Carbon Markets and Financing Mechanisms for Food Banking Organizations

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The Global FoodBanking Network®

Developed by:

energylab
climate | sustainability | technology

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About EnergyLab

With more than 15 years of experiences, EnergyLab is a leader in developing and implementing climate action, decarbonization, and circular economy strategies in various sectors and industries in Latin America. EnergyLab specializes in identifying climate risks and opportunities, monitoring and certifying carbon footprint and CO_2e reduction under international standards and creating innovative technological solutions to drive corporate sustainability. www.energylab.cl

About The Global FoodBanking Network

Food banking offers a solution to both chronic hunger and the climate crisis. GFN works with partners in over 50 countries to recover and redirect food to those who need it. In 2023, our Network provided food to more than 40 million people, reducing food waste and creating healthy, resilient communities. We help the food system function as it should: nourishing people and the planet together. For more information, visit foodbanking.org.

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Contents

1. Introduction

Food loss and waste (FLW) stands as a critical yet often overlooked factor at the nexus of climate change and sustainable development. With approximately a third of all food produced globally going to waste, the environmental consequences are profound, particularly in terms of greenhouse gas emissions (GHG). Methane, a potent greenhouse gas released during the decomposition of organic waste in landfills, plays a significant role in accelerating global warming. Addressing food waste thus emerges as a pivotal strategy within the broader context of climate finance, where investments in reducing waste can yield substantial returns in terms of both economic savings and environmental benefits. By diverting food waste from landfills and adopting more sustainable consumption and production patterns, we can mitigate methane emissions and move closer to achieving global climate goals, highlighting the interconnectedness of our food systems and environmental sustainability.

Figure 1: Summary of Wasted Food Generation and Management Flows (Food Retail, Food Service, and Residential Sectors) (2019). Source: EPA.

As shown in the diagram above, according to the Environmental Protection Agency (EPA) most of the food waste from retailers, food services, and households ends up in landfills. This significant waste not only represents a loss of valuable resources but also contributes to environmental issues, such as increased GHG emissions [1].

Globally, around 13% of food produced is lost between harvest and retail, while an estimated additional 17% of total global food production is wasted in households, food service and retail all together [2].

Global FLW emitted 9.3 Gt of CO2 equivalent from the supply chain and waste management systems in 2017, which accounted for about half of the global annual GHG emissions from the whole food system [3].

Methane emissions are estimated to be around 580 million tons annually, with approximately 40% originating from natural sources and the remaining 60% from human activities. The energy sector—including coal, oil, natural gas, and bioenergy—is responsible for nearly two-fifths of human-related methane emissions, making it the second-largest contributor behind agriculture.

In 2022, methane emissions from the global energy sector were estimated to be nearly 135 Mt. Notably, the International Energy Agency (IEA) estimates that approximately 70% of methane emissions from fossil fuel operations could be mitigated using existing technologies. For instance, in the oil and gas sector, emissions could be reduced by over 75% through measures like leak detection and repair programs as well as upgrading leaky equipment [4].

Every year in the United States, approximately 31% of the overall food supply is wasted (~133 billion pounds), which impacts food security, resource conservation, and contributes to the nearly one-fifth of total U.S. methane emissions that come from landfills. Reducing the amount of food waste sent to landfills can help ease the impact of climate change and put food in the mouths of millions of people [5]. More than 75% of the food disposed of in landfills comes from restaurants and households, as shown in the following pie chart.

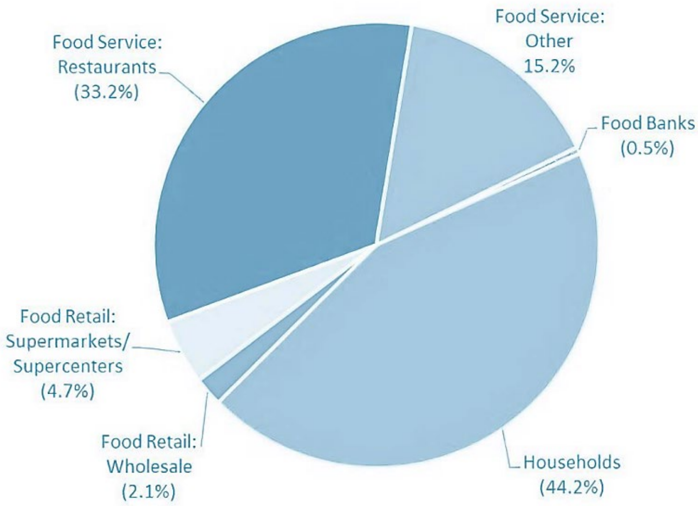

Figure 2: Controlled Combustion Sources (Food Retail, Food Service, Residential, and Food Bank Sectors). Source: EPA 2023.

In 2021, the EPA updated the baseline and goal for the food waste portion of the Sustainable Development Goal Target 12.3, a [6], a coordinated national effort that aims to cut in half the amount of food from the food retail, food service, and residential sectors that have been removed from the human food supply chain (i.e., food waste that is being sent to anaerobic digestion, composting, land application, controlled combustion, landfill, sewer/wastewater, and litter, discards, and refuse) [1].

2. Understanding the climate financing landscape

Climate finance refers to local, national, or transnational financing—drawn from public, private, and alternative sources of financing—that seeks to support mitigation and adaptation actions that will address climate change [7]. Given that mitigation actions are the best way to reduce long-term impacts and costs [8], they have increased visibility as they are related to corporate commitments. Thus, mitigation measures represent an expedient and quantifiable means of communicating results and projecting them over time, being a key part of sustainability strategies. This is reinforced by trends in regulatory and corporate compliance, with entities such as the SBTi [9] and GHG Protocol [10], both of which function as tools for quantifying progress in slowing climate change.

On the other hand, the effects of the scarcity of adaptation funds may have a deep impact in building resilience, as even if the GHG emissions dropped to zero, the impacts of climate change would be present for many decades to come [8]. Because of this, initiatives that tackle both adaptation and mitigation may have a critical impact on improving results-based financing trends, as is the case of food recovery projects.

In this context, the food banks influence food security, which can be measured in the amount of food returned to the consumer, tackling adaptation challenges such as improving food security, alleviating poverty and achieving zero waste goals. But, as mentioned earlier, one of the most efficient ways to qualify the impact on GHG inventories still is the emission reductions involved in the operations of the food recovery activities.

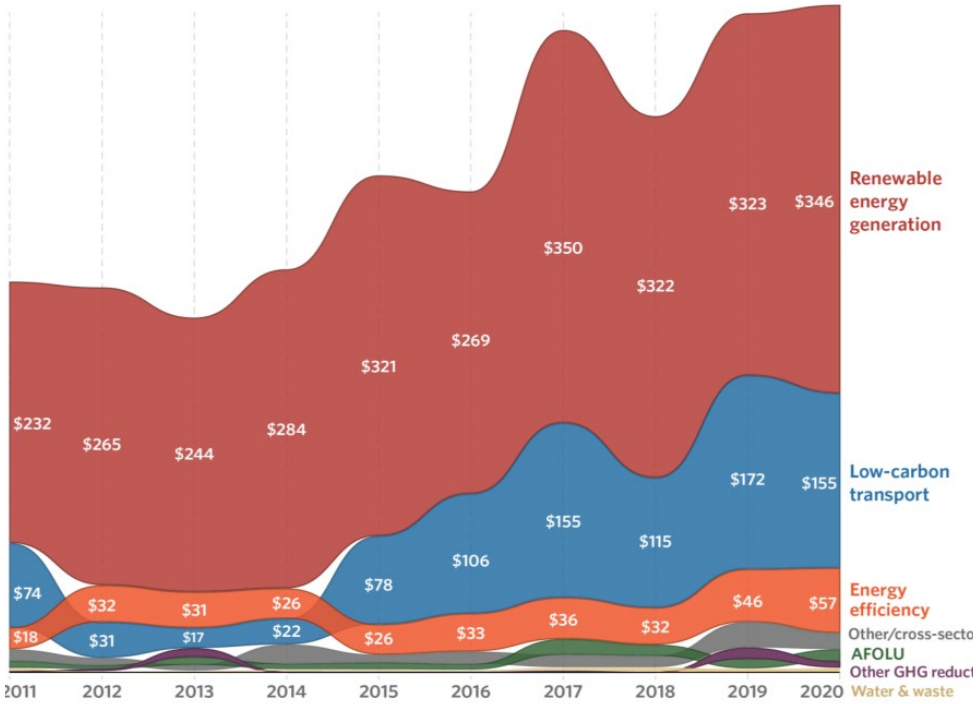

Figure 3: Climate mitigation finance by solutions between 2011-2020 (USD bn). Source: CPI.

Within climate change mitigation, finance toward renewable energy has made the most progress during the last decade, accounting for almost 70% of total financial inflow. This has transformed the renewable energy sector into an established and competitive one, with seven times the return on investment than fossil fuels [11].

However, less than 2% of climate mitigation finance tackles methane emissions, although it is responsible for half of net global warming to date, and methane abatement is one of the most effective mitigation investments.

Targeted waste management solutions, such as landfill gas capture and food waste anaerobic digestion accounted for a small share of finance (USD 223 million) [11], through governments and multilateral development financial institutions using debt and grant instruments, with the sub-Saharan Africa (SSA) region accounting for 57% of this amount. This value falls far below the global estimated investment requirement of USD 48 billion annually by 2030 [11]. However, this figure should also grow significantly from 2030 to 2050, due to the urgent need to accelerate financing at a continuously increasing rate. Even though the waste sector is second in terms of amount of finance flows, organic waste management finance accounts for only 1% of it [11].

