferable to ethanol from sugar or starch because these materials are not part of the direct human food chain. However, with the ability to produce and use co-products and by-products in an integrated farm and distillery operation, a highly sustainable use of biomass can be achieved that neither compromises food production nor depletes soils of nutrients and carbon. In a simple sugar or starch process, lignocellulosic materials are valued as fuel for process heat and, if not burned, are composted or biodigested with their nutrients and carbon returned to the soil.

Global production of ethanol amounted to 111 billion litres (29.33 billion gal) in 2019 (EIA, 2024) and, following the COVID downturn, recovered to 107 billion litres in 2022 (EIA, 2024). Despite COVID, the nameplate capacity of the world's ethanol plants has steadily grown and reached 166 billion litres in 2024 (Statista.com, 2025). The United States (primarily corn) and Brazil (primarily sugarcane) are the major

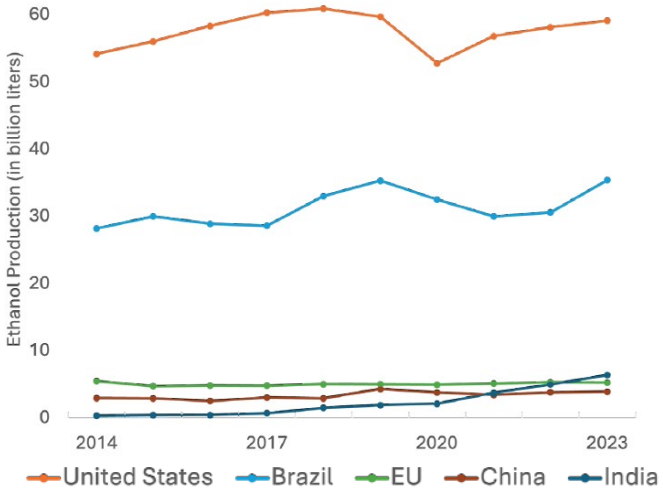
producers of ethanol. About 5 per cent of ethanol was produced in the European Union (EU) in about 50 ethanol production plants (primarily wheat, sugar beet and corn). Globally, about 46 per cent of ethanol was produced from corn, followed by 38 per cent from sugarcane, and 5 per cent from wheat. **Figure 5** below shows production trends for the world's top 5 producers of ethanol.

In 2023, the U.S. and Brazil together accounted for 86 per cent of global ethanol production: the U.S. produced 59 billion liters, while Brazil produced 35 billion liters. India surpassed the EU to become the third-largest producer of fuel ethanol, with 6.4 billion liters in 2023, reflecting a 28 per cent increase from the previous year. This growth was due to the country's ethanol-gasoline blending programme, which achieved a 12 per cent blending rate in 2023, with a target of E20 by 2025 (World Bioenergy Association, 2024).

Figure 5: **Ethanol production of the 5 largest producers**

Year	U.S.	Brazil	EU	China	India
2016	58	29	5	3	0.5
2017	60	29	5	3	1
2018	61	33	5	3	2
2019	60	35	5	4	2
2020	53	33	5	4	2
2021	57	30	5	3	4
2022	58	31	5	4	5
2023	59	35	5	4	6

Values in billion litres



Source: **USDA GAIN Reports (https://www.fas.usda.gov/data/commodities/biofuels).**

Establishing an ethanol industry may be regarded as a promising opportunity to contribute to economic development, job creation, modern energy access, reduced pollution and climate change mitigation in developing countries. The ethanol economy helps to support several sectors linked to the industry, such as capital goods for mill construction and farm operation, and investments in development and innovation up and down the agro-industrial market chain for ethanol production. For instance, the development of an ethanol industry in Brazil in response to the oil crisis of the 1970s led to remarkable environmental and socio-economic benefits, namely the reduction of GHG emissions in the transport sector, a significantly reduced dependence of Brazil on imported oil, enhancement of the national gross domestic product (GDP), the mobilization of investments in sugarcane and sugar production, and the creation of employment.

The sugar industry in many developing countries can support value chain and technology development, as well as bioethanol market penetration. Encouraged and promoted by a supportive policy framework, the establishment of an ethanol sector will be driven and implemented by private sector actors. Such actors cover the whole value chain, including feedstock production and supply, conversion technologies and the production of ethanol, logistics and fuel supply, and the end use of ethanol as transport or clean cooking fuel.

3.2 Ethanol as Clean Fuel for Cooking

Considerable effort is being devoted by the development community to new stoves, particularly biomass and electric stoves, but less attention has been devoted to new fuels such as ethanol, which is one of the most promising fuels available. This fuel has been demonstrated to be viable in developing countries because of its growing availability at competitive prices. It has also been shown, from studies in many countries, to be attractive to consumers. Most developing countries have the potential to grow suitable feedstocks to produce ethanol fuel domestically. It can be produced in small, medium or large plants, and all sizes of these plants exist around the world. As a liquid fuel, it has a high energy-to-volume ratio, which makes it easy and efficient to store, handle and transport. Its handling in the supply chain does not require expensive, materials-heavy equipment, as pressurized fuels like Liquified Petroleum Gas (LPG). At current market prices, ethanol is a competitive cooking fuel in most developing countries when compared to kerosene, LPG and electricity, and it is only slightly more expensive than biomass fuels.

Ethanol is now an emerging cooking fuel choice in several developing countries, with many others showing interest. Ethanol burns cleanly with low carbon monoxide and particulate emissions, alleviating the harmful health effects of solid-fuel cooking fires. In 2016, IRENA reported that liquid ethanol fuel was competitive against charcoal and purchased wood in Ethiopia, Kenya, Malawi, Mozambique, Senegal, and South Africa; nevertheless, its use, estimated at around 6 million litres per year, was minimal compared to the number of stoves deployed, estimated at 70,000 to 80,000 (IRENA, 2016).

Since then, ethanol cookstove deployment has rapidly increased in East Africa, with Koko Networks deploying hundreds of thousands of stoves in Kenya and Rwanda, BURN Manufacturing partnering with Cleancook Sweden AB to produce its ethanol stove in Nairobi for sale in Tanzania under the UNIDO and UNCDF cookstove programmes, Bukona Agro Processors—an ethanol producer in northern Uganda—deploying its own ethanol stove in Kampala and Dar es Salaam, and *Nosy Maitso*, an ethanol stove business operating in Madagascar with its own local ethanol production, having received carbon finance support from the World Bank's Ci-Dev programme. However, the amount of fuel used compared to the number of stoves deployed remains low, largely due to the practice of stove stacking (using more than one stove in a home), and the continued underdevelopment of ethanol fuel production, supply, and trade. This has resulted in upward pressure on fuel prices, making it more difficult to penetrate the market. There are still substantial barriers to producing ethanol fuel domestically, barriers to importing ethanol fuel cheaply, and continued skepticism from producers and governments regarding the viability of the ethanol cooking fuel market. In almost all African countries, the ethanol fuel market is still in its infancy.

More than 2.5 billion people worldwide still cook with traditional biomass, with all of the known harmful effects on health and deforestation (IEA, 2022). The establishment of a domestic production industry for ethanol will create the necessary conditions to introduce ethanol as cooking fuel and perhaps also as a blending component in transport fuel. The use of biofuels will give rise to a strategy that many African countries already reference in their NDCs.

Although the highest impact countries for clean cooking have substantial resource potential to produce bioenergy sustainably in a variety of ways, they rely predominantly on forest biomass fuels traditionally managed, or unmanaged, and delivered through unregulated or loosely regulated supply chains in the informal economy. The production and use of these fuels are generally unregulated or only loosely regulated, or if regulated, the regulations are not enforced. The result is that these fuels are being consumed unsustainably.

With sufficient inputs and regular management, commercial agricultural systems, whether small or large, can be highly productive. At the same time, they can be regenerative, contributing to sustainability. The selection of crops determines the amount and type of biomass produced, whether for food, fibre, energy, other uses, or a combination of these. The selection of crops also determines the amount and

type of nutrients used and produced as excess, the amount of nutrients and carbon returned to the soil, and the water required.

Lignocellulosic or woody biomass is not easily converted into liquid biofuels but can be burned in a well-designed boiler to provide heat for the process of transforming sugars and starches into fuels. Crops that produce ample starch or sugar provide the biomaterial that is most easily converted to ethanol through the natural process of fermentation. But these crops also produce fuel for the heat needed to drive the conversion process. For every ton of sugary or starchy crops grown, several tons of lignocellulosic biomass are produced, some of which may be returned to the field after harvest, while some are burned to produce heat for the ethanol transformation process. Some starch and sugar crops are especially suited for producing both food and fuel, with their residues used to produce biogas, silage, compost, natural fertilizers, and ultimately returned to the soil. Seeds and grains used for ethanol production do not lose their food value. This food value can be recovered after distillation and is enhanced by the action of enzymes and yeast on the starches and sugars. High protein feed, and even food, can be made from these residues. Root and tuber crops also provide value-added residues, including animal feed, fuel and fertilizer. The production of biofuels from crops thus produces valuable co-products for use or sale, along with by-products that can be reintegrated into a regenerative agricultural system.

Ethanol production from starch and sugar thus can stimulate a developing country's economy through the nexus of agriculture and energy. It can help a nation to develop according to the Sustainable Development Goals (SDGs) and meet its commitments under the Paris Agreement to its NDCs. ●

4. Carbon Finance for Ethanol Cookstoves

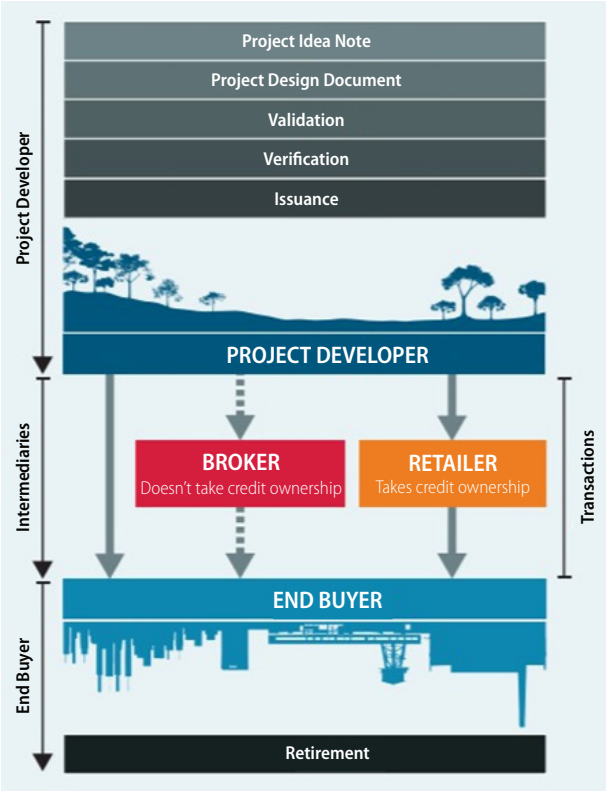
Even though the core purpose of carbon finance is to reduce GHG emissions, many programme implementers are tapping into carbon finance to support the commercial scale-up of their businesses (Lambe et al., 2014). Carbon credits generated from emission-reducing stoves have in notable cases played a very important role in enabling stove businesses to grow, usually by subsidizing the delivery of the stove. Carbon finance should thus be able to enhance the commercial viability of ethanol stove and fuel distribution businesses.

Clean-burning, efficient ethanol cookstoves used by households and communities to replace non-renewable biomass and/or fossil fuels is an accepted and proven emissions reduction programme. Carbon credits generated from emission reductions can return revenues to businesses selling stoves and fuel. A project in a specific location can establish a standalone carbon finance programme or, if multiple implementers are anticipated, an umbrella programme to accommodate projects to be replicated in different markets and geographical locations.