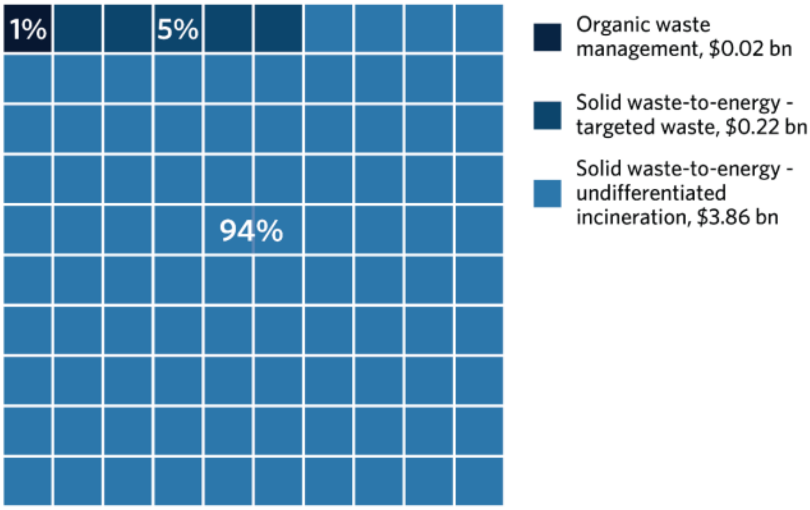

Figure 4: Methane abatement finance in the solid waste subsector (USD billion, 2021/22 annual average). Source: CPI.

Private sources formed the largest portion of methane finance in 2021/22, accounting for USD 9.6 billion, and seeing a significant 55% increase on the amount tracked for 2019/20. Public methane finance in 21/22 was USD 4 billion (a 10% decrease from 2019/20). The largest sources of methane finance were multilateral and bilateral DFIs, contributing USD 1.4 billion and USD 1.1 billion, respectively, following the distribution shown in Figure 5.

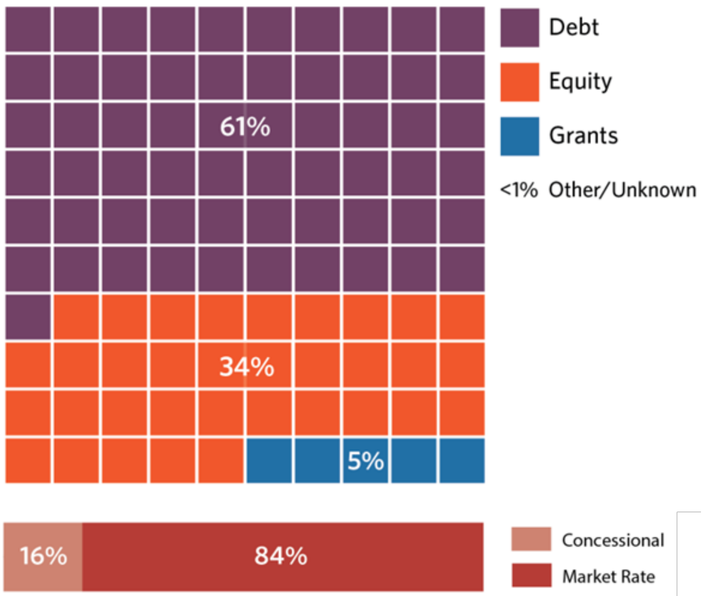

Figure 5: Climate finance by instrument (USD bn) between 2011-2020. Source: CPI.

Private capital flows to low- and middle-income countries are often constrained by investors unfavorable perceptions of risk (actual or perceived). The risks of investing in emerging markets range from macro-financial risks (e.g. credit, currency and inflation risks) to political and regulatory risks (e.g.

laws around investor protection, protection of property rights, unstable legal environments), to technical risks, which are particularly important in large-scale infrastructure projects (e.g. time and cost overruns). The public or philanthropic capital employed in blended finance[1] transactions provides a buffer to such risks, making the investment more attractive to private commercial investors, thereby drawing in private capital that would otherwise not have been available—including finance for achieving climate goals and the Sustainable Development Goals (SDGs) [12].

As it is shown in the diagram below, among all the regions included in the CPI's study "Landscape of Methane Abatement Finance 2023" [13], Latin America and the Caribbean along with South Asia stand out as the regions with the least amount of financial flows. And, in terms of sectors, there seems to be a bias toward using food waste to generate energy from biogas instead of recovering it for food banks.

The success of blended finance rests critically on the ability to maximize additionality, both in terms of the financial resources mobilized and the developmental impact created, while minimizing concessionality, i.e. providing public capital at as close to market conditions as possible [12].

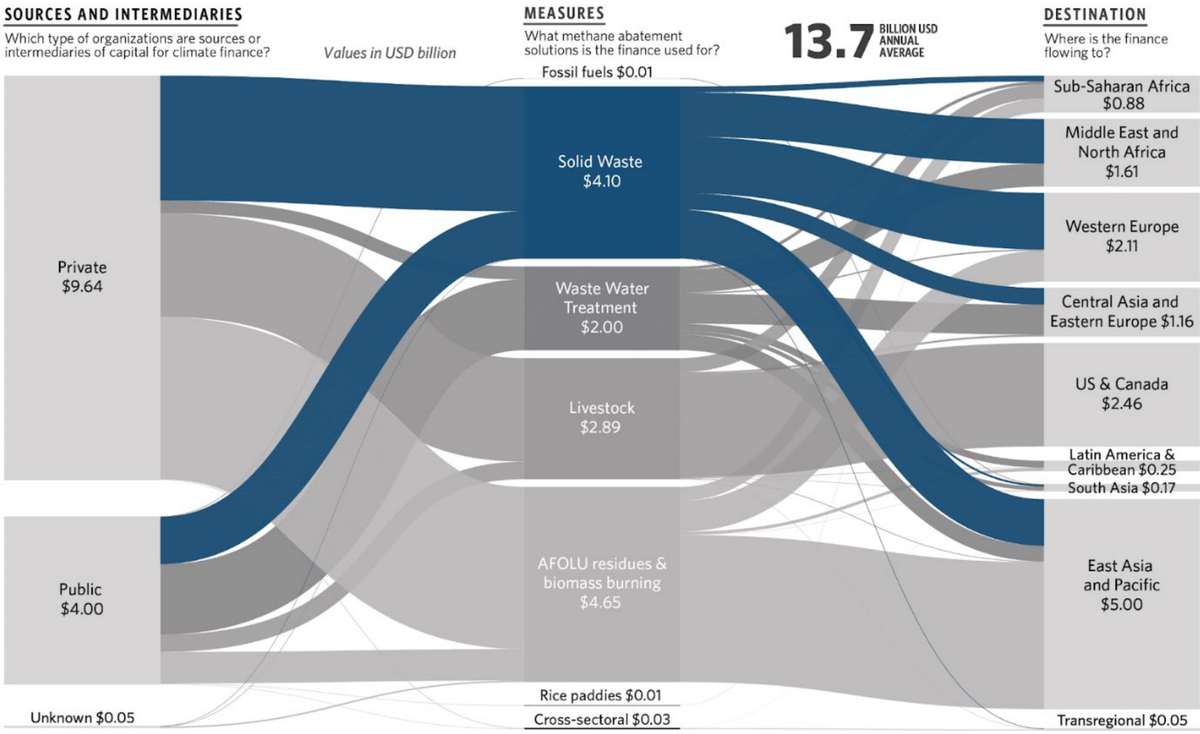

Figure 6: Financial inflows by organization type and destination regions. Source: CPI.

Blended finance offers an opportunity to use development aid in an innovative way to mobilize investment and narrow the investment gap. It can help alter the risk-return trade-off that affects the ability of development projects in developed countries to attract private investment that otherwise would be deployed elsewhere. It can also help projects that may never get off the ground become economically viable projects that have measurable development benefits. Moreover, it allows development assistance, capital from multilateral development banks and other public funds to go much further [14].

[1] The OECD Development Assistance Committee (DAC) defines blended finance as the strategic use of development finance for the mobilization of additional finance towards sustainable development in developing countries [14].

3. Types of financial instruments

Traditional financing instruments primarily rely on well-justified funding requests, substantiated by robust descriptions of initiatives that may pique the interest of investors, philanthropists, or entities dedicated to promoting activities related to specific subject matters.

For public funds, the funding application process often aligns with competitive grant applications. These applications require detailed reports that justify the requested resources through thorough expenditure planning [15]. The planning results from evaluating various alternatives to execute the project within the tight timelines stipulated by the grant guidelines. It's important to note that even if funds are granted, they rarely cover the entire project cost, necessitating diversification of funding sources. The proposed project acts as a restrictive framework for resource allocation, ensuring consistency with the initially described activities. This restrictiveness limits flexibility in responding to unforeseen circumstances and precludes using the same resources for expanding similar activities. Additionally, public financing may also stem from eligibility for non-renewable subsidies.

In the private sector, funding requests are closely tied to activities that promise a return on investment or specific outcomes that create value for investors. Consequently, project owners engage in financial analyses and sensitivity assessments to prepare proposals that pique the interest of investors. These proposals may involve sacrificing a portion or the entirety of the economic surplus generated by the project or even relinquishing partial or full ownership.

Common characteristics are shared among various funding instruments that align with this approach. Classic mechanisms demand rigorous preparation, meticulous planning, and robust analysis to justify funding requests, whether from public or private sources. These pre-funding activities often require substantial resource investments, which can be threatening for initiatives lacking the financial backing to sustain complex activities or nonprofit endeavors.

In addition to the efforts invested in these activities, the delay in response from the granting agencies creates uncertainty regarding whether funds will be granted or if only a fraction of the requested amount will be awarded, potentially rendering the project unfeasible. Time also plays a critical role in the development of externally funded projects, leading to project delays while awaiting requested funds or once again rendering the entire project unviable. Moreover, every funding application competes against other initiatives that may be of greater interest to financial entities.

Despite these challenges, effective management and strategic diversification of funding sources can transform traditional financing mechanisms into powerful tools for project execution. Currently there are many institutions dedicated to centralizing funding sources to finance projects with environmental impact, which need to boost their resources to make their project optimal and feasible. Some examples are briefly presented in the following list:

- The Green Climate Fund (GCF): GCF was established under the Cancún Agreements in 2010 as a dedicated financing vehicle for developing countries within the global climate architecture, serving the Financial Mechanism of the UNFCCC and the Paris Agreement. GCF can structure its financial support through a flexible combination of grants, concessional debts, guarantees, or equity instruments to leverage blended finance and crowd-in private investment for climate action in developing countries. This flexibility enables the fund to pilot new financial structures to support green market creation [16].
- The Adaptation Fund: The Adaptation Fund finances projects and programs that help vulnerable communities in developing countries to adapt to climate change. Initiatives are based on the country's needs, views, and priorities with specific funding for project deployment and innovation initiatives [17].

- The Global Environmental Facility: Funding is provided by participating donor countries and made available to developing countries and countries with economies in transition to meet the objectives of international environmental conventions and agreements. This is made by offering a set of programs for specific types of projects or entities [18].
- Climate Investment Funds: The Climate Investment Funds (CIF) is an enabler of pioneering climate-smart planning and climate action in low- and middle-income economies, many of which are the least prepared yet the most prone to the challenges of climate change. CIF responds to the worldwide climate crisis with large-scale, low-cost, and long-term financial solutions to help countries achieve their climate objectives. CIF has developed a set of programs to finance specific types of projects, always considering the impact to governments, civil society, Indigenous peoples, and providing other benefits to people and the environment [19].
- Euroclima: is a 140-million-Euro program jointly funded by the EU and the German Federal Government via the Federal Ministry for Economic Cooperation and Development. The initiative focuses on building partnerships between the EU and the Latin America/Caribbean regions as they lead the movement to fulfill the EU pledge to allocate at least 30% of its cooperation budget to initiatives focusing on climate change and biodiversity [20].
- IDB's "Too-Good-to-Waste": IDB aims to assist borrowing member countries in accelerating the implementation of solid waste management (SWM) projects to mitigate methane emissions, therefore contributing to the goal established by the Global Methane Pledge (GMP) of mitigating at least 30 percent of methane emissions by 2030. The fund is focused on projects for improving measurement and traceability, scaling subnational actions through mobilizing resources and knowledge generation, among other priorities [21].

Additionally, a brief description of the most common traditional climate financing mechanisms [22] is presented in Table 1:

Table 1: Financial instrument types: Source: Global Center Adaptation.

Instrument	Description
Debt-for-Climate Swaps	Debt swap in which the debtor nation, instead of continuing to make external debt payments in a foreign currency, makes payments in local currency to finance domestic climate projects.
Financing Facilities	Debt or equity funding for a pool of projects, companies, or individuals at various levels of concessionally including subordinated debt and equity, private equity funds, and other debt facilities.
Grants	Non-repayable or no-interest-rate reimbursable funding. Can include development grants, Technical Assistance funding, and Project Preparation Facility.
Guarantees	A financial safeguard where a third-party guarantor commits to repaying part or all of a loan to the lender if the borrower defaults.
Insurance	The most common form of risk transferring, which may include catastrophe bonds, parametric insurance, index insurance. Mainly focused on adaptation.
Liquidity Instruments	Grant or debt facilities that are designed to provide immediate access to capital. Most frequently shock-responsive cash transfers, liquidity support, and domestic budget reallocations.
Local Currency Swaps	Long-term finance options in local currency through fixed and inflation-linked swaps designed to mitigate the dual risks of currency and interest rate fluctuations for climate investments.
Project Finance	Direct debt or equity investments into a single(set) of project(s) across commercial or concessional finance including first-loss debt, off-taker guarantees, direct infrastructure investments, and Public–Private Partnerships financing.
Results-based Finance	Debt or grant capital for a project or portfolio of projects that is contingent on the achievement of certain outcomes. Can include impact notes, climate bonds, and conservation trusts.

Based on the different financial mechanism available to distribute, result-based finance stands out as the one that considers the project performance and the outcomes of its operation. Taking this concept one step further, there is still some mechanisms that can directly translate environmental results into tradable assets adding a new branch into result-based financing.

4. Exploring new financial instruments and mechanisms

4.1. General overview

The Paris Agreement, established at COP 21, marks a critical juncture in climate policy, uniting nations to address climate change and transition to a sustainable future. It sets ambitious targets to keep global warming well below 2°C (aspiring to stay below 1.5°C) and fosters resilience and adaptation strategies, particularly aiding developing countries [23]. The agreement mandates financial, technological, and capacity-building support to align with global efforts to reduce emissions and enhance climate resilience, underscored by a robust transparency framework to track progress.

Under the Paris Agreement, participating countries submit their Nationally Determined Contributions (NDCs), progressively enhancing these efforts over time, reporting regularly on emissions and implementation progress to ensure its integrity. Additionally, a global stock-take will occur every five years to assess collective progress toward the agreement's objectives and inform future actions by individual countries.

To facilitate emissions reduction, the agreement establishes international frameworks for regulated carbon markets under Articles 6.2 and 6.4, and by default, the working space for voluntary carbon markets, which is still developing. However, both approaches should play critical roles in facilitating emissions reductions and fostering climate-friendly financing ensuring transparency, environmental integrity, and accountability.

One key aspect of regulated carbon markets is the concept of Internationally Transferred Mitigation Outcomes (ITMOs), which allows countries to transfer or acquire emission reductions achieved through projects or activities outside the country, providing flexibility in meeting their NDCs. Mechanisms are supported by stringent rules to prevent double counting and to ensure that emission reductions are real, measurable, and verifiable [24].

Moreover, the Paris Agreement establishes a supervisory body, often referred to as the "Sustainable Development Mechanism" (SDM), to oversee the implementation of Article 6 activities. This body ensures that projects contribute to sustainable development goals while delivering emission reductions.

In addition to regulated international markets, the Paris Agreement recognizes the importance of voluntary action by non-state actors, such as businesses, organizations, and individuals, in addressing climate change. Voluntary carbon markets enable these actors to offset their emissions by purchasing carbon credits generated from emission reduction projects.

While voluntary carbon markets operate outside the regulatory framework of the Paris Agreement, they still adhere to principles of transparency, additionality, permanence, and verification to ensure the credibility of carbon credits. Various standards and certification schemes, such as the Verified Carbon Standard (VCS) and the Gold Standard, provide assurance that projects meet rigorous criteria and contribute to real emissions reductions [25].

In order to complement and reinforce climate action at a national or subnational level, many countries and subnational jurisdictions have implemented carbon pricing mechanisms as a key policy tool to incentivize emissions reductions and drive the transition to a low-carbon economy. These mechanisms typically take the form of carbon taxes or cap-and-trade systems, wherein a price on carbon emissions is placed, providing economic incentives for emitters to reduce their carbon footprint.

Carbon pricing mechanisms operate by internalizing the social cost of carbon emissions, thereby reflecting the environmental harm caused by greenhouse gas pollution. By setting a price on carbon, these mechanisms create a financial incentive for businesses and individuals to invest in cleaner technologies, improve energy efficiency, and deploy waste management and residue avoidance practices, among others.

Even though the Paris Agreement does not explicitly mandate carbon pricing, it encourages countries to implement domestic policies to drive emissions reductions in line with their NDCs. Then, national and subnational carbon pricing mechanisms play a complementary role to international climate efforts.

By aligning domestic policies with global climate goals, countries can enhance their image, demonstrate leadership, and contribute to collective efforts to combat climate change. Moreover, carbon pricing can help mobilize private sector investment, producing significant impacts on companies' GHG emissions and catalyzing the development of offsetting and/or insetting GHG reduction projects [26].

Since carbon pricing introduces a financial cost for emitting GHGs, it incentivizes companies to reduce their emissions to avoid paying higher costs, driving operational efficiency improvements, technological innovation, and investments in cleaner sources. That may mean that companies facing challenges in reducing their own emissions may opt to invest in offsetting projects, generating emission reductions or removals elsewhere. These projects can include activities such as reforestation, afforestation, renewable energy projects, residues avoidance, or methane capture from waste management facilities. Carbon offsetting allows companies to compensate for their emissions by supporting projects that reduce emissions elsewhere, thereby achieving carbon neutrality.

Rather than solely relying on external offsetting projects, companies may pursue insetting projects, which focus on reducing emissions within their own value chains[2]. Insetting involves implementing emission reduction measures directly within a company's supply chain, offering companies greater control over emissions reduction efforts and contributing both to long-term climate sustainability and the resilience of their suppliers.

The demand for offsetting and insetting projects is driven by companies seeking to meet their carbon reduction goals and achieve carbon neutrality. This creates market opportunities for project developers, technology innovators, and service providers involved in the design, implementation, and monitoring of GHG reduction projects. Additionally, carbon pricing mechanisms provide a financial incentive for the development of innovative and cost-effective emission reduction technologies and practices.

In summary, national or subnational carbon pricing mechanisms influence companies' GHG emissions by introducing financial incentives to reduce emissions, which may be deployed under different approaches, like emission trading systems (ETS) or cap & trade schemes, carbon taxes and tax & trade mechanisms, among other combinations [27].

Moreover, compliance with the Paris Agreement and NDCs creates a conducive environment for the issuance of green bonds by signaling commitment to climate action, providing policy incentives, stimulating demand for green investments, and facilitating project financing for sustainable development initiatives. These financial instruments may be issued by governments, municipalities, corporations, or other entities to raise funds for projects or activities that have positive environmental benefits. These bonds are specifically designated to finance projects that contribute to environmental sustainability, and under this document will be focused on climate action [28].

4.2. Environmental and carbon pricing basic concepts

Given the environmental impact linked to global food losses, the strategy of food recovery emerges as a pivotal measure for climate change mitigation, on the premise that recovered food that has been diverted away from landfills or incineration correlates with an avoidance of GHG emissions.

Within this framework, methodologies for the calculation of carbon footprints and the quantification of the positive impact on FLW reduction are highly relevant for financing opportunities predicated on the internalized GHG emission reductions attributable to food bank operations.