Carbon finance projects must use third-party verified standards to approve their offsets to ensure "additionality". Additionality means that service would not have been rendered without carbon finance. Third-party standards bodies require several steps to be taken before a project developer can turn a project idea into reality. The steps include a project idea note, a project design document, validation, registration, verification, and ultimately issuance to access the carbon market (**Figure 6**). The Project Idea Note (PIN) assesses the feasibility and risks of a project. The Project Design Document lays out how the project will calculate and reduce or avoid emissions. A third-party auditor then "validates" these assumptions, and, after project implementation and monitoring, another auditing process called "verification" assesses the delivery of GHG mitigation.

There are also intermediaries, including brokers and retailers, who connect the project developers and the carbon credit buyers.

***Figure 6:* The offset cycle – from project development to retirement**



***Source:* Ecosystem Marketplace (2017).**

Moving a project from conception to final issuance of offsets takes two to two-and-a-half years on average (Ecosystem Marketplace, 2017). The extended time and resources required to develop a carbon finance project were a challenge for many small-scale projects in developing countries. To lower the burden, a programmematic approach was officially established in 2007 by the CDM Executive Board with the adoption of guidelines and procedures for a PoA approach. Due to high transaction costs, small single CDM projects

had previously been underrepresented in the CDM portfolio. The PoA approach was designed to create the opportunity for small projects to be part of CDM. With the PoA approach, the project approval process for many individual activities that are distributed over space and time is consolidated. The PoA allows the inclusion of as many CPAs as possible. The PoA provides the organizational and financial framework for the activities and is managed by a Coordinating/ Managing Entity (CME). The PoA approach is expected to be functional under the Article 6 mechanism.

4.1 Applicable Carbon Finance Methodologies for Ethanol Cookstove Projects

The technology implemented under the ethanol cookstove project will be energy-efficient bioethanol cookstoves that use ethanol fuel, a renewable biomass that will displace the use of fuelwood, charcoal and/or fossil fuel, which are non-renewable fuels used by the baseline stoves.

There are CDM-approved methodologies applicable for activities to displace the use of non-renewable biomass or fossil fuels by introducing renewable energy technologies and fuels, such as bioethanol and bioethanol stoves, namely:

- AMS-I.E., "Switch from non-renewable biomass for thermal application by the user".
- AMS-I.I., "Biogas/biomass thermal applications for households/small users".

AMS-I.E. and AMS-I.I. are methodologies that have already been used for ethanol cookstove programme registration, under both the CDM and Gold Standard. At present, there are four CDM -and Gold-Standard-registered ethanol stove programmes in Africa. These are Project Gaia's programme (Project Gaia Cook Stove Programme of Activities) (Project Gaia, 2016), Green Development's programme (PoA for the Reduction of Emission from non-renewable fuel from cooking at household level) (Green Development, 2012), Koko's programme (KOKO Kenya – Ethanol Cookstoves Programme) (KOKO, 2019), and Garner Advisors' programme (Garner Sustainable Biomass and Renewable Energy Programme) (Garner, 2020). While Project Gaia is a non-profit entity, Green Development, Koko and Garner are private businesses.

4.2 Emission Reduction Calculations

Emission reduction calculations are a function of consumption of baseline fuel, stove usage, stove efficiency and other variables. The following sections estimate emissions reduction that can be achieved in different scenarios when bioethanol stoves replace biomass (firewood/charcoal) and fossil fuel stoves.

4.2.1 Ethanol stoves replacing biomass fuel

Stoves that will displace the use of non-renewable wood fuel (firewood and charcoal) with ethanol stoves that use bioethanol as fuel, deemed a renewable biomass, will use the approved AMS-I.E. Methodology. According to this methodology, project developers can determine the amount of non-renewable biomass consumed in the baseline scenario from historical sources (e.g., government or third-party reports), or calculate from thermal energy generated by the project activity. Per capita daily firewood consumption in developing countries is estimated to be 1.8 kg/person/day (Tika Ram & Hom Bahadur, 2020). However, a conservative 1.0 kg/person/day, for urban households (the target market for ethanol stoves), is applied to estimate emissions reduction. An average family size of 5 is also applied. The emissions reduction estimation is shown in **Table 2** below, using the AMS-I.E Methodology. The results show that an average emission reduction of 5.2 tCO_2e per household per year can be achieved when an ethanol stove completely replaces a biomass fuel in the household.

AMS-I.E. equation for emissions reduction estimation:

$$ER_y = (B_y \times f_{NRB,} \times {}_{biomass} \times EF_{projected\_fossil\_fuel} - PE_{BC,y}) \times LE_y$$

Table 2: **Emissions reduction estimation**

Parameter	Description	Value	Unit	Source
ERy	Emission reductions per device during the year *y* in tCO_2e	5.2	tCO_2e	Calculated
By	Quantity of woody biomass per device that is substituted or displaced in tons	5	t/device/yr	Estimated[1]
$fNRB,y$	Fraction of woody biomass used in the absence of the project activity in year *y* that can be established as non-renewable biomass	85%	fraction	Average estimation
$NCVbiomass$	Net calorific value of the non-renewable woody biomass that is substituted	0.015	TJ/t	Meth default
$EFprojected\_fossil\_fuel$	Emission factor for the substitution of non-renewable woody biomass by similar consumers	81.6	tCO_2/TJ	Meth default
$PEBC,y$	Project emissions due to cultivation of biomass	0.002	tCO_2e	Estimated[2]
LEy	Leakage related to the non-renewable woody biomass saved by the project activity	0.95		Meth default

[1] Estimated based on average family size of 5 and 1 ton/annum/person firewood consumption for cooking in developing countries.

[2] Calculated based on average lifecycle GHG emissions for bioethanol production.

Source: **Project Gaia.**

4.2.2 Ethanol stoves replacing kerosene fuel

Stoves that will displace kerosene fuel with ethanol stoves that use bioethanol as fuel, which is a renewable biomass, will use the approved AMS-I.I. Methodology. According to the applicable methodology, project developers can use the baseline kerosene usage data and the efficiencies of kerosene and ethanol stoves to determine the amount of ethanol required to be used by a household for 100 per cent replacement of kerosene. **Table 3** below makes an estimation of emissions reduction based on an estimated 1 lit/day/household kerosene usage in the baseline and its 100 per cent replacement by ethanol fuel.

The results show that an average emission reduction of 1.4 tCO_2e per household per year can be achieved when an ethanol stove completely replaces kerosene fuel in a household.

AMS-I.I. equation for emissions reduction estimation:

$$ERy = N_{k,0} \times n_{k,y} \times BS_{k,y} \times EF \times \eta_{PJ/BL} \times NCV_{biomass} - LE_y$$

Table 3: **Emissions reduction estimation (biomass fuel in baseline)**

Parameter	Description	Value	Unit	Source
ERy	Emission reductions during the year *y* (tCO_2)	1.4	tCO_2e	Calculated
$N_{k,0}$	Number of thermal applications k commissioned	1	number	Assumed
$n_{k,y}$	Proportion of Nk,0 that remain operating in year *y*	1	fraction	Assumed
$BS_{k,y}$	The net quantity of renewable biomass or biogas consumed by the thermal application	0.48	t/yr	Calculated based on 1 lit/day kerosene
EF	CO_2 emission factor (tCO_2/GJ)	0.0741	tCO_2/GJ	Calculated
$\eta_{PJ/BL}$	Ratio of efficiencies of project equipment and baseline equipment	1.46	fraction	Calculated
$NCV_{biomass}$	Net calorific value of the biomass(ethanol) (GJ/unit mass or volume, dry basis)	27.000	GJ/t	Default values
LE_y	Annual leakage due to the implementation of the project activity	0	tCO_2e	

Source: **Project Gaia.**

4.3 Baseline Fuel Displacement Scenarios

Practically all households use several cooking fuels during the same meal or the same day, and ethanol may not replace baseline fuels by 100 per cent. Baseline emission depends on the type and quantity of fuel used by project households. **Table 4** below simulates several scenarios of baseline fuel usage and different displacement rates by ethanol, with the resulting emissions reduction that can be achieved.

Table 4: **Emissions reduction scenarios**

Baseline fuel		Ethanol displacing baseline fuel (tCO_2e)		
		100%	75%	50%
Biomass		5.20	3.90	2.6
Kerosene		1.40	1.05	0.70
Biomass (75%)	Kerosene (25%)	4.60	3.45	2.30
Biomass (50%)	Kerosene (50%)	3.30	2.48	1.65

Source: **Project Gaia.**

Based on the various scenarios simulated, an emissions reduction of 4.0 tCO_2e/stove/year is a reasonable average emissions reduction that can be achieved. Estimations show that an average saving of 4 tons of CO_2 per stove/annum can be expected. This presents a potential of $40 per stove per annum for $10 per ton of CO_2. Under the mechanism of Article 6.4, projects will have two 5-year crediting periods, and this implies a potential total earning of $200 per stove in one crediting period.

An ethanol distribution business that sells 1 litre of ethanol/day for a household while keeping a $0.1/lit profit margin makes a profit of $36.5/household per annum. Noting that the $0.1/lit profit margin on fuel does not yield a very high earning for the fuel distribution business, the potential earning of $40/household/annum from carbon finance (although this could include some expenses) becomes significant and quite helpful for the ethanol distribution businesses.

4.4 Project Monitoring

Project monitoring is one of the most important activities in a carbon finance project. The parameters to be monitored by an ethanol stove project for carbon finance are discussed below based on the guidance provided by the approved methodologies (AMS-I.E. and AMS-I.I.).

4.4.1 Net quantity of renewable biomass consumed by the thermal application

This will be measured through surveys carried out during monitoring through sampling. Depending on the frequency of monitoring, the sample results will be required to attain a set precision. When the biennial inspection is chosen, a 95 per cent confidence interval and 10 per cent margin of error requirement must be achieved for the sampling parameter. When the project developer chooses to inspect annually, a 90 per cent confidence interval and a 10 per cent margin of error requirement may be achieved for the sampling parameter. The project developer or third party contracted to carry out the survey will visit households that possess ethanol stoves.

4.4.2 Net calorific value of ethanol

This shall be monitored annually through sampling. The sample size should satisfy a 90/10 confidence precision level. The project developer or contracted third party will visit the selected households to take samples. A sample of ethanol from households where the ethanol stove has been found to be in operation shall be collected, and a laboratory analysis carried out. The laboratory analysis shall meet international standards. Based on the results, an average will be calculated and should be used for the ex-post emissions reduction calculation.

4.4.3 Number of thermal applications commissioned

This is required to be conducted continuously. At the time of installation, all stoves shall be inspected and undergo acceptance testing (commissioning) for proper operation by qualified personnel. Proper operation of the stoves shall be confirmed and evidenced through a signed delivery note between the end-user and the project developer. The records will be archived in a project database, which will capture the following: customer's address, sales date of the stove, phone number, stove's serial number, and the baseline stoves replaced.