Broadly speaking, and irrespective of the carbon standard or methodology used, financing would be generated based on calculating the emission reductions generated by the FLW activity, represented through tons of CO2 equivalent (tCO2e) reduced in comparison to the baseline scenario.

[2] Given some discrepancies around the term "insetting" [62], this document avoids any other use of the word that does not apply to activities eligible under the Gold Standard's document "Value Chain (Scope 3) Interventions - Greenhouse Gas Accounting & Reporting Guidance" [53].

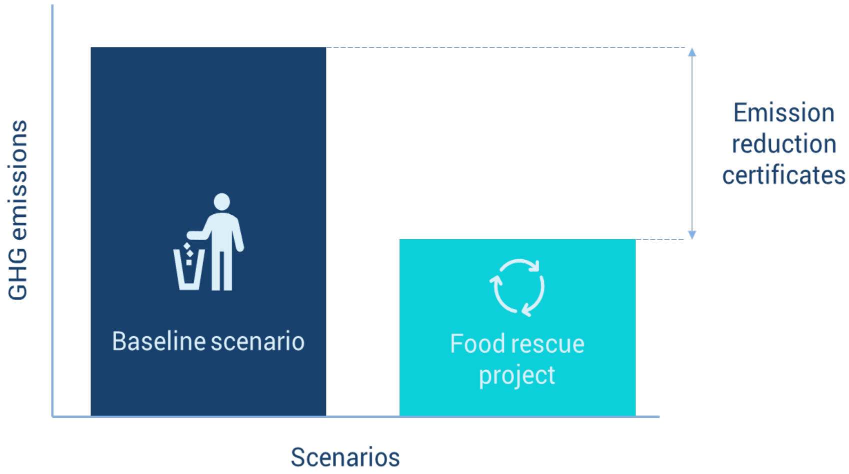

Figure 7: Representation of emission reduction certificates. Source: Developed by EnergyLab.

The concepts presented above should be understood as follows:

- Baseline scenario: Emissions from the FLW disposal and treatment.
- Food recovery projects: Emission from the food recovery operations mostly associated with transport, storage, and other direct activities. It should be less emission intensive than the baseline scenario.
- Emission reductions: The difference between the baseline scenario and food recovery project emissions, which can be subdivided into certified emission reductions, verified emission reductions, and other emission reduction claims represented by tCO_2e.

Eventually, if the emissions reductions are aiming to be traded under the compliance or a voluntary carbon market, they may be subject to additional assessments, such as additionality assessment and demonstration of common practice. The combination of both assessments aims to prove that the GHG reductions would not have occurred without the potential income of the emission reductions and the project is not a wide-spread activity in the regional context, indicating that most of the similar projects require additional financing to operate properly.

> *"The greenhouse gas (GHG) emission reductions or removals from the mitigation activity shall be additional, i.e., they would not have occurred in the absence of the incentive created by carbon credit revenues."*
>
> The Integrity Council for Voluntary Carbon Market

The quotation above is instrumental in defining the financing potential of an initiative under the carbon crediting standards, as described in the following equation:

$$Financing = [Amount\ of\ emission\ reductions] * [Price] - [Project\ costs]$$

Despite the linear relationship between the positive impact and the credits generated, the variables presented in the equation depend on several factors, such as those described in Table 2:

Table 2: Variables involved under financing calculation through emission reduction certificates. Source: Developed by EnergyLab.

Amount of emission reductions	Price	Project costs
▪ Quantity of recovered food. ▪ Type of food. ▪ Packaging waste treatment. ▪ Emissions from operations,	▪ Supply and demand. ▪ Market (regulated or voluntary). ▪ Host country.	▪ MRV costs. ▪ Consultancy requirements. ▪ Auditing for validation and verification of GHG emission

logistics, storage, processing, and transportation.	▪ Standard ▪ Year of emission reductions. ▪ Project type. ▪ Project co-benefits.	reductions. ▪ Standard and registry fees.

Currently, there are a few methodologies specifically designed to quantify GHG reductions through waste disposal intervention applicable to food recovery activities. In addition to the ISO 14064 standard and GHG Protocol Guidelines, which can be used for quantifying GHG reductions for any project that is less emission-intensive compared to a baseline scenario, these guidelines and methodologies are applicable for food bank activities and are briefly described in the following subsections.

4.2.1. GHG protocols and ISO 14064

The GHG Protocol methodologies along with the ISO 14064 focus on the quantification of emissions within the boundaries of an activity, project, or company, providing guidelines to define those boundaries and classifying the emissions according to the source and whether those sources are within or outside the boundaries.

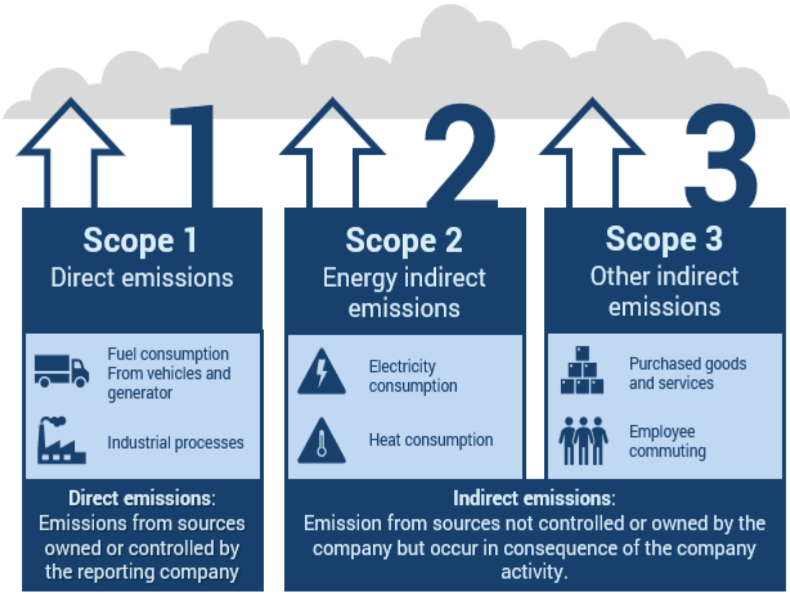

Figure 8: Description of the Three Scopes of GHG Protocol. Source: Developed by EnergyLab based on National Grid Group [29].

Since these are global standards that do not apply to a specific industrial sector or project type, they provide the necessary guidelines and decision trees to perform an emission calculation in many different situations, maximizing the accuracy according to the accessibility and quality of the data. Broadly speaking, these methodologies indicate that the emission calculation can be modeled as:

$$Emissions = (Activity\ data) * (Emission\ factor)$$

Thus, through the previous formula and the guidelines to maximize the accuracy of the calculations based on the information availability, the following table displays the hierarchy by which the choice of the activity data and emission factors to use is derived.

Method	Activity data	Emission factor	Description
Supplier specific	Supplier specific	Supplier specific	Both activity data and emission factors are delivered directly from supplier measurement.

Hybrid	Average	Supplier specific	Activity data or emission factors are delivered directly from supplier measurement while the other value comes from industrial average data bases.
	Supplier specific	Average	
Average	Average	Average	Both activity data and emission factors come from industrial average data bases.
Spend based	Spends	Average	Activity data correspond to spends related to a specific activity, while the emission factor comes from industrial average data bases.

Table 3: Methodologies for GHG emission calculations. Source: GHG Protocol, Technical Guidance for Calculating Scope 3 Emissions.

4.2.2. ACM0022: Alternative waste treatment processes

The ACM0022 is a methodology published by the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change, with its latest version updated on September 2021 [30].

This methodology applies for projects that reduce CH4 emissions due to anaerobic decay of organic waste by:

- One or more alternative waste treatment processes.
- Using organic waste as a renewable source of energy.
- Any combination of both.

As a consolidated methodology, it allows for a diverse range of project types and its baseline definition conditions only require waste treatment that is more emission-intensive than the proposed project, regardless of the type of waste or the treatment.

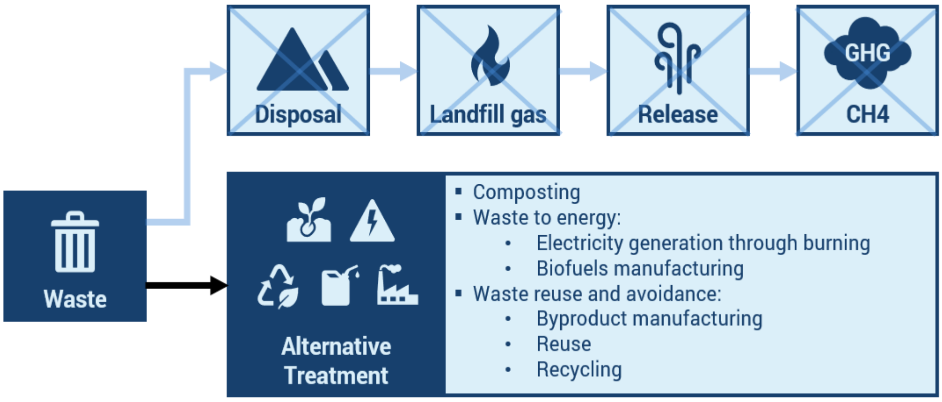

Figure 9: Baseline and Project scenario modeling for ACM0022 applicable projects. Source: Adapted from Clean Development Mechanism of UNFCCC [31].