4.4.4 Proportion of stoves that remain operating

This shall be assessed at least once every two years (biennial) during the crediting period of the project. The surveyor will visit households in which the selected stoves are located, and go through visual inspections of the stoves. The proportion of stoves that are still operating will be determined by relating the stoves thought to be operating to the stoves surveyed. The surveyor will also capture the type of stove that was used by the end-user before acquiring the ethanol stove. This will be used to determine which type(s) of fuel the stove replaced, i.e., either fossil fuel or non-renewable biomass. Based on the proportion of stoves replaced, the population shall be classified by the fuel replaced. When sampling is done on an annual basis, the survey will meet a 90/10 confidence precision level, and a 95/10 confidence precision level if the surveys are done biennially. ●

5. Alternative Approaches to Establish a Carbon Finance Programme

5.1 Standalone vs. Programmematic Approach

Carbon finance programmes can be developed using varied approaches that take into consideration project size, geographic coverage, technology used, time, host country requirements, and other variables. Although a standalone carbon finance project applies a similar methodology to that of a PoA, when the standalone project reaches its maximum allowable size (45 MW, or 30,000 one-burner ethanol stoves powered at 1.5 KW), it must submit to the entire registration process anew to establish another standalone project. In contrast, a programme that uses an umbrella PoA allows the inclusion of multiple projects from different geographic locations as "component project activities" or CPAs. A CPA is like a standard CDM project in that it must comply with the procedures and modalities of the CDM, and must include an activity that has a direct, real and measurable impact on emission reductions. By definition, a CPA is: "a single or set of interrelated measure(s) to reduce GHG emissions or result in net anthropogenic greenhouse gas removals by sinks, applied within a designated area defined in the baseline methodology" (CDM, 2007). A CPA also has a maximum threshold of 45 MW (30,000 stoves).

Ethanol stove deployments can be managed as either independent CDM projects or under a programmematic approach. While a standalone approach might appear to be easier at the outset (e.g., securing only a single Letter of Approval, a single stakeholders' consultation, etc.), the PoA approach enables the inclusion of multiple projects from different geographic locations as CPAs (CDM, 2025).[6]

A government or private entity, whether for-profit or non-profit, can develop a PoA that defines broad parameters for CPAs. Once the PoA has been approved and registered by the CDM Executive Board (EB), individual CPAs can be added without the need for approval by the EB, provided they meet the requirements laid out in the registered PoA. The programme is managed by one entity, the CME, which can be private or public, and does not have to be the entity achieving the reductions, though it enables others to do so. The coordinating entity is responsible for the CER distribution and communication with the EB.

[6] *CDM (2025). Small scale CDM project activities. Accessed at: https://cdm.unfccc.int/Projects/pac/pac_ssc.html. See also: https://cdm.unfccc.int/Reference/catalogue/document?doc_id=000002183#:~:text=(c)%20The%20sum%20of%20the,the%20plant%20(e.g.%20boilers).*

Table 5: **Advantages of a PoA over stand-alone CDM projects**

The multiplicity of activities to reduce GHG distributed in time and space	Numerous actors are participating in the programme and working to achieve GHG emission reductions in multiple locations over the lifetime of the programme. The project sites may be in one or more countries.
Lower transaction costs	Registration and verification processes for CPAs are greatly streamlined.
Reduced risk of non-registration	Since the time to registration and associated uncertainties are greatly reduced for CPAs compared with standard CDM projects, it becomes easier to provide pre-payments or other forms of securitization for future CDM revenues.
Duration (PoA and CPA)	The length of the PoA is up to 35 years. The crediting period of a CPA is either a maximum of five years, which may be renewed at most two times, or a maximum of ten years with no opportunity for renewal.
Size / Scalability	For small-scale (SSC) programmematic CDM, only the individual CPAs must be under the SSC threshold (45 MW thermal output), while the overall programme can go beyond any limit. This reduces transaction costs and generates economies of scale.
Monitoring and Verification	A combination of several methodologies may be applied within a PoA.
No registration of CPAs	After the registration of the PoA, individual CPAs are not required to request registration. Instead, the DOE includes the CPA after checking that the CPA follows the rules for inclusion in the PoA.

Source: **Project Gaia.**

As seen in **Table 5**, the PoA provides several advantages for different organizations to replicate their programmes in several countries and by a variety of implementing entities, including local businesses. These businesses may be financially unable to make an upfront investment in a carbon finance programme, and may lack the skills or training to design, develop and run a programme. The PoA approach was created precisely because small and single CDM projects were facing barriers like these and not making their way into the CDM portfolio. The process was too complex, time-consuming, and expensive. With the PoA approach, the project approval process for many individual activities that are distributed over space and time can be brought together. The PoA provides the organizational and financial framework structure for such activities, and can be managed by a single entity, the CME, which has the expertise to do so.

5.1.1 Alternative approaches for bringing carbon finance to ethanol cooking

In most developing countries, local businesses implementing clean cooking programmes face capacity issues and financial constraints in establishing a carbon finance programme. Businesses generally have three alternative approaches for developing a carbon finance project or PoA. If a development organization steps forward as a facilitator and "aggregator" to help businesses join a carbon finance programme on a shared basis, this could offer a fourth alternative. The alternatives, including the "aggregator" option, are discussed here.

The first approach (**Alternative 1**) is for a business to act as its own Coordinating and Managing Entity (CME). Under this approach, the business would develop and manage the PoA, or a stand-alone programme, using its own staff and budget. It owns the PoA or stand-alone programme and has control over the carbon credits it produces. The business manages its own monitoring activities while collaborating with a DOE for validation and verification. Because the business is in direct control of its carbon credit activities, and provided it remains in close contact with its customers, it may be able to show and maintain a high degree of integrity for its carbon credits. However, this approach may not be feasible for small businesses because of the complexity of carbon finance requirements. Additionally, small businesses may struggle to generate enough carbon credits to attract an institutional buyer willing to pay a good price. If the business can produce high-quality credits, this concern may be mitigated.

The second approach (**Alternative 2**) is for a business to hire a consultant or consultants to provide all CME-related services and coordinate the carbon finance programme on its behalf, while still retaining the official status of CME and ownership of its carbon credits. In this case, the business would enter into a contract with the consultant, who would either be paid for services rendered or agree to defer some or all compensation until the successful issuance of carbon credits. The DOE (validator and verifier) must be retained separately. If non-profit service providers are contracted to perform the CME duties, then the fees charged could be lower than those charged by for-profit consultants.

The third approach (**Alternative 3**) involves a business contracting with an established carbon developer that has an existing carbon finance programme or the ability and willingness to develop one based on the business's activities. While a stand-alone programme could be feasible under alternatives 1 and 2, in this case, the carbon developer would almost certainly choose to establish a PoA that could take on more than one client through the use of multiple CPAs. The carbon developer, not the business, would own the PoA. The carbon developer would retain a percentage of the carbon credits generated by the business's activities, while the business would receive earnings from its share of the credits. Although this arrangement would reduce the business's overall earnings from carbon credits, it would offer the advantage of leveraging the developer's experience, expertise, established network, and infrastructure. The business must be careful in managing its relationship with the carbon developer to ensure the developer is operating diligently and transparently, especially if the carbon developer, as would be likely, manages an entire portfolio of carbon credit projects, in which the business is just one of several or many clients.

The fourth approach (**Alternative 4**) involves a development organization, NGO, or a business suited for this purpose acting as an aggregator or umbrella organization to serve as the CME owner or manager. This entity would bring together multiple small businesses and projects under one PoA, with multiple CPAs. Under this alternative, businesses can benefit from shared knowledge and resources and streamlined processes, as well as shared costs, reducing the individual burden of managing and paying for carbon finance. The aggregator would select a carbon developer to serve as the CME and provide a PoA, or it could produce and own the PoA while selecting a developer, broker or investment fund to assist with sales. This approach could be very attractive for small businesses. However, as with the other alternatives, it would require careful coordination and agreements on service delivery and credit distribution to safeguard the position of each participating business. An organization like UNIDO could take on this aggregator role on behalf of multiple small businesses distributing ethanol cookstoves. This would be a valuable add-on to the services UNIDO already provides through its Market Enabling Framework (MEF) using results-based finance (RBF), which is set up in Tanzania to promote the rapid scaleup and wide dissemination of ethanol cookstoves (UNIDO, 2021).

Under **Alternative 2**, which balances control by the business with experience and expertise from the consultant to mitigate risk, the business would retain ownership of its carbon development programme while hiring a consultant to perform the tasks of the CME. This approach allows the business to procure services competitively and potentially engage a consultant with an existing PoA, expediting the process of launching a carbon credit programme. The PoA would focus on the dissemination of efficient cookstoves powered by renewable ethanol to households currently relying on non-renewable biomass and/or kerosene, achieving emission reductions through fuel displacement and/or gains in efficiency. Given the current carbon market dynamics, it is advisable to establish a PoA for the voluntary market while also exploring opportunities under Article 6 of the mandatory market. This dual-market approach provides flexibility in selling credits based on market accessibility and performance.

Once the PoA is approved and registered, individual CPAs can be added according to the requirements established in the PoA. The hired consultant would handle the procurement of validation, verification, and reporting services, while the business, as the CME, would retain control over credit ownership, revenue allocation, monitoring, and interactions with buyers. The consultant could assist in identifying carbon buyers or developers, as well as investment funds willing to buy carbon credits, and help the business optimize its credit sales.

Table 6: **Alternatives Analysis**

Alternative 1	**Opportunities**	**Risks**
The Business (project developer) acts as its own CME (carbon developer).	• Exercises direct control over the administration of its PoA or stand-alone programme. • Ability to obtain speedy approval from government as a local business. • Credibility of carbon credits generated by the business because of CME's direct role in implementation. • Keeps ownership of the carbon credits. • Control over timing and allocation of proceeds from carbon credit sales. • Saves money for the business and enhances the business's understanding of the market.	• May not be feasible due to capacity and financial constraints. • Operational difficulties and bureaucratic hurdles. • High investment of time and costs to develop and manage either the stand-alone programme or the PoA. • The business is directly responsible if the carbon credit programme underperforms or is not well rated. • Risk of being too small to attract an institutional buyer.
Alternative 2	**Opportunities**	**Risks**
The Business hires a consultant to perform the tasks of CME while still retaining ownership of its carbon programme.	• Procures the services competitively. • May select a consultant with an existing PoA who can transfer it to the business, saving time. • Ability to negotiate costs and payment structure. • Retains ownership of its PoA and thus its official role as CME. • Keeps ownership of its carbon credits. • The consultant deals with procurement of validation, verification, and reporting services. • The consultant may help with identifying a carbon developer or buyer.	• Cost of hiring a consultant may be burdensome. • Need to provide oversight of the consultant. • Failure of the carbon credit programme to yield sufficient returns while still creating costs. • Risk of underperformance by the hired consultant. • Risk of being too small to attract an institutional buyer.

Source: **Project Gaia.**

***Table 6:* Alternatives Analysis** *(continued)*

	Opportunities	Risks
Alternative 3 The Business contracts with a professional carbon developer. The developer owns the carbon credit programme and is the CME.	• "Hands-off" approach. The developer is responsible for monetizing the credits. • Carbon developer brings expertise, networks, and infrastructure. • Carbon developer pays upfront costs for the carbon finance programme. • Carbon developer may be willing to commit seed capital to enlist the business in its carbon credit programme and help the business generate carbon credits. • Carbon developer may be able to negotiate competitive carbon sales agreements. • Developer may be able to work with governments and institutional buyers to negotiate an Article 6 project.	• The priorities of the developer may not align with those of the local business. • The local business does not own the PoA or the carbon credits. • The developer may retain a significant percentage of carbon credits. • The developer may not be transparent. • There may be a power imbalance between the business and the developer. • The developer may blame the business for failing to deliver expected services and results. • Host government may be hesitant to approve the developer's PoA. • Host government's fees may be higher for the outside developer.
Alternative 4 Aggregator serves as an umbrella organization for multiple businesses and contracts for services. This may be a carbon developer or an organization above the developer.	• Shared resources and streamlined processes because of scale. • Access to the PoA is shared by use of multiple CPAs. • Costs are shared. • If the aggregator is a nonprofit development organization, it may be able to offer its services at no or low cost. • If the PoA is owned by a third-party carbon developer, the aggregator can provide the required oversight. • Reduces the burden on individual businesses. • Facilitates access to carbon finance for smaller businesses. • Small businesses coming together create scale. • Encourages collaboration among multiple stakeholders. • The aggregator, if a UN or multilateral organization, may be well placed to negotiate an Article 6 project.	• An aggregator may not be available. An organization may have to be set up to perform this role. • Requires coordination and agreements on relationships and credit distribution. • Aggregator may charge fees or take proceeds from credit sales. • Potential for administrative complexity. • Dependence on the aggregator for oversight and management. • Red tape in dealing with the aggregating organization.

Source: **Project Gaia.**

As discussed in Chapter 4, the PoA for ethanol stoves is developed using one or two approved CDM methodologies: AMS-I.E. "Switch from non-renewable biomass for thermal application by the user" for projects displacing fuelwood or charcoal, and AMS-I.I. "Biogas/biomass thermal applications for households/small users" for projects replacing kerosene.

As seen in **Table 5**, multiple CPAs can be added under the PoA, and these do not require individual field validation, reducing transaction costs and registration time. This allows the expansion and replication of the project. In this way, a small business can grow, or, as in **Alternative 4**, small businesses can be aggregated to operate under one PoA. An accredited DOE must review and approve CPAs for inclusion in the PoA. Verification for multiple CPAs could be conducted together to help reduce costs, with the aggregator facilitating this process.

5.2 Roles and Responsibilities of the Carbon Finance Programme Participants

Who are the essential participants in a cookstove carbon finance programme? They are the project developer, i.e., the business that distributes stoves and fuel; the consumers of these services, who, by their actions, produce the emissions reductions that are the basis for carbon credits; the CME, who implements the carbon credit programme (which could be the business itself or a contracted entity); the third-party verifier or DOE; the certifying body that issues the credits (Gold Standard, Verra, etc.), and the traders, brokers and buyers who buy the credits or get them to market.

If there are multiple businesses engaged in similar ethanol stove and fuel distribution businesses, then an aggregator could be added to this list, who would step in to bring the businesses together under a single PoA using multiple CPAs, each addressing the capacity of a separate business or a particular market to produce the carbon credits. The CDM small scale project requirements, as discussed in **Chapter 4**, limit CPAs to 45 MW, or, for ethanol stoves powered at 1.5 KW, about 30,000 stoves. The aggregator can deploy new CPAs to include a growing number of businesses in the portfolio, or to accommodate businesses as they grow and exceed the limits of their CPA.

The Aggregator

The role of this organization could be filled by a business established for purpose, or by a development organization like UNIDO that could serve as the organizing and contracting entity and as the aggregator that brings multiple small businesses together under the umbrella PoA to access carbon finance. This organization could develop its own PoA, or it would contract with a CME, presumably a carbon developer. It would set the terms and conditions under which the CME would offer services to the participating businesses. Also, it would negotiate the fees and costs the CME would take, as well as select and hire a DOE to perform the validation, verification and reporting functions. Furthermore, it would raise funds from the participating businesses to pay the costs of administration, programme design, registration, and fees and taxes, or it would seek to raise all or part of these costs from the CME, which, as carbon developer, could be willing to invest in the project and recover its costs when carbon credits are sold.

The aggregator assists the carbon developer by giving it access to a portfolio of carbon-credit-producing businesses and by serving as the single point of contact with them. The more businesses brought into the portfolio, presumably the lower the risk for the carbon developer, as its likelihood of being able to produce carbon credits from the portfolio increases as the businesses in the portfolio grow.

Coordinating/Managing Entity (CME)

This should be a carbon developer capable of managing and coordinating the carbon finance activities related to ethanol cookstove programmes located in multiple markets and countries. The entity contracted by the aggregator to serve as the CME would bring an already approved PoA or be equipped to write and expedite the approval of one, preferably both for the regulated and voluntary markets. The programme the carbon developer designs should set up the conditions for accurate and verifiable quantification of the emissions reductions achieved, so that a ratings agency will highly rate the programme.[7] The CME acts as the owner or custodian of the carbon credits generated from the programme, facilitating the sale of credits, paying all necessary costs and fees, and distributing net earnings from

[7] *Rating agencies such as BeZero and CalyX Global provide integrity ratings for some VCRs. Standards organizations such as The Integrity Council for the Voluntary Carbon Market (ICVCM) and the Voluntary Carbon Markets Integrity Initiative (VCMI) provide principles or standards by which VCRs are rated. These entities are new participants in carbon finance programmeming.*

the carbon credit sales back to the project implementers (the businesses) through the aggregator, according to the agreements made by the aggregator. The CME would benefit from its share of the carbon credit sales once sales begin, with the implementers' share due to them ideally on a first-dollar basis, i.e., beginning with the first dollar earned, not after the CME has been paid.

The ultimate beneficiaries of the carbon finance revenues coming to the businesses must be the customers themselves, who are purchasing and using stoves and fuel. This is essential for meeting the requirement of additionality. Thus, the businesses will use their portion of revenues to subsidize stoves for households and/or provide other essential, related economic benefits. The bulk of the earnings on carbon credits should go for this purpose; the share that the carbon developer and other service providers earn, in aggregate, should be the minor share. How the carbon credit proceeds are to be distributed should be spelled out in the contracts between the aggregator, the CME and the businesses, and how the customers will benefit must be spelled out in the CME's project design document.

The CME assures that each CPA complies with the requirements of the PoA. In addition, it conducts adequate monitoring and data collection to oversee the monitoring activities carried out by the implementers/ local businesses. The CME is responsible for hiring the DOE or third-party auditor to validate the CPAs and verify the ERs achieved under them and, with the assistance of the local implementers, it must facilitate their work. Under the small scale CDM project activity rules, the same DOE may be used for both validation and verification (UNFCCC, 2025).[8] Upon successful issuance of carbon credits, the CME is responsible for the sale of credits to buyers. However, the aggregator, or even the local project implementers (the businesses), could assist in identifying buyers if this is agreed to in the aggregator's contract with the CME. Possibly the aggregator or the implementers can identify buyers willing to pay a better price.

The carbon developer should be encouraged to set up a framework for the businesses to produce the highest quality credits. These are achieved with good monitoring and reporting activities by the businesses and a strong relationship with their consumers. This should be embodied in the PoA. High-quality credits are now believed to be the growth market within the VCM. With the adoption of the Article 6 rules at COP29, these high-quality credits may also enter the regulated market through Articles 6.2 and 6.4. As the VCM becomes more regulated, and the problem of double counting is addressed with voluntary credits, the boundaries between voluntary and compliance markets are becoming increasingly blurred (carboncredits.com, 2025).[9]

Project Developers (Implementing Partners)

The project developers or implementing partners are the businesses, small or large, that engage in the business of distributing clean-burning stoves and ethanol fuel to customers who are being asked—or given the opportunity—to switch from burning wood, charcoal, kerosene, or other fuels that produce greenhouse gases, to clean fuels and more efficient stoves. They are recruited by the aggregator into the carbon finance programme. If the switch from dirty to clean fuels takes place in a high impact country (defined as a country that offers high potential to make rapid progress towards the SDGs), the opportunity to benefit from carbon finance is likely to be enhanced.[10] Implementing partners will be responsible for managing their participation in the carbon finance programme by adhering to the requirements of the CPA in which they are enrolled. They will have to collect and manage stove use and fuel consumption data to provide to the CME, facilitate the work of the DOE, and provide benefits from the carbon finance, as set forth in the CPA, back to their customers. The aggregator may recruit multiple implementers in each market or each country in consultation with the CME. If the PoA is designed accordingly, the aggregator may have implementers in multiple countries. If the demand for carbon finance exceeds the number of CPAs that have been written, the aggregator and CME can agree to add new CPAs to the PoA to accommodate additional implementers. Each new CPA must be validated by the DOE. There is effectively no limit to the ability to expand the carbon finance programme, provided the market is there to support it.

[8] *UNFCCC (2025). Small scale CDM project activities. Accessed at: https://cdm.unfccc.int/Projects/pac/pac_ssc.html.*

[9] *Carboncredits.com (2025). Voluntary Carbon Market Evolution. Newsletter dated 8 February 2025. Available at: https://carboncredits.com/?s=Voluntary+Carbon+Market+Evolution+.*

[10] *Rating agencies such as BeZero and CalyX Global will rate projects that contribute to the SDGs more highly. The Gold Standard also evaluates projects according to their SDG contributions.*

Carbon Developers, Buyers and Brokers

Individual businesses with promising carbon finance potential, or an aggregator with a promising portfolio of such businesses, can engage with a carbon credit developer to set up a carbon finance programme. In return for the right to receive a share of the carbon credits from the programme (either for a defined period or throughout its duration), a carbon developer could agree to pre-purchase a percentage of the anticipated credits or even provide seed capital to assist implementers to jumpstart their businesses. These funds could be used to pay for infrastructure or even to set up an investment incentive to attract local business capital into the project, for example by fuel producers to increase their production. Financial guarantees for distilleries could be used to obligate producers to supply agreements. Other activities could include underwriting the cost of essential infrastructure for fuel distribution or reducing the risk for commercial banks that give loans for bulk purchases of stove.

Many carbon developers specialize in selling credits on the voluntary market. Because the projected supply of VERs, including those in the pipeline, is limited, while corporate demand for VERs, especially for high-quality credits, is expected to increase, carbon developers have an interest in investing in carbon credit development to lock in a steady supply of credits over ten years or more, indeed out to 2050, or as long as it is believed that VERs will remain an important tool for corporate offsetting, compliance and mitigation (Blaufelder et al., 2021) (Colorado School of Mines, 2022) (carboncredits.com, 2025). As high-quality VERs become more acceptable to the regulated market under Article 6, this creates an additional incentive for carbon credit developers to participate with businesses to develop carbon credit programmes.

UNIDO has a compelling case to make to carbon developers to invest in its Market Enabling Framework (MEF) project structure. The MEF structure has been deployed in Dar es Salaam (Tanzania) to roll out up to 500,000 stoves (UNIDO, 2019).[11] This MEF structure increases the likelihood that substantial volumes of carbon credits will be produced in a market where risk has been reduced because of UNIDO's involvement with its MEF. To take full advantage of this, and attract carbon finance investment into the MEF, UNIDO could take on the role of aggregator for businesses earning carbon credits. By offering its services as an aggregator for carbon credits along with the MEF services, it could present a compelling case for a carbon developer to invest in and pre-purchase carbon credits.

UNIDO seeks to achieve scale with its ethanol and clean cooking programme. Its Tanzania programme is to be replicated across other high-impact countries. By setting up, diversifying and scaling a market intervention that increases the capacity of the players and reduces risk, favourable conditions are created for carbon developers to invest. The pre-purchase of carbon credits from businesses operating in MEF projects could result in increased volumes and steady flows of VERs, which developers need for sale into a demand market.