Adapting the comparison shown in Figure 9 to a food recovery activity, the baseline and project flow diagram should be expressed as follows:

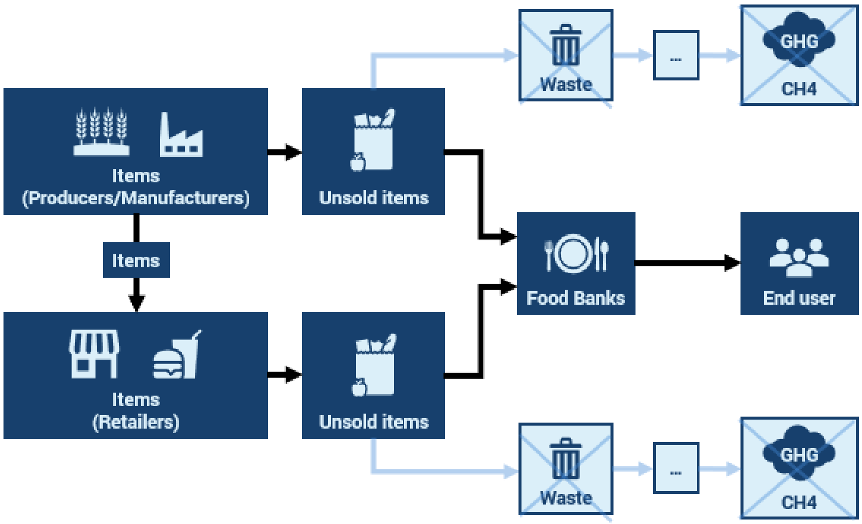

Figure 10: Baseline and Project scenario modeling for ACM0022 for food recovery activities. Source: Developed by EnergyLab, based on Mexican Food Banking Network Design Document on GHG CleanProject Registry [32].

Under this methodology, the additionality is assessed in accordance with the document "TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality" published by the CDM, where additionality must demonstrate:

- The project is not mandated or enforced by any law, statute, or other regulatory framework or for UNFCCC non-Annex I countries.
- Economic implementation barriers such as lack of financing compared to similar initiatives, unfavorable profitability, commercial disadvantages, among others.
- Technological implementation barriers like risks to access to technology, complex logistics, and scarcity of trained personnel.
- Institutional barriers like lack of incentives compared to other initiatives, lack of knowledge and communication regarding the type of project within society, along with ingrained practices in the local culture that go against the project activity.
- The project typology is not widely developed in the local environment, known as "demonstration of common practice."

It should be noted that despite the reduction of emissions involved in project operations, there are still emission sources associated with food recovery processes, so it is relevant to consider:

- Emissions from food bank operations, such as fuel consumption for transport and energy generation, as well as electricity consumption.
- Emissions from eventual discards, despite the food recovery operations.
- Emissions from alternative waste treatments other than food recovery, which still differs from baseline scenario treatment.

4.2.3. VM0046: Methodology for reducing food loss and waste

The VM0046 is a methodology published by Verra under its Verified Carbon Standard (VCS) program. Its latest version was updated in July 2023, and it has been jointly developed by Quantis and Wrap [33].

The methodology applies only to FLW activities that are keeping food in the human supply chain and adhere to food health and safety legislation, providing procedures to quantify emission reductions from diverting food from a waste treatment destination (e.g. landfills) in any stage of the food chain, including farms, food processing, retailers, food services/hospitalities, and households.

As this methodology is exclusively developed for food recovery, the characteristics of the project, baseline, and activity data as well as additionality requirements are more specific and less flexible, being only applicable for projects with the following main structure:

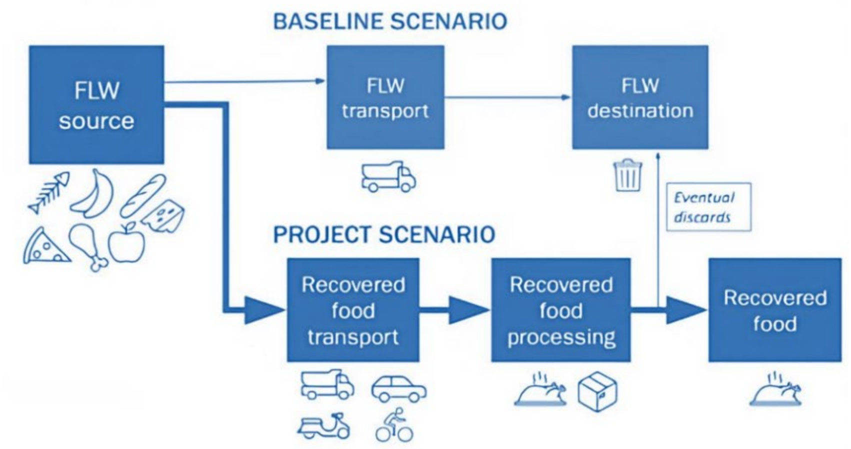

Figure 11: Baseline and Project scenario modeling for VM0046 applicable projects. Source: Verra.

From the additionality point of view, while this process presents similarities with the CDM ACM0022 methodology, it provides guidelines that apply specifically to food recovery and must be verified by third parties, where the demonstrations may include, among others:

- Demonstration of additionality through barriers in a similar way to those previously mentioned in the ACM0022.
- Demonstration of additionality through cultural barriers, where they include:
    - Lack of incentives.
    - Low visibility of these initiatives in the cultural environment.
    - High aesthetic standards on the part of consumers, which prevent them from consuming products that originate from food recovery.
- Being the first or only activity of this type within a radius of 200 kilometers.

The additionality assessment must be complemented with a common practice analysis by comparing the project with activities developed in the last 10 years, which recover food from the same stages of the supply chain, in the same region and in a range of +/- 50% of the volume of food annually recovered.

Aside from the emission reductions associated with the food recovery, there are still emission sources associated with the food recovery processes to take into consideration:

- The emissions from fuel consumption for transportation and generator sets within the project operations.
- The emissions from electricity consumption for food storage and processing.
- The emissions associated with potential food waste, despite the food recovery operations.

In this regard, the data collection of the baseline GHG emission calculations is divided into six steps, and it is more specific for FLW data than its counterpart from the CDM:

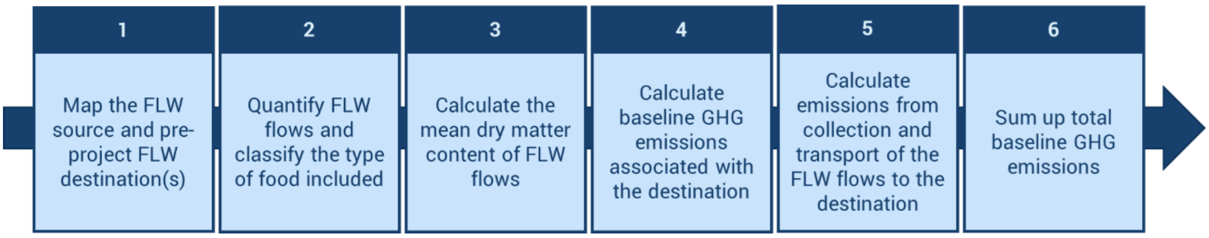

Figure 12: Steps to calculate baseline emissions. Source: Verra.

The main progress toward a more specific method for FLW treatment baseline emissions, are Steps 2 and 3 in Figure 12, which are briefly described below:

- Step 2 - Quantify FLW flows and classify the type of food included:
    - Project proponents are not required to use a particular quantification method to calculate FLW flows but must minimize the degree of uncertainty based on Chapter 9 of the WRI "FLW Standard."
    - FLW flows must be described using FAO's Codex General Standard for Food Additives (GSFA) system. As a minimum, food ingredients must be classified down to the second non-null digit category of the GSFA Codex system.
- Step 3 - Calculate the mean dry matter (DM) content of FLW flows using default values from the United States Department of Agriculture (USDA) Food Data Central database [34]:
    - Project proponents must select the water content for the food ingredients that best represent the content of the FLW flows according to the classification performed in Step 2.
    - Project proponents may extend or complement water content data of food ingredients or prepared foods that are not listed in the Food Data Central with region- or country-specific food databases available on the FAO/Infoods website [35].

These steps result in an emission calculation relatable to the particular characteristics of the FLW source, allowing for the differentiation of the environmental impact that different types of food can generate when treated as a waste and promoting consensus for their quantification through the use of the WRI's FLW Standard, taking a step ahead of average data calculations mostly allowed in other methodologies.

4.2.4. The Gold Standard suppressed demand small-scale methodology for low GHG food preservation

This Gold Standard methodology [36] is applicable for quantifying greenhouse gas (GHG) emission reductions resulting from activities that enhance food preservation by increasing the quantity, quality, and/or durability of food available for consumption, provided that the project limits GHG emission reductions to 60,000 tCO_2e annually due to its small-scale nature.

Accordingly, projects eligible under this methodology must meet one of the following objectives:

1. Reduce the amount of emissions involved in the activities of food preservation.
2. Enhance food preservation beyond the baseline through less emission-intensive initiatives.

These types of projects include drying or cooking food using renewable energy sources, installing equipment, or implementing processes that result in increased energy efficiency within conservation activities (if existing), as well as activities and processes that extend the shelf life of preserved food.

These activities are accompanied by a series of restrictions that ensure the project's integrity, such as not using equipment and products that contain HFCs or ozone-depleting substances, among other conditions that may negatively affect the environmental performance of the project or the availability of food.

Thus, baseline emissions are constituted as the emissions from drying, refrigeration, and other conservation processes achieved through replacing more emission-intensive energy sources or less efficient equipment and processes than those proposed in the renovation or retrofitting project.

Similarly, greenfield projects must model the baseline as the annual amount of greenhouse gases that would have been emitted to achieve the same results as the project but using traditional technologies, such as wood drying or fossil fuel use. In this case, the baseline model must be adjusted to industry benchmarks, technology access, and other factors characteristic of the locality where the project is executed.

Meanwhile, the project's emissions correspond to those from fuel and electricity consumption during its operational stage. Depending on the characteristics of the locality and the beneficiaries of the food conservation project, the methodology may consider an additional source of emissions within the baseline calculation (resulting in an increase in the quantified emission reductions), known as suppressed demand emissions.

The suppressed demand emissions are associated with activities carried out (or that would be carried out) to enable a geographic/demographic sector subjected to food insecurity to overcome such conditions by meeting its minimum daily nutritional needs (which can be assumed to be 2,100 kcal/person/day).