Examples of private carbon development companies include (in alphabetical order): 3Degrees, Allcot, BP, carbonsink (a South Pole company), Carbon Streaming, Climate Impact Partners (formerly ClimateCare), Climate Neutral Group, ClimatePartner, co2balance, EcoEye, EcoAct, Element Markets (Anew), First Climate, Mercuria, Respira, Shell Global, South Pole, TotalEnergies, VNV Advisory and others. These are all investors in carbon credit development that have made or shown interest in cookstove projects. The list continues to grow.[12]

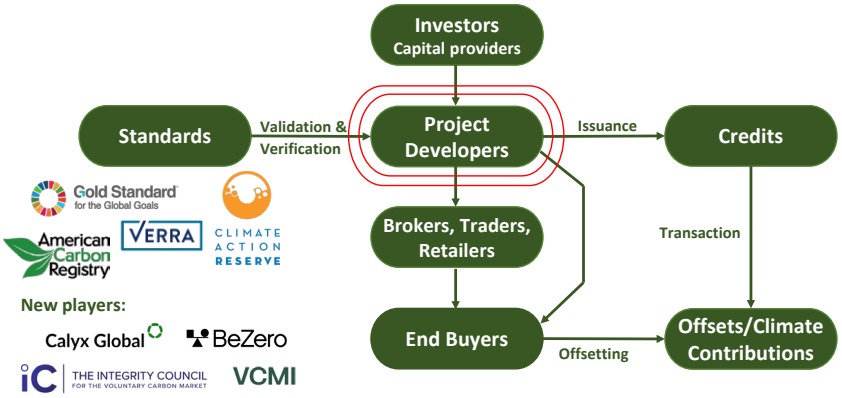
Development finance institutions (DFIs), which include multilateral development banks (MDBs) and national development banks (NDBs), are playing a growing role in supporting socioeconomic development through access to finance. Increasingly, they are focusing on sustainable development and the SDGs. At the same time, there is a growing awareness that they must support the transition to a 1.5°C world if it is to be achieved (Climate Bonds Initiative, 2024).[13] Thus, in addition to seeking investment from private-sector carbon developers, organizations should approach DFIs that have shown an interest in carbon finance programmes. Obvious examples are the World Bank Carbon Initiative for Development or Ci-Dev trust fund, the African Development Bank Sustainable Energy Fund for Africa (SEFA), and the Green Climate Fund.

[11] *UNIDO (2019). UNIDO rolls out 500,000 clean cook stoves in Dar es Salaam. Available at: https://www.unido.org/news/unido-rolls-out-500000-clean-cook-stoves-dar-es-salaam.*

[12] *The names of these developers are hyperlinked to the page of their website showing their interests or their portfolio.*

[13] *Climate Bonds initiative (2024). The Role of Development Finance Institutions in Accelerating the Mobilisation of Green Capital. Accessed at: https://www.climatebonds.net/files/reports/the_role_of_dfis_in_accelerating_the_mobilisation_of_green_capital.pdf.*

Figure 7: **Role of Carbon Developers in the Voluntary Market**



Source: **Abatable Carbon Developer Ecosystem Report (after Filmanovic, 2022).**

DFIs that have engaged in climate funding include the African Development Bank (AfDB), Asian Development Bank (ADB), Asian Infrastructure Investment Bank (AIIB), Council of Europe Development Bank (CEB), Development Bank of Southern Africa (DBSA), Dutch Development Bank (FMO), European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB), Inter-American Development Bank Group (IDB), Islamic Development Bank (IsDB), KfW Development Bank, New Development Bank and the World Bank Group.

It is becoming increasingly urgent for both public and private finance to flow into the climate transition, and banks are looking for the opportunity to do so but at the lowest risk possible.

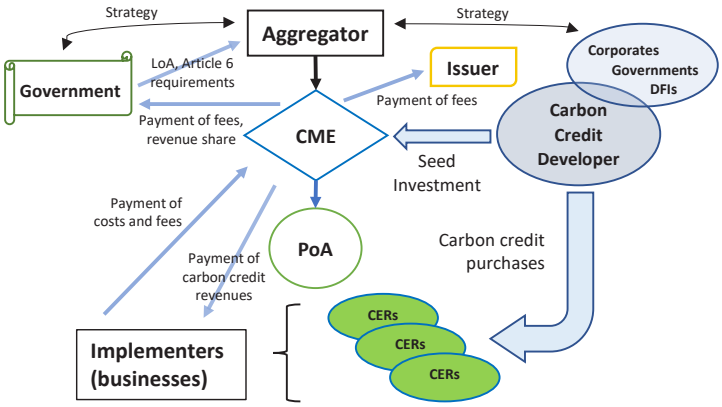
Along with public capital, DFIs can play an important role in mobilizing private capital. This requires a shift from the 'originate and hold' model to the 'originate and sell' model (Climate Bonds Initiative, 2025). Buying and selling carbon credits represents an 'originate and sell' opportunity. Such a strategy frees up the bank's funds to enable greater green lending using instruments such as securitization, typical of a commercial bank business approach. A DFI could be asked to invest in carbon credits, or businesses that earn credits, and in a companion fund, such as a guarantee fund. Revenues from carbon credit sales could then flow into the fund.

Guarantees and credit enhancement are ways for DFIs to mobilize private finance while lessening the impact on balance sheets (Climate Bonds Initiative, 2023, 2025). If DFIs agree to subordinate their lending to private lending, this gives strong encouragement for private investment to come into projects that might otherwise be considered too risky. Many DFIs now provide green guarantee facilities for solar projects. These instruments could be adapted to clean cooking programmes, where carbon finance plays a role in securitizing debt.

DFIs have been pioneers in the green bond market, with the European Investment Bank (EIB) and the World Bank issuing the first green bonds in 2007. A national development bank could issue green bonds in its market to help kickstart the sector, with the green bonds at least partially underwritten by carbon finance. If the NDB lacks the capacity to do this, an MDB could be asked to step in and issue the bond (Climate Bonds Initiative, 2023).

UNIDO could work directly with national governments and its member states, especially those that have shown the greatest commitment to renewables and mitigation funding. Examples are the Government of Switzerland with its recent, first ever internationally transferred mitigation outcome (ITMO) agreement with Ghana, under Article 6.2 of the Paris Agreement (UNDP 2022), and NEFCO, the green finance institution of the five Nordic countries, anchored by Norway and Sweden, which has been one of the most committed supporters of ethanol fuel development, while also refraining from support of LPG for cooking (NEFCO, 2022) (Modern Cooking Facility for Africa, 2023). Another example is the Abu Dhabi Fund for Development (ADFD), and the Energy Transition Accelerator Financing Platform (ETAF), both administered by IRENA and headquartered at Masdar (IRENA, 2022) (ETAF Platform, 2025). Other examples could arise from discussions with India and Brazil, global leaders in the use of bioethanol fuel. The development banks of these countries could play a key role in blended finance for distillery projects.

***Figure 8:* Opportunity for early investment by a carbon credit developer in the UNIDO programme**



Overview of the carbon credit framework under **Alternative 4**, led by the aggregator. It outlines the key stakeholders, financial flows, and compliance requirements under voluntary mechanisms. At the center is the CME, which could be assumed by either the aggregator or the carbon developer.

***Source:* Project Gaia.**

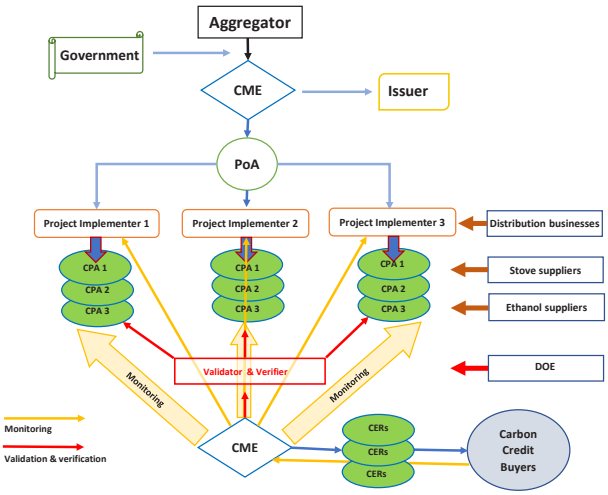
Ethanol Fuel and Stove Suppliers

The suppliers will provide fuel and stoves to the implementing partners on commercial terms. The implementing partner may agree to share carbon finance revenues with its suppliers to reduce the wholesale cost of purchases. This is a particular opportunity for stove purchases. The stove manufacturer could receive a portion of the carbon finance revenues in exchange for selling the stoves at a subsidized cost from its factory. If the stoves originate from outside the country, this could yield savings on import duties and value-added tax (VAT). Carbon finance would also be used on the retail sales end to further reduce stove costs for consumers. While carbon finance could play a small role in reducing the price of fuel, fuel purchases are on a scale that does not allow for meaningful subsidization by carbon finance revenues. Its true utility is in subsidizing stoves.

Government Role in the Carbon Finance Programme

The national government must approve the carbon finance programme, and the DNA is responsible for this. Depending on the type of credits being issued and how they are to be credited or sold, the DNA's review may be cursory or thorough. If it decides to approve it, a Letter of Approval (LoA) is issued, which allows the CME and Implementing Partner(s) to proceed with registering a CPA or CPAs. A public consultation process follows, in which the government, the CME

***Figure 9:* Carbon finance design for UNIDO/aggregator-led ethanol stove programme**



Structure of a Carbon Finance PoA under **Alternative 4** illustrating the interactions among the key players. The figure shows how the addition of CPAs permits the programme to grow.

***Source:* Project Gaia.**

and the implementing parties listen to citizens, local communities and other stakeholders. Public input provides an opportunity for affected communities to comment on the design of the carbon finance project and influence the PDD. Under Article 6, there is an increased emphasis placed on demonstratable local benefits.

As an illustration of the government's role, the government of Tanzania recently adopted its National Carbon Trading Guidelines (October 2022), which present the duties and responsibilities of the government as well as applicants under the new Article 6 procedures (United Republic of Tanzania, Vice President's Office, 2022). These guidelines are designed to address regulated and voluntary carbon crediting mechanisms, including ITMOs. The Division of Environment, Vice-President's Office (VPO), led by Minister of State Seleman Jafo, is the DNA. Dr. Richard S. Muyungi, Director of Environment, serves as a focal point.

The Norwegian government has been instrumental in assisting the government of Tanzania to become current in national carbon trading law and regulation. Moreover, the Norwegian government helped fund the establishment of the National Carbon Monitoring Center (NCMC) at Sokoine University of Agriculture (SUA) in Morogoro. REDD+ is a major focus of NCMC, but it addresses all sectors, i.e., emissions from the combustion of fuels, industrial processes, forestry, agriculture, methane, waste, transportation, land use, land use change and forestry (LULUCF) sources, and sinks (NCMC, 2022).

Under the National Carbon Trading Guidelines, some of the key steps in the process are as follows:

1. The CME or implementer applies for approval of the carbon trading project idea to the DNA by filling out an application form provided by the National Focal Point (Registrar)
2. The completed application form is submitted with an application fee of $250 (for citizens) and $500 (for non-citizens).
3. The DNA or National Focal Point must respond to the CME within 30 days of the registration of the project idea.
4. If the requirements for the application are met and the project is registered, the CME or implementer must submit a Project Concept Note within 90 days.
5. A registration fee of one per cent of the expected value of CERs from the project must be paid to the Registrar. If an implementer is submitting the Project Concept Note, it must have the approval of the CME.[14]
6. The DNA or National Focal Point shall within 30 days of receiving the Project Concept Note issue a letter of no objection for a qualified Project Concept Note or a letter of recommendation for improvement of the Project Concept Note.
7. The implementer, CME and project partners will have 12 months to develop a PDD after obtaining the letter of no objection. The implementer may obtain one extension of not more than six months to complete the PDD.
8. The PDD must conform to accepted international standards on carbon trading including validation where required (voluntary commitments may not require validation).
9. The DNA or National Focal Point shall within 30 days from the receipt of the Project Document submit to the Minister responsible for environment the project proposal for endorsement of implementation, and
10. The implementer shall, within two years after receiving the endorsement, start implementing the project.