The method to determine which foods would have compensated for the nutritional deficit involves requesting local food aid agents to provide information on the types, quantity, quality, nutritional content, density, and moisture content of the food aid sent to the project site region, which typically consists of a food basket with various components.

The emissions from this food aid correspond to those of the food necessary to reach the minimum nutritional value according to the demographic characteristics of the beneficiaries and are composed of:

1. The upstream emission intensity of each of the components of the dry base basket.
2. The emissions from the transportation of such food, considering its wet base weight.

With the inclusion of suppressed demand emissions, additional challenges arise in terms of information gathering, as it requires robust identification of the project beneficiaries who are in food stress, quantification of the period they are in such condition, and quantification of the nutritional gap to reach the minimum caloric requirements.

Furthermore, not all projects applicable to this methodology are eligible to consider suppressed demand emissions within their baseline, as they must demonstrate that the project results in an increased availability of food for subsequent consumption in one of the following contexts:

- The project exports food resulting in an accumulation of currency reserves for the specific sake of food imports in periods of food shortage.
- The project involves preservation in areas where it previously did not exist, resulting in food degradation.
- The project reduces storage losses through improvements in the quality and length of the preservation.
- The need for food aid is reduced as a result of the preservation.

4.2.5. Sustainability impacts of food recovery & redistribution organizations

The Global Foodbanking Network [37], in collaboration with Carbon Trust [38], is currently developing a methodology to calculate the avoided emissions and co-benefits of activities that redirect FLW directly into the human consumption chain through food recovery and redistribution operations.

This methodology incorporates the core concepts and guidelines from Verra's VM0046 methodology (see Section 4.2.3), adding the ability to quantify suppressed demand emissions within the baseline as indicated by the Gold Standard methodology (see Section 4.2.4), solely applicable to food bank activities.

With more specific applicability regarding its sources, it adds monitoring variables for quantifying avoided emissions and slightly modifies the additionality analysis, as well as considering the quantification of co-benefits.

The baseline calculation follows the same guidelines as the VM0046 methodology, considering only the dry fraction of FLW, as the wet fraction does not impact GHG emissions, thus preventing the overestimation of environmental results. Furthermore, based on this principle, the methodology requires that when calculating the avoided emissions resulting from project execution, the mass fraction of food that is inedible must be discounted, as it is assumed that this will be discarded following the same process stipulated in the baseline, meaning the project does not impact this fraction of the FLW on a dry basis.

Moreover, the co-benefits within the methodology are quantified as indicators related to the following Sustainable Development Goals (SDG):

- SDG 2: Zero hunger.
- SDG 8: Decent work and economic growth.
- SDG 12: Responsible consumption and production.

Among these indicators, SDG 2 is closely related to the suppressed demand emissions that need to be accounted for in the baseline, as the calculation of its impact is achieved through the quantification of:

1. The number of beneficiaries, characterized by their nutritional requirements based on age group, gender, pregnant women, and the regularity with which they require the services of the food bank.
2. The amount of food and its nutritional content in terms of macro and micronutrients.

This data, combined with the quantification of each beneficiary's nutritional gap, provide the necessary information for calculating suppressed demand emissions, allowing for an expansion of the baseline that more accurately represents the impact of food bank activities on reducing GHG emissions in the atmosphere.

Again, the inclusion of suppressed demand emissions represents a challenge in terms of data collection process sophistication, as a certain maturity and robustness in the processes are required to carry them out cost-effectively. Furthermore, the addition of suppressed demand emissions implies that the beneficiaries' consumption is considered within the baseline. Therefore, any food waste by these individuals must be considered and quantified as emission leakage, further complicating the calculation.

Finally, compared with their predecessors (mainly the methodologies of Verra and Gold Standard), the methodology under development takes two significant steps concerning its main references:

- It requires the monitoring or modeling of the inedible fraction of FLW on a dry basis for its exclusion from the calculation, avoiding the overestimation of the project's environmental impact.
- It reflects the diversity of the beneficiaries and their minimum nutritional needs based on age ranges and specific demographic characteristics, allowing for a more specific calculation of suppressed demand emissions and providing the necessary guidelines to carry it out.

4.3. Emission reduction monitoring, reporting, and verification under different methodologies

Through the ISO and ACM0022 methodologies it is possible to calculate GHG emissions using average values backed by official sources such as IPCC or local government data, allowing a conservative and representative approximation of the reductions involved in the alternative treatment of waste based on aggregated data.

While this process simplifies the calculation, it does so at the expense of losing information regarding the specific differentiation FLW streams sources, risking non-representativeness when the typology and conditions of these wastes are clearly identifiable and restricting the possibility of developing improvement initiatives, given the specific characteristics of the FLW and its sources are lost in the averages.

That is why Verra's VM0046 methodology represents an advancement in specificity compared to methodologies that are strictly based on the ISO 14064 standard, which widely relies on official averages and constant factors that may need to be updated.

Regardless of the methodology, the model for emission calculation still relies on the multiplication between the activity data and the emission factor, meaning that the uncertainties of both values accumulate in the final emission calculation, with the possibility of an exponential growth when any of those values is constructed by the combination of values with its own uncertainty.

Considering the average data from IPCC guidelines [39] and local averages [40], the emission factors are constructed based on the average composition of the waste and the average methane capture of the landfills of the applicable region, allowing the input of the total mass of food recovered and not wasted (on a wet basis) for the emission calculation.

Of course, the use of this model responds to the lack of access to specific data or difficulties in managing a large number of FLW sources that could or could not be prepared to report detailed data, being conservative enough when it is applied correctly.

As an example, under this modeling, the Mexican Food Banking Network, known for being the first food bank issuing carbon credits [41], establishes that the baseline emission factor for the year 2021 corresponds to approximately 1.4 kgCO2e per every kilogram of FLW on a wet basis within a landfill with flaring treatment baseline [32].

As a brief materiality and representativeness analysis, the Verra methodology states that the emission factor for the same baseline waste treatment is equivalent to 2.22 kgCO2e per every kilogram of FLW on a dry basis with the same treatment (world average) [33]. So, taking on consideration the dry matter content of different typologies of food, the emissions will vary as presented in Table 4:

		Emission intensity[3] [33] $\left[\frac{kgCO2e}{kg_{FLW,wet}}\right]$		
Typology	**% of dry matter** [34]	**Landfill without flaring**	**Landfill with flaring**	**Controlled combustion**
Canola oil	100%	6.25	2.22	0.13
Cooked chicken, boneless	35%	2.17	0.77	0.05
Raw beef, boneless	29%	1.82	0.65	0.04
Raw apple	25%	1.53	0.54	0.03
Tomato juice	6%	0.39	0.14	0.01

Table 4: Emission intensity for different waste treatments of specific FLW. Source: Developed by EnergyLab, based on Verra's VM0046 methodology and USDA data.

Assuming that the world average is representative enough, when FLW can be characterized by a few typologies and its corresponding percentages of dry matter, the average emission factor could differ significantly from the value obtained with specific data. This could be the case for food banks with well-known suppliers utilizing documented and verifiable typologies, like farms, industries, and retailers, which can impact positively or negatively on the number of emission reductions to be claimed by the

[3] Emission factor on wet basis, because the %of dry matter is applied to the emission factor and not to the activity data.

food recovery activity[4].

This comparison between ISO-based and Verra measurement methodologies implies that measurement based on specific data is essential to provide robust and analyzable impact signals. This is especially the case in markets where confidence in environmental actions is highly questioned and plays a fundamental role in the acquisition of results-based financing, since it:

- Minimizes risks to financiers and stakeholders.
- Allows informed decision-making based on materiality and impact.
- Provides spaces for optimal improvement projects, where impact can be maximized while minimizing resources.
- Allows constant monitoring of the status of the projects and enhances the capacity to expand operations to activities with greater potential results.

Thus, the measurement of the specific characteristics of the FLW flows represents an enabling mechanism for informed, responsible and risk-minimizing financing, both for investors and for the owners of food recovery

projects.

On the other hand, higher levels of specificity are associated with greater management, planning, initial investment in infrastructure and audits of the information used for the calculation of GHG emissions and reductions, which can be a decisive factor regarding the feasibility for developing MRV systems with such a level of sophistication. This can be especially relevant when the scale of the project is such that it does not justify the costs or the number of sources to be measured and is not profitable enough to manage it according to higher measurement standards.

For this reason, planning and the correct use of the available technology is essential to tackle these issues, considering the robustness that they can provide:

- Adoption of commitments and corporate culture updated to the current needs of the industry.
- Integrated management systems, where robust measurement and reporting are part of the operational and communication strategies of the company.
- Digitized MRV systems, with cloud and IoT based technologies, which streamline the collection and communication of results, along with cryptographic methods for the validation of the information.

4.3.1. Displacement of food primary production by food recovery activities

In the context of corporate emissions reporting methodologies, such as the GHG Protocol and ISO 14064, it may be reasonable to quantify the emission reductions implied in the food primary production displacement given the food recovery activities.

This kind of reduction cannot be quantified by ACM0022 and VM0046 methodologies, because the boundaries of emission reduction projects established by these methodologies do not include the primary production of emissions, assuming that there is no difference in the level of activity of the food value chain in presence of the project. As will be briefly discussed in Section 5.2, this is the most widely accepted assumption, given that there is no recognition of these reductions in national or subnational Emission Trading Schemes.

From the corporate point of view, following the guidelines of the GHG Protocol, the acquisition of recovered food may impact the Scope 3 of the emissions inventory related to upstream emission associated with the acquisition of goods and services. This can be applied to Scopes 1 & 2 as well, but

[4] It is worth noting that the Mexican food banks' emission factor representativeness can only be assessed under Verra terms if the specific data of the baseline FLW flows is available.

it will depend on the FLW specific characteristics and the internal processes that may be applied or skipped on the recovered source of food. It may be evaluated case by case.

Considering a cut-off[5] approach for recycled goods and services on the corporate value chain and the information on the "Organic Material Chapters" of the EPA's "Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM)" [42], the reductions associated with the use of recovered food on the emission inventory of a given company is described in the following table along with the avoided emissions due to the waste diversion from landfilling without flaring of VM0046 methodology.

		Upstream emission intensity [42] $\left[\frac{kgCO_2e}{kg}\right]$	**Emission intensity waste diversion** [33] $\left[\frac{kgCO_2e}{kg_{FLW,wet}}\right]$	**Ratio**
Typology	**% of dry matter** [34]	**Food source reduction**	**Landfill with flaring**	**Upstream emissions over waste treatment emissions**
Raw beef, boneless	29%	34.30	0.65	53.27
Raw chicken, boneless	15%	2.72	0.34	8.06
Rice	89%	0.34	1.97	0.17
Bread	64%	0.73	1.42	0.57
Raw apple	25%	0.01	0.54	0.02

Table 5: Upstream emission and emission intensity for different waste treatments of specific FLW. Source: Developed by EnergyLab, based on Verra's VM0046 methodology, USDA data and EPA WARM.

As shown in Table 5, when it comes to food from animal sources, the upstream emissions are at least eight times more intensive than the emissions from landfilling with flaring waste treatment, reaching a ratio of 53.27 when it comes to beef. These differences are mainly related to manure degradation and its methane emissions associated to animal husbandry.

Given this information—and depending on the industrial activity and the amount of recovered food supplied to the value chain—a specific measurement of the FLW recovered may significantly impact the GHG inventory, especially when most of its production is associated with food from animal sources. That said, it is still uncertain if any market mechanisms and standards will recognize the source reduction involved in the use of recovered FLW in the short term, given the difficulties in the demonstration and verification of food primary production displacement.

During the last decade the trends and drivers toward a circular economy have developed documents like the EPA's when the emission reduction of the use of recycled assets may be relevant for determining environmental impact, and not only when it comes to carbon footprints [43]. That's why robust tracking of the data of the source of recovered food could play a lead role in the early adoption of new enabling mechanisms for climate finance.

[5] In the cut-off approach, also known as 100:0 or recycled content approach, the burdens associated with the product's recycling at end-of-life are "cut-off" and shifted to the life cycle that uses the recycled materials. The environmental impacts of recycled materials on the input side starts with the recycling treatment to produce the materials, which are used in the value chain.

5. Application of new financing instruments for food banks

5.1. Article 6 of the Paris Agreement

Depending on each country's specific circumstances, food bank activities could become a part of a nation's strategy for achieving its NDCs either directly or indirectly. The environmental impact associated with food loss may be significant, prompting institutions to advocate for including food loss reductions as a high-impact measure within NDCs, affecting both the national GHGs emission inventory and the economy itself [44].

However, various parameters must be established within each NDC, considering that governments may impose limitations on transferring environmental outcomes from activities like food banks and given that their positive impact may be considered strategic for the national objectives. This means that credits issued by food recovery activities cannot be transferred across nations since they are relevant to a nation's achievement targets.

The case of Indonesia represents a precedent of how the commitments of countries to achieve their NDCs and their plans for emissions trading under the Paris Agreement can limit financing through credits issued in independent standards in the short term and generate high levels of uncertainty to long-term projections.

In November 2021, Indonesia's finance minister had indicated that the country would not allow international carbon trading until its own domestic targets were met. The finance minister stated that because of the low prices of credits in Indonesia, international buyers from countries with high prices would be jostling to buy Indonesian credits for their offset requirements, leaving few credits for the country's own requirements. According to S&P Global Commodity Insights' sources [45], the Indonesian government had earlier sent a letter to Verra and a few other voluntary carbon standards saying that its permission would be needed for issuances of credits from 2021 onwards.

As is stated in the Paris Agreement, every country must determine the requirements for baseline and emission reduction calculations given its voluntary nature [46]. This could mean that even in the case of restrictions on the international transfer of credits and the respective enforcement of trading on local carbon schemes, it is expected that additionality and common practice assessments (as well as MRV requirements) may still be prevailing among the activities necessary for credit issuance, which could directly depend on the markets where the reductions are planned to be transferred (Article 6.2 or Article 6.4).

Currently, there are no NDCs identified that specifically commit to a certain amount of FLW or a specific impact of its treatment on the national GHG inventory within the defined timeframe. This does not mean that food banks could not be indirectly eligible for NDC compliance on a broader GHG or environmental strategy.

Notably, Gambia and the UK are two countries that stand out in terms of their impact assessment relating FLW with GHG emissions and natural capital. Both countries plan to address FLW's impact in these terms, moving away from weight-based indicators that do not fully represent the actual impact, with Gambia one step ahead setting a potential amount of GHG reduction of 131,000 tCO_2e due to the reduction of food losses by 2030, as it is stated on its NDCs [47]. The UK has published its plan for tackling GHG emissions by reducing FLW, halving the global waste at the consumer and retailer level by 2030 [48].

Despite the progress made in the aforementioned countries among others, most NDCs still lack quantitative objectives and deadlines, in cases when explicit references to food recovery and security do exist. So, it is anticipated that opportunities for financing based on results will continue to be available, always subject to country-specific conditions and the NDCs updating processes.

In the context of pricing under Article 6.2, bilateral agreements will define the equivalent price for the ITMOs, which may not be well represented by the indicator USD per tCO_2e, due to the numerous factors and specific interests inherent to every country. In the context of Article 6.4, it is expected that prices will be basically regulated by the dynamics of supply and demand, with some specific conditions established country by country, as it is developed in Section 5.2 and Section 5.3.

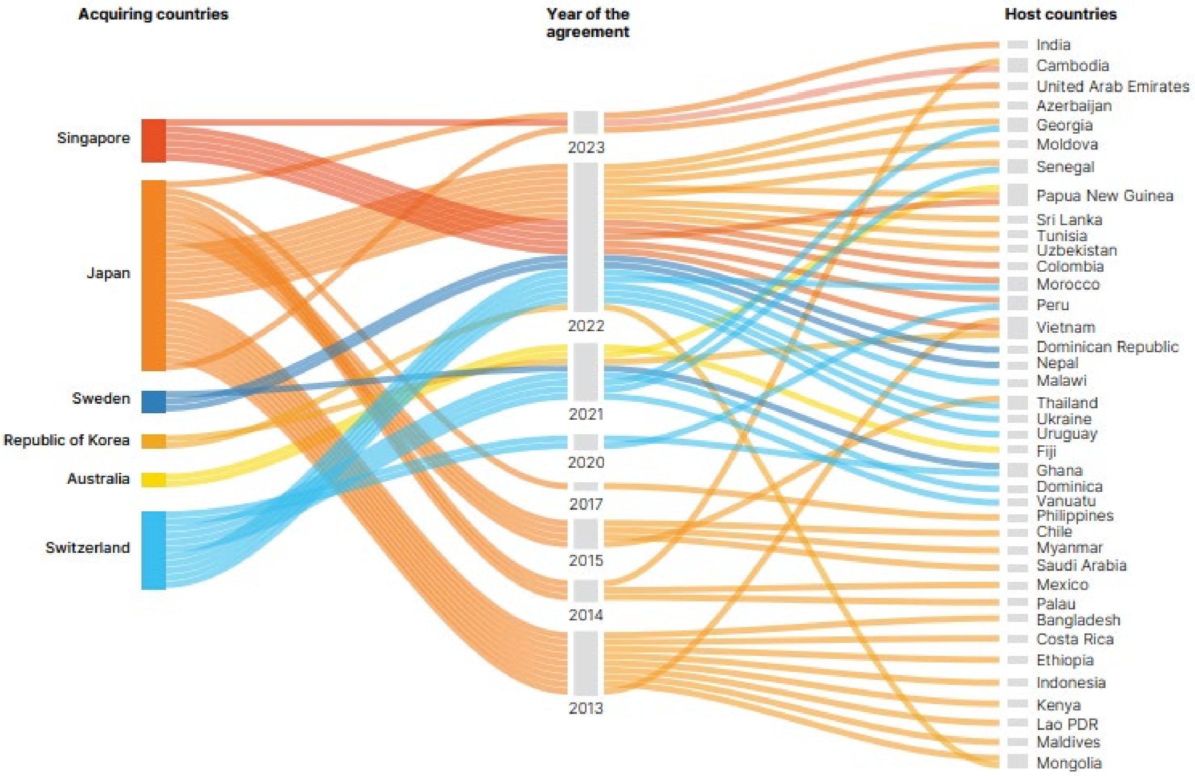

Figure 13: Article 6.2 bilateral agreements as of April 1, 2023. Source: World Bank.

5.2. National or subnational carbon pricing schemes

There might be several rationales behind implementing carbon pricing mechanisms within different jurisdictions, including addressing market failures related to climate change, incentivizing emissions reductions, and promoting the transition to a low-carbon economy.

National and subnational carbon pricing mechanisms represent powerful tools for addressing climate change by internalizing the social cost of carbon emissions. Carbon pricing, whether through taxes or emission trading systems, aims to incentivize emissions reductions, drive innovation in clean technologies, and promote the transition to a low-carbon economy [26]:

- Emission trading systems (ETS): Systems that define a set of facilities to limit their emissions to a certain level at a predefined reduction rate, allowing them to trade their potential surplus according to the expected yearly levels. These systems, also known as cap and trade schemes, produce a price signal to the market based on the supply and demand balance of traded GHG reductions. In some jurisdictions, the usage of offsets, which stand for reductions originated in sectors beyond the ones with emissions targets, is allowed to comply with limits established by the legislation.
- Carbon taxes: Levies which are established for a certain economic sector or a set of facilities due to their GHG emissions levels and/or intensity. In some jurisdictions, the usage of offsets is considered as tax credits, where they could be eligible to partially or fully compensate the taxed emissions.