If UNIDO brings a CME to its programme with a PoA already approved, then only CPAs need to be written and approved. This could be expected to greatly speed up the process. The DNA will evaluate the CPAs to determine how they will benefit the local community and individuals in the community. The DNA will also be concerned with oversight. The regulations provide for the following (they are paraphrased) (United Republic of Tanzania, 2022):

4.1.3 Regulatory Authorities – key institutions responsible for overseeing carbon trading projects, including institutions mandated for environmental management, regional administration and local governance, and relevant sector ministries... will collect fees associated with administering carbon trading projects by the national laws.

4.1.4 Local Communities – Carbon trading projects... are required to show explicitly how the local communities are going to be taken on board to participate and benefit from the project... the project should clearly clarify how social corporate responsibilities will support the local community's development activities and welfare. ●

[14] *A 1 per cent fee on a CPA for ethanol stoves could amount to $18,000 for 30,000 stoves over five years.*

6. Analysis of UNIDO's Ethanol Cooking Project in Tanzania

Carbon markets can be a cost-effective way to achieve emissions reductions and can help countries meet their climate goals if robust rules are applied. They could be a useful tool for UNIDO's ethanol stove programme. As of December 2023, the CDM was responsible for over 8,065 registered project activities and over 2.36 billion certified emission reductions issued (CDM, 2025). However, extending the mandate of the CDM required agreement by the parties to the Kyoto Protocol. Since there was no agreement before the CDM expired on December 31, 2020, the formal CDM market ceased to operate, and the carbon market went through a period of turbulence and uncertainty. Not until November 2021 at COP26 in Glasgow were countries able to agree upon rules for a new international carbon trading system under the Paris Agreement. The lack of clarity regarding new rules made investors reluctant to back projects, which typically have a lifespan of seven or more years.[15] This pushed developers, investors and buyers to the voluntary market.

Carbon credits serve as results-based financing for cookstove programmes, similar to what UNIDO is implementing in Tanzania with funds from the 6th project cycle of the Global Environment Facility (GEF6). Carbon finance for ethanol stoves has already been used by private sector players, such as Green Development AS in Madagascar and Kenya, and KOKO Networks in Kenya. Project Gaia has had a programme in place since 2016, and two CPAs open in Ethiopia. Emissions reduction calculations (see **Table 4**) show that four tCO_2e per household per annum can be achieved on average when replacing wood and charcoal fuels. Carbon credit prices vary widely in the voluntary market, which has generally provided better returns. This could change as Article 6 becomes fully operational and the mandatory market begins to function more robustly. Overall, prices for cookstove credits have ranged from $10 to $55 per tonne, depending on the project and provider (Energy Monitor, 2024). The volume of sales, however, has been in the lower-priced credits, ranging from $2 to $10 (AlliedOffsets, 2023). Although the value of voluntary credits declined significantly between 2022 and 2024, many predict the prices in the VCM will increase again (World Bank, 2024) (carboncredits.com, 2025). Carbon credits from projects with high socio-economic value, such as UNIDO's ethanol stove programme in Dar es Salaam, could qualify as premium credits and command a higher price, provided there is also good monitoring, reporting and verification (MRV) to support integrity claims. If four credits per stove per annum can be earned from users who fully commit to their stove and use it as their main stove, this could reasonably earn $40 annually per stove, which is roughly equivalent to the margin an ethanol fuel distribution business might expect to earn annually from selling fuel to a fully participating client household (estimated at 300 litres x $0.14 margin/litre fuel). This highlights the importance of carbon credit earnings to a business.

UNIDO has begun its ethanol cooking programme in Dar es Salaam, Tanzania, with a plan to replicate the programme in 20 high-impact countries, modifying it as needed. There are two underlying assumptions the programme addresses: (1) under the business-as-usual scenario, there is little motivation for end users to switch from charcoal or wood to clean-burning ethanol fuel if the ethanol fuel does not provide financial savings to the customer, and (2) the stove must be as cheap to purchase as a typical, locally made improved charcoal stove of reasonable quality. Convenience, time savings, safety and health considerations alone may not be sufficient to trigger a change in habits to ensure the switch to ethanol (UNIDO, 2016) (GEF, 2017).

[15] *Under the new Article 6 rules, the crediting period for the issuance of emission reductions is five or 10 years, or five years, renewable once, but without option in either case for further renewal (UNFCCC, 2022).*

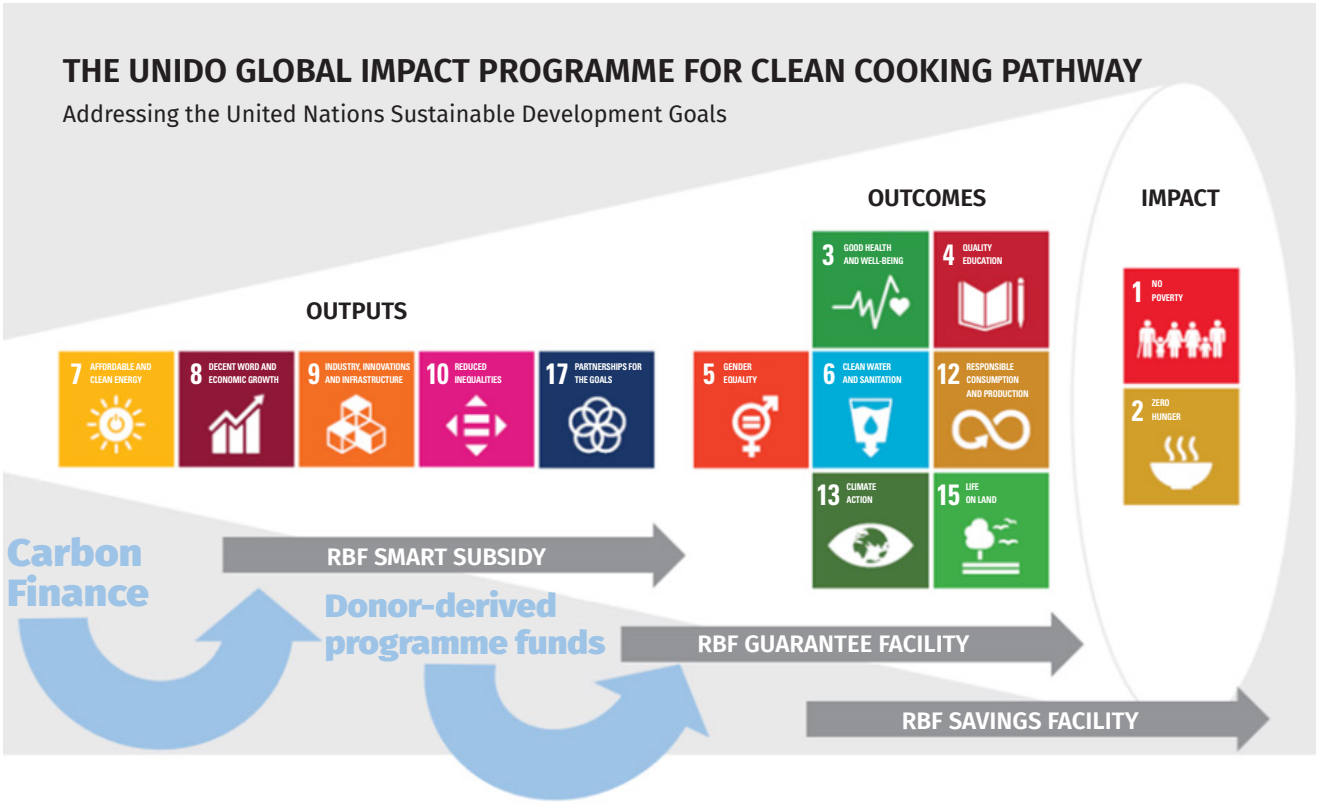
To conduct the programme, UNIDO has invested GEF6 funds in (1) a subsidy for a good quality ethanol stove, (2) costs of marketing, to be undertaken by the selected distributor(s), and (3) technical, business, programme and administrative support to facilitate the acquisition of ethanol, the design and set up of a supply chain, the marketing of stove and fuel, the delivery of GEF6 funds as RBF, the coordination of the programme with government, capacity building for key institutions, and other services. In this rich menu of supports, a necessary condition of the programme is that there be a reliable supply of ethanol available to be purchased for stove fuel. The Tanzania programme was fortunate to have at least two producers of ethanol available in the country, with several others preparing to commence production during the life of the project (coinciding with round two of the programme). An important feature has been included in the programme, designed to encourage fuel production for the cookstoves, as well as the building of essential infrastructure. This is the guarantee fund, to be managed by Tanzania's TIB Development Bank, intended to be used to reduce risk on loans for capital projects (UNIDO, 2022). However, this guarantee fund is dependent on an appropriation from the government, which has been slow to come.

Guarantee Fund

Because the availability of fuel for stoves is the necessary condition, without which an ethanol stove market cannot be built, it may be important or even essential for UNIDO to place more of the resources at its command into the development of ethanol fuel in the country. In the Tanzania programme, if carbon finance can be deployed to fund the subsidy on cookstoves and marketing activities, then funds for these purposes could be reallocated to catalyze the guarantee fund (**Figure 10**). Priming the fund with startup capital could be an important first step to attracting DFIs and other public investors to the fund to raise capital.

The guarantee fund would be used to encourage private investor capital to flow into ethanol production, ideally for smaller or even "micro" distillery projects (defined as in the range of 2,500 to 5,000 litres/day). Larger projects would be too large for the fund and probably best left to private business, i.e., the sugar industry and large banks specializing in large-scale projects supported by government-backed export-import guarantees or other incentives. Smaller projects tend to be neglected or lie out of the scope of large banks and struggle to find lenders. This is especially true for micro projects. At the same time, these projects cannot usually be funded through grants alone. Thus, small and micro projects may represent the "sweet spot" for a UNIDO-facilitated guarantee fund.

Figure 10: **Using carbon finance to shift donor programme funds to the guarantee facility for the development of fuel supply**



Source: **UNIDO Global Impact Programme for Clean Cooking.**

Assuming a small project would benefit from a 30 per cent leveraged guarantee, this could represent a financial commitment of $3.5 to $4 million for five years. A small project could be defined as a 10-million litre-per-year plant. For a micro project, this would be a commitment of $300,000 over three to five years. A micro plant would produce up to 1 to 2 million litres per year. Two or three such plants financed in a national market could be transformative for that market. Therefore, a fund of $10 million could be impactful for a market. As the plants are built, commence commercial operation, and are paid off, the fund is recharged and able to support additional projects. If carbon finance is helping to build the stove and fuel market, creating the demand for ethanol fuel, then the distillery projects are benefiting from the work of the carbon finance. The carbon finance for stoves and UNIDO's investment of programme funds in the guarantee facility to build distilleries are working together.

The guarantee fund could also help businesses overcome the hurdle of buying stoves in bulk to secure the best price possible. An order of three or four containerloads of stoves (6,000 to 8,000 stoves) represents an investment of $150,000 to $200,000, which could be securitized by a guarantee of 50 per cent, perhaps $75,000 to $100,000. This would help the borrower secure a commercial loan at a favourable rate. The size of the loan might be reduced by a carbon finance pre-payment from a participating carbon developer, leveraged with some cash from the buyer. The payback to the guarantee fund could be expected to be shorter than for a distillery—one to three years.

Other capital investments that the guarantee fund might help with include storage tanks, fuel depots, and tanker trucks. If the government eases import duties on ethanol, portside infrastructure for receiving bulk deliveries of ethanol could become important. But since governments will favor domestic production over imports, the guarantee fund might best be focused on boosting local production.

In fact, if the government sees the endowment of a guarantee fund to spur industrial projects such as distilleries, this could galvanize their interest in UNIDO's ethanol programme and encourage them to be more confident about the transition to ethanol fuel. African governments have been overwhelmed with messaging about LPG—another imported fuel—as the clean cooking paradigm. Nothing will challenge this more than progress in the domestic production of ethanol.

The guarantee fund might also be used to pay for the cost of setting up the carbon finance programme or for adding CPAs to the programme, although these are relatively small costs. Such costs probably could not be returned to the fund from carbon finance revenue, as this should be committed to activities that address additionality, i.e., stove and fuel subsidies and other activities that address accessibility. Maintaining a bright line between the use of carbon financing and other types of funding in the programme would be important. The carbon finance revenue is conditioned on additionality. A comprehensive project design should be followed to avoid pitfalls.

Donor support for stove subsidies, or support from funds like the GEF, the UNCDF CookFund or other special funds, may not be as durable or long lasting as carbon finance, a market-based programme, which could be expected to be available for many years, certainly through 2050, or for as long as nations agree to set benchmarks and strive to address climate change. Under the current UNIDO MEF project design, finance coming from the GEF for subsidizing stoves will cease in several years. Then the affordability price gap on stoves, if it has not been addressed in the market, will have to be addressed in some other way. By integrating carbon finance from the very start in new national programmes, the subsidy requirement for stoves could presumably be met for as long as cookstove carbon credits are valued in the marketplace. This allows funding from the GEF to go to industrial development projects, like increasing the domestic production of ethanol and other low-carbon fuels, which, with renewable power, are the building blocks of a new, low-carbon energy economy. The market itself, and market-based mechanisms like carbon credits, can pay for or subsidize cookstoves. The guarantee fund and other financial tools are critically important for building distilleries to assure the supply of fuel. It is only the fuel supply that will unlock ethanol for fuel. Given that the ethanol industry in Africa still needs to transition away from its traditional potable alcohol market, the use of these funds should commit the producer to serving the fuel market.

Moving forward with carbon finance—the CME

If UNIDO were to take on the role of aggregator, it could assign an expert entity to serve as CME for an umbrella carbon finance programme to support local implementers engaged in ethanol stove and fuel distribution businesses. This enables multiple projects to be grouped under one umbrella programme. The expert entity can be contracted by UNIDO to fulfill the duties and responsibilities of a CME, which include the following:

- Develop the PoA Design Document (PoA DD) and Component Project Activities (CPAs) Design Documents (CPA-DD) for CPAs developed under the PoA. Generally, a CPA is developed for each market, defined by geography, by implementer, and possibly also by social and economic indicators.
- Obtain a Letter of Approval (LoA) for the implementation of the PoA from the host country in partnership with local project implementers.
- Liaise with the Designated National Authority (DNA) on matters relating to the implementation of the PoA and inclusion of CPAs.
- Carry out a quality check on CPAs to be included in the PoA to ensure that the CPA meets all the eligibility criteria formulated in the PoA-DD.

- Collect and compile monitoring records from all the CPA entities.
- Coordinate monitoring activities and data management during the lifetime of the PoA and CPAs.
- Contract a DOE for validation and verification purposes.
- Prepare and submit monitoring reports, and facilitate verification of the information in these reports.
- Act as the focal point for matters related to the PoA.
- During the lifetime of the PoA, maintain all monitoring reports of all CPAs following record keeping systems outlined in the PoA-DD.

The project implementers (local distribution businesses) serve as CPA implementing entities and will be responsible for:

- Implementing individual CPAs under the PoA.
- Operating under and adhering to the CPA requirements for the project's duration.
- Maintaining records of parameters according to the monitoring plan and providing hard and electronic records to the CME regularly.
- Providing the CME and DOE with required documents and access to stove users as needed.
- Making staff available for validation and verification activities when necessary.

The CME will enter into contractual agreements with all CPA entities as a precedent for their inclusion in the programme. The agreements will summarize the roles and responsibilities regarding the implementation of the individual projects as CPAs. Moreover, they will ensure that the CME has access to all records and information related to the implementation of individual CPAs, and that each CPA is being implemented according to the provisions outlined in the PoA-DD. The agreement will also put in place measures to avoid double counting of the proposed CPA.

The eligibility requirements to be used for the inclusion of the CPA into the PoA will be set forth in the PoA. However, the cumulative capacity of each CPA cannot exceed 45 MW, which is equivalent to about 30,000 single burner stoves.

The CME will provide the necessary managerial, technical, legal, communication, and administrative functions to operate and manage the PoA in accordance with the registry body requirements, covering the process of including CPAs. In cases where certain functions or tasks may be outsourced, the ultimate responsibility for final quality control and approval will rest with the CME. **Figure 11** below shows the simplified basic steps of a carbon finance programme.

If the selected CME does not bring an existing PoA to UNIDO's programme, developing and registering a PoA is a one-to-two-year process. There will be an investment required of approximately $150,000 to design the PoA, meet validation requirements, receive approval, and register. A carbon developer may agree to prepurchase carbon finance generated in the programme. Otherwise, an upfront revolving fund will be required to finance the subsidy of stoves until carbon finance earnings can contribute. Thus, UNIDO, as the aggregator, would need to budget funds to establish the PoA and provide upfront money until carbon finance begins to flow, or else work with a carbon developer willing to invest in the PoA. Once a PoA is in place, adding individual CPAs can greatly reduce the time for registration, uncertainties associated with the registration process, and costs associated with joining the carbon finance programme. In addition, individual CPAs are not required to ask for registration. Instead, the DOE, serving as the validator, agrees to include the CPA after checking that it follows the rules for inclusion in the PoA. The PoA approach makes it possible for CPAs to be added to meet an Emission Reduction Purchase Agreement, or ERPA. Having an ERPA in the early stages of implementers' projects is a way to bring in seed capital or early investment when it is most needed. ●

Figure 11: **Basic processes to establish a PoA**

Source: **Project Gaia.**

7. Terms & Definitions

Additionality – For a CDM project activity or CPA, the effect of the CPA is to reduce anthropogenic GHG emissions below the level that would have occurred in the absence of the CPA. Additionality includes the idea that if the CPA or project activity can be implemented without the assistance of carbon finance, then the project will not qualify for carbon offset credits because the project developer would likely have executed the project anyway.

Article 6 – Under the Paris Agreement, an agreement about how countries can cooperate and trade mitigation outcomes (carbon credits) with one another to help meet their climate targets (NDCs) and raise fully shared ambitions to meet climate goals. There are three frameworks for trading:

a. **Article 6.2** (market): Countries can trade emissions reductions or removals bilaterally or multilaterally. The seller country can sell emissions reductions or removals over and above what it needs to meet its Paris commitments. The buyer country would be any country that has or will fall short of its commitments.
b. **Article 6.4** (market): This mechanism is similar to carbon trading under the Kyoto Protocol, which established a UN-governed body called the Clean Development Mechanism (CDM). The CDM created centralized rules around what types of activities (methodologies) were allowed, how these should be verified, and other rules. The new 6.4 mechanism will follow a similar centralized approach, while seeking to improve upon the CDM. Article 6.4 is referred to as the Sustainable Development Mechanism (SDM).
c. **Article 6.8** (non-market): Additionally, there can be financing of other, non-market approaches through 6.8. This mechanism is less defined, but would provide a formal framework for climate cooperation between countries, such as programmes involving development aid, where no trade of emission reductions is involved.

Article 6 Markets – New carbon markets resulting from the operationalization of Article 6 of the Paris Agreement that allow international carbon credit trading between countries.

Cap and Trade – See **Emissions Trading Scheme (ETS)**.

Carbon tax – A tax on GHG emissions, which puts a price on the emissions to encourage consumers, businesses, and governments to produce less of them.

Carbon allowance – A term used for a certificate or permit that represents the legal right to emit one metric ton of carbon dioxide or equivalent GHG. Such certificates or permits are issued to companies and organizations participating in a mandatory national or international carbon market.

Clean Development Mechanism (CDM) – As set forth in Article 12 of the Kyoto Protocol, the CDM allows emission reduction (or emission removal) projects in developing countries to earn certified emission reductions (CERs), each equivalent to one tCO_2. CERs can be traded or sold to finance sustainable development projects. They are intended to be used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol.

The CDM established three market-based mechanisms, (1) International Emissions Trading, (2) the Clean Development Mechanism (CDM), and (3) Joint Implementation (JI).

A CDM project must provide emission reductions that are "additional" to what would otherwise have occurred. Designated National Authorities approve CDM projects, which must go through a rigorous public registration and issuance process to qualify. Official development assistance is not to be used in CDM projects to ensure that these funds are not diverted from their intended purpose.

The CDM was discontinued at the end of 2020. Once implemented, Article 6 provisions of the Paris Agreement will take the place of CDM.

Certified Emission Reduction (CER) – A unit issued for GHG emission reductions from CDM project activities or PoAs under the CDM rules and requirements, which is equal to one metric ton of carbon dioxide equivalent, calculated using global warming potentials defined in Article 5 of the Kyoto Protocol. CERs can be accepted by entities wishing to voluntarily offset their carbon footprint, and thus may be sold on the voluntary, as well as the regulated market.

Coordinating Managing Entity (CME) – An entity authorized by the host country's DNA to implement a particular PoA. The CME communicates with the CDM board and the secretariat, including on matters relating to the distribution of CERs.

Component Project Activity (CPA) – A single measure or a set of interrelated measures under a CDM PoA to reduce GHG emissions by source, or a net anthropogenic GHG removal by sinks, applied within a designated area defined in the baseline methodology(ies).

Core Carbon Principles – A set of principles developed in 2023 by the ICVCM to establish a high integrity standard for carbon credits in the voluntary market, based on measured data, disclosure and sustainable development values. (See also **ICVCM.**)

Corresponding Adjustments (CA) – Article 6.2 of the Paris Agreement requires nations to apply CAs to carbon credits that are used for trading between nations. This is to ensure that an emission reduction is not counted as mitigation by two different countries towards their Paris pledges. Specifically, it applies double-entry book-keeping when a country funds a mitigation project in another country with the expectation of being able to count the verified emission reductions arising from that financial contribution as its own when reporting progress against its NDC to the UNFCCC (CarbonNeutral.com, 2023).

CPA-DD – The design document prepared by the CME, which sets out in detail, under the CDM rules and requirements, the CPA that is to be undertaken. The form of CPA-DD is publicly available on the UNFCCC CDM website.

Designated national authority (DNA) – A deliberative body granted responsibility by the national entity that has ratified the Kyoto Protocol to issue a letter of approval concerning CDM project activities or PoAs on behalf of the national entity, and by the CDM rules and requirements.

Designated Operational Entity (DOE) – An entity designated by the Conference of the Parties (Kyoto governing body), based on a recommendation by the CDM board, that is qualified to validate proposed CDM project activities and PoAs, as well as verify and certify reported GHG emission reductions.

Emission reduction unit (ERU) – A Kyoto Protocol unit equal to 1 metric ton of CO_2e. ERUs are generated for emission reductions or emission removals from joint implementation (JI) projects.

Emissions Reduction Purchase Agreement (ERPA) – A legal contract between entities that are buying or selling carbon credits with one another.

Emissions Trading Scheme (ETS) – A market mechanism that allows entities (such as countries, companies, or manufacturing plants) that emit or release GHG into the atmosphere to buy and sell those emissions (as permits or allowances) amongst themselves.

Emissions trading, or cap and trade, is a government-mandated, market-based approach to controlling pollution by providing economic incentives for achieving reductions in the emissions of pollutants. Under an established "cap and trade system", an emissions cap limits the maximum amount of certain GHG emissions companies may emit during a certain period. Emissions trading systems are intended to create incentives to reduce emissions.

Gold Standard (GS) – Established by the World Wildlife Fund (WWF) in 2003, Gold Standard is a standard and certification programme for non-governmental emission reduction projects in the CDM, the Voluntary Carbon Market and other climate and development interventions. It is published and administered by the Gold Standard Foundation, a non-profit foundation headquartered in Geneva, Switzerland.

Gold Standard is widely endorsed by nongovernmental organizations (ONGs), and several UN agencies use Gold Standard for their carbon mitigation and sustainable development projects. It certifies and has quantified SDG impacts by use of its Sustainable Development Matrix (Goldstandard.org, 2023).

High-Integrity Carbon Credits – A new focus on carbon credits with stringent verification to ensure that emission reductions are real, additional, and permanent.

ICVCM – The Integrity Council for the Voluntary Carbon Market is a multi-stakeholder led independent governance body that was set up in 2021 by a taskforce of stakeholders seeking to bring credibility to the VCM. A similar organization is the Voluntary Carbon Markets Integrity Initiative (VCMI).

Internationally transferred mitigation outcomes (ITMO) – ITMOs use a carbon dioxide equivalent [CO_2e] metric for a new set of market provisions under Article 6 of the Paris Agreement. ITMOs differ from previous offset programmes because they can count toward a country's NDCs. If ITMOs are traded bilaterally or multilaterally to support emission reduction goals in other countries, then they must not be counted by the selling country toward its NDCs. These deductions are referred to as Corresponding Adjustments (CA). The Paris Agreement rules for Article 6 are not finalized, but some countries have begun to engage in ITMO transactions.

ITMOs are supposed to reflect and support the NDCs both in the sending and the receiving country. They are to use robust accounting to prevent double counting. The parties to ITMO transactions are encouraged in Article 6 to pursue voluntary cooperation to achieve more towards their climate goals.

Joint implementation (JI) – A mechanism under the Kyoto Protocol through which a developed country can receive "emissions reduction units" (ERU) when it helps to finance projects that reduce net GHG emissions in another developed country (in practice, the recipient state is likely to be a country with an economy in transition).

Kyoto Protocol – The Kyoto Protocol was adopted on 11 December 1997, and after extended negotiations entered into force on 16 February 2005. Among other things, the Kyoto Protocol set binding targets for the reduction of GHG emissions by industrialized nations, under the principle that they are largely responsible for the high levels of GHG emissions. Somewhat less stringent targets were set for certain "economies in transition," including East European states, under the principle of "common but differentiated responsibility and respective capabilities."

The Kyoto Protocol set binding emission reduction targets for 37 industrialized countries and economies in transition, and the European Union, which added up to an average 5 per cent emission reduction compared to 1990 levels over five years from 2008–2012 (the first commitment period).

A key element of the Kyoto Protocol was the establishment of flexible market mechanisms, based on the trade of emissions permits or credits. Under the Protocol, countries had to meet their targets primarily through national measures. But they could also reach targets by trading or purchasing credits or savings from developing countries. The three market mechanisms were (1) International Emissions Trading, (2) the Clean Development Mechanism (CDM), and (3) Joint implementation (JI).

In Doha, Qatar, on 8 December 2012, the Doha Amendment to the Kyoto Protocol was adopted to approve a second commitment period for the Protocol, from 2013 to 2020.

In 2015, the Kyoto Protocol was replaced by the Paris Agreement, a new international treaty with more ambitious targets to reduce global emissions. The Paris Agreement was to go into force after the close of the second commitment period of the Kyoto Protocol.

While only industrialized nations and certain economies in transition were to reduce emissions under the Kyoto Protocol, all signatories to the Paris Agreement are required to cut emissions, according to their NDCs.

Letter of Approval (LoA) – The Letter of Approval is issued by the DNA of a Kyoto signatory country. It grants permission for participation by a project in the CDM. This letter must confirm that the project activity contributes to sustainable development in the country, that the country has ratified the Kyoto Protocol, and that participation in CDM is voluntary. It is submitted to the CDM Executive Board to support the registration of the project.

MRV – Monitoring (Measuring), Reporting and Verification. MRV is a multi-step process to measure the amount of GHG emissions reduced by a specific mitigation activity over a period of time, and report these findings to an accredited third party. The third party then verifies the report so that the results can be certified and carbon credits can be issued. MRV seeks to prove that an activity has avoided or removed GHG emissions, so that actions can be converted into credits with monetary value.

Nationally Determined Contributions (NDCs) – Nationally determined contributions are core to the Paris Agreement and the achievement of its long-term goals. NDCs embody the efforts made by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate, and maintain the periodically updated NDCs it intends to achieve. Parties are to pursue domestic mitigation measures to achieve their contributions.

NDCs are to be submitted every five years to the UNFCCC secretariat. Parties were requested to submit their initial round of NDCs by 2020, with new rounds in 2025 and 2030. However, Parties are encouraged to adjust their NDCs at any time to increase their level of ambition or commitment.

Nature-Based Solutions (NBS) – Activities such as reforestation and soil carbon sequestration, which provide credible sources of carbon credits. (See also **Technology-based solutions**.)

Paris Agreement – An international treaty on climate change adopted in 2015 and ratified by almost every country in the world. The Agreement commits its signatories to keep global warming to well below 2°C above pre-industrial levels, and preferably limiting the increase to 1.5°C. (See also **Article 6** and **Sustainable Development Mechanism**.)

Permanence – A principle for evaluating carbon removal projects. A carbon removal project is permanent if it will result in a quantifiable amount of carbon being kept out of the air forever.

PoA DD – The design document prepared by the CME of a PoA that sets out in detail, in accordance with the CDM rules and requirements, the PoA that is to be undertaken. The form of PoA-DD is publicly available on the UNFCCC CDM website.

Programme of Activities (PoA) – A CDM programme of activities is a voluntary coordinated action by a private or public entity that coordinates and implements a policy, measure or stated goal (i.e., an incentivized voluntary programme), which leads to GHG emission reductions that are additional to any that would occur in the absence of the PoA. To prepare and register a PoA, it must be validated through a DOE. Compared to regular CDM project activities, this programmematic approach has streamlining benefits, particularly for less developed countries or regions. An unlimited number of component project activities (CPAs) can be added under the PoA without undergoing the complete CDM project cycle.

Project Design Document (PDD) – UNFCCC has developed guidelines for completing PDDs for small-scale CDM projects. The PDD covers a general description of the project activity, the application of the baseline methodology, the duration of the project activity (the crediting period), the application of the monitoring methodology and plan, the estimation of GHG emissions by sources, environmental impacts, and stakeholder comments. The PDD also includes baseline information, a monitoring plan and information regarding the use of public funding. PDD templates are available on the UNFCCC website (UNFCCC, 2023).

Regional Greenhouse Gas Initiative (RGGI) – A multi-state (11 US states) cap-and-trade scheme first established in 2009. Each participating state has its limitations on fossil-fuel-fired electric power plant emissions.

Registration – The formal acceptance by the CDM Executive Board of a validated project as a CDM project activity.

Retire – The permanent removal of carbon offsets from the market to prevent them from being resold after they have been used.

Sustainable Development Goals (SDGs) – A set of global goals designed to be a "blueprint to achieve a better and more sustainable future for all." The goals were established by the UN General Assembly in 2015 and are intended to be achieved by 2030. Goal 13 is to "take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy" (un.org/sustainabledevelopment).

Sustainable Development Mechanism (SDM) – The Paris Agreement's Article 6 creates a new, more cooperative and collaborative approach to international carbon markets and their use to reduce carbon emissions. It provides a legal basis for "cooperative approaches" and establishes the Sustainable Development Mechanism (**Article 6.4**), which replaces the Kyoto Protocol's Clean Development Mechanism (CDM) and Joint Implementation (JI). Like the CDM and JI, SDM's goal is to contribute to the mitigation of GHG emissions and support sustainable development.

The SDM allows for all countries to be able to generate and use credits towards their climate pledges since, under the Paris Agreement, all countries must meet their climate commitments. It also places more emphasis on not just the purchase of tradable credits, but also the investment in actual sustainable development work.

Technology-based solutions – A growing market for credits from emerging technologies like Direct Air Capture (DAC) and biochar production. Cookstove credits, which result from fuel-switching or energy efficiency, can be considered a technology-based solution.

United Nations Framework Convention on Climate Change (UNFCCC) – The international legal framework adopted in June 1992 at the Rio Earth Summit to address climate change. It commits the Parties to the UNFCCC to stabilize human-induced GHG emissions at levels that would prevent dangerous manmade interference with the climate system.

Validation – The assessment of a project's Design Document (DD), which describes its design, including its baseline and monitoring plan, against the requirements of the CDM, by an independent third party, the DOE, before the implementation of the project.

Verifiable Offsets – Carbon offsets that can be quantified, tracked, and validated are referred to as "verifiable offsets".

Verra (Verified Carbon Standard, VCS) – A certification standard for non-governmental emission reduction initiatives. Verra is like Gold Standard. It participates in the Clean Development Mechanism (CDM), the Voluntary Carbon Market, and many climate and development initiatives. It is the most widely used voluntary GHG reduction programme.

Verified (or Voluntary) Emission Reductions (VERs) – A unit of GHG emission reductions that has been verified by an independent auditor but has not undergone the requirements for verification, certification and issuance of CERs under the CDM, or ERUs under the JI, as authorized by the Kyoto Protocol. Unlike a CER, a VER cannot be used to achieve obligations under the Kyoto Protocol compliance regime. In contrast, a CER can be accepted by entities wishing to voluntarily offset their carbon footprint.

Verification Report – A report prepared by a Designated Operational Entity (DOE), or by another independent third party, pursuant to a verification, which reports the findings of the verification process, including the number of reductions in the emission of GHG that have been found to have been generated.

Vintage – The year in which carbon credits were generated.

Voluntary Carbon Market (VCM) – Market in which carbon credits are purchased voluntarily, in contrast to the "compliance market", where regulated entities must purchase carbon credits to meet emission reductions obligated by law.

The transition from the Kyoto Protocol to the Paris Agreement, with the uncertainty created around the CDM, has led to an increase in demand for carbon credits on the voluntary carbon market, and demand seems likely to increase in the future.

For additional terms and definitions, see:

CDM Glossary of Terms at: https://cdm.unfccc.int/Reference/Guidclarif/glos_CDM.pdf (CDM, 2022) and https://unfccc.int/sites/default/files/itl_rfp_16_glossary.pdf (UNFCCC.int, 2005 – Annex 16 Glossary and Abbreviations).

See also this UNFCCC webpage: https://unfccc.int/resource/cd_roms/na1/ghg_inventories/english/8_glossary/Glossary.htm.

UNDP Climate Dictionary at: https://www.undp.org/publications/climate-dictionary (UNDP, 2023).

For Article 6 definitions, see: https://goldstandard.cdn.prismic.io/goldstandard/80c9417b-9c93-43ae-bf58-24bbfa5355f6_glossary_-_article_6_of_the_paris_agreement.pdf (Gold Standard, 2023).

See also: https://www.nature.org/content/dam/tnc/nature/en/documents/Article_6_Common_Questions_V2.pdf (The Nature Conservancy, 2022 – Article 6 Common Questions). ●

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