Then, the main design and implementation considerations include aspects like expected carbon price, coverage and exemptions, compliance mechanisms, and competitiveness concerns. This is in addition to stakeholder engagement, transparency, robust monitoring, reporting, and verification (MRV) systems for ensuring the effectiveness and integrity of the system. Similarly, NDCs requirements, additionality and common practice demonstrations, and MRV requirements, among others, depend on the national or subnational authorities that are behind the system implementation.

When a national or subnational authority evaluates options to adopt international carbon standards, such as the Verified Carbon Standard (VCS) and Gold Standard, versus local developments for offset certification, several approaches are considered. These may vary in terms of their alignment with international general rules, adaptability to local contexts, and potential trade-offs in terms of credibility, cost-effectiveness, and administrative complexity.

A full adoption of international standards provides credibility and recognition at the global stage, as projects certified under internationally recognized standards are widely accepted and trusted by investors and buyers. It also facilitates participation in international carbon markets, enabling access to a broader pool of potential buyers and investors. However, this approach may entail higher administrative and compliance costs, as projects will experience rigorous bureaucracy, certification requirements, and verification processes. Additionally, it may not fully accommodate local contexts and priorities, potentially limiting the scalability and inclusivity of the offsetting projects.

On the other hand, the development of local certification frameworks, tailored to local circumstances, promotes ownership and capacity-building at the local level, fostering the development of Indigenous expertise and infrastructure for carbon offset projects. However, these frameworks may lack immediate recognition and credibility on the international stage, potentially limiting market access and investor confidence. Moreover, developing and implementing robust local certification frameworks requires significant investment in capacity-building, technical expertise, infrastructure, and institutional support, which may pose challenges for resource-constrained jurisdictions.

Evaluating options such as international carbon standards versus local developments for offsetting certification must weigh the trade-offs between global credibility, adaptability to local contexts, administrative complexity, and cost-effectiveness. Each approach offers distinct advantages and challenges, and the optimal strategy may vary depending on food-bank-specific factors such as institutional capacity, objectives, stakeholder preferences, and market dynamics.

These definitions will be critical when it comes to assessing the options for a food bank, being a location-based analysis. This can potentially simplify some processes and recognize the local situation of the FLW, but also limits the potential profits to be obtained due to the food bank operations (reducing the impact of this revenue stream).

For example, in an analysis conducted by New Zealand's Ministry for the Environment regarding the next steps in terms of food recovery incentive policies, a mention is made of incorporating these activities within their Emissions Trading System (ETS). However, it is deemed unlikely that these initiatives will be accepted for credit generation (NZUs) within the country's ETS.

The reason lies in the design of the ETS, which primarily aims to incentivize carbon sequestration and emission reductions from primary sources. In other words, the system encourages emitters to progressively enhance their reduction initiatives within their productive activities. Food recovery, within this context, does not provide sufficient incentives for food-producing companies to reduce their production in exchange for recovering food. Consequently, it is not anticipated that these companies will systematically decrease their production due to the volumes associated with food recovery [49].

With respect to price signals, it will depend on the supply and demand balance and the maturity of the development of the local mechanism, impacting the price growth implicit in the carbon pricing design.

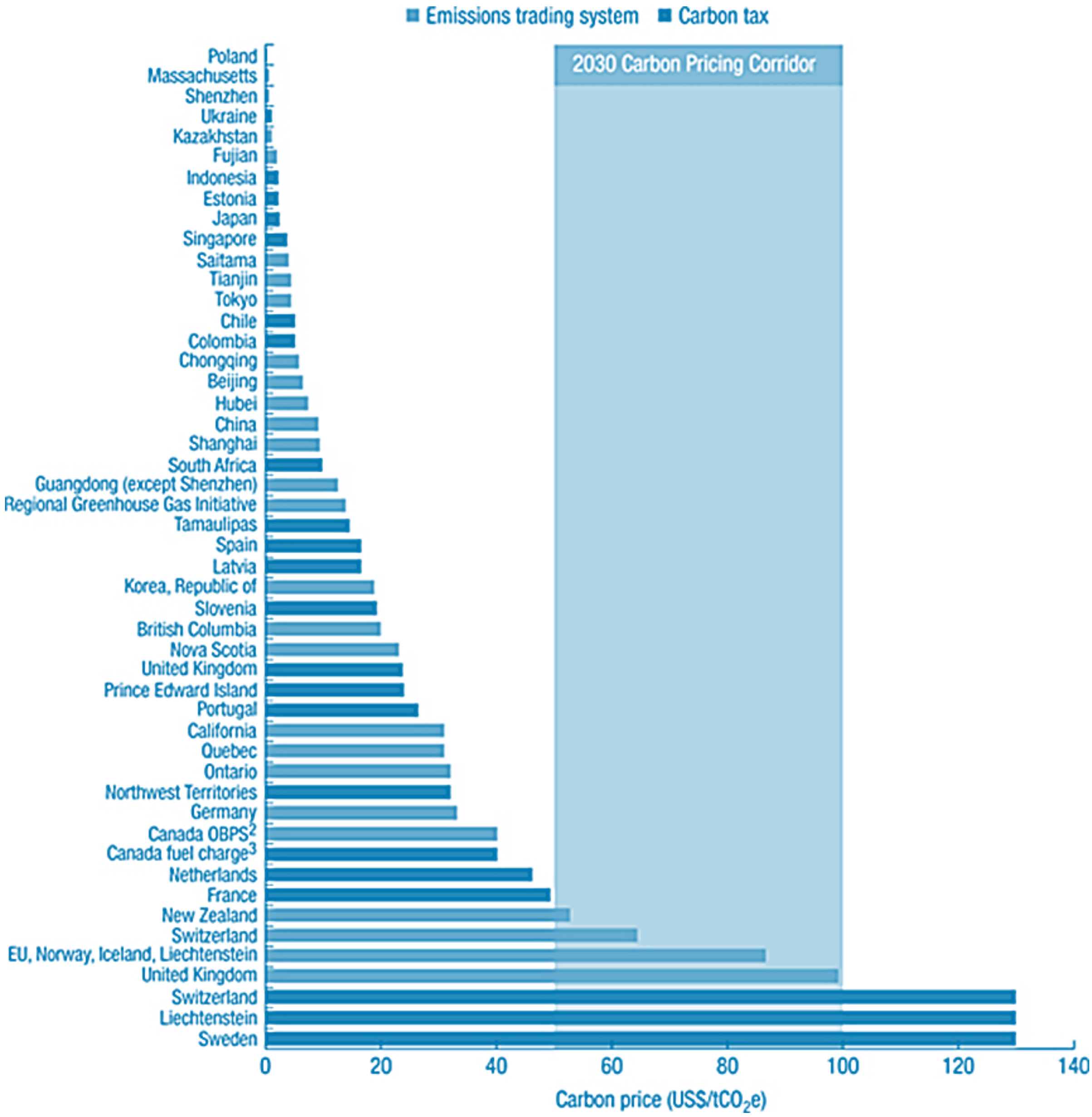

Figure 14: Direct Carbon Prices per Jurisdiction and Instrument as of April 1, 2022[6]. Prices are not necessarily comparable between instruments because of (for example) differences in the sectors covered and allocation methods applied, specific exemptions, and compensation methods. Carbon price on the y-axis is expressed in USD$ per metric ton of carbon dioxide equivalent (tCO2e). Source: World Bank.

5.3. Voluntary carbon markets

Voluntary carbon markets (VCM) are ecosystems where individuals, organizations, and businesses voluntarily purchase or invest in carbon credits to mitigate their GHG emissions beyond regulatory requirements. These markets operate independently of government-mandated emissions reduction targets and allow participants to offset their carbon footprint by supporting projects that reduce or remove GHG emissions.

VCMs provide a mechanism for stakeholders to demonstrate their commitment to addressing climate change, support sustainable development initiatives, and contribute to global efforts to reduce emissions. These markets facilitate transactions between buyers and sellers of carbon credits,

[6] The 2030 carbon price corridor is based on the recommendations in the report of the High-Level Commission on Carbon Prices [63].

enabling the financing of emission reduction projects, while promoting transparency, integrity, and accountability in the carbon offsetting process.

Currently, there are several standards that allow, through its own governance and validation and verification processes, to make public and tradable the GHG emission reduction and/or emission sequestration originated through different project types.

Each of these standards has its own rules and safeguards to determine which project types and quantification methodologies are admissible for the issuance of verified emission reduction, in terms of eligible technologies, geographies, additionality requirements, positive lists, start dates, crediting periods, safeguards against losses and uncertainties, among others.

	2021			2022			2021-2022 PERCENT CHANGE			2023 (YTD)
STANDARD	VOLUME ($MtCO_2e$)	VALUE (USD)	PRICE (USD)	VOLUME ($MtCO_2e$)	VALUE (USD)	PRICE (USD)	VOLUME	VALUE	PRICE	PRICE (USD)
VERIFIED CARBON STANDARD (VCS)	203.8	$945M	$4.64	79.3	724.5M	$9.14	-61%	-23%	+97%	$9.06
CLEAN DEVELOPMENT MECHANISM (CDM)	37.7	$73M	$1.94	18.2	51.7M	$2.84	-52%	-29%	+46%	$2.24
GOLD STANDARD	10.8	$58M	$5.42	11.8	98.4M	$8.35	+10%	+69%	+54%	$6.25
CERCARBONO	-	-	-	4.1	23.5M	$5.73	-	-	-	$4.14
CLIMATE ACTION RESERVE (CAR)	3.1	$14M	$4.56	4	28.5M	$7.18	+28%	+101%	+57%	$6.58
AMERICAN CARBON REGISTRY (ACR)	1.8	$22M	$12.14	1.8	36.6M	$19.85	+1%	+65%	+64%	$9.50
PLAN VIVO	2.3	$23M	$9.92	1.2	16.3M	$13.29	-46%	-28%	+34%	$12.49
UK WOODLAND CARBON CODE (WCC)	0.233	$4.7M	$20.25	0.212	5.2M	$24.41	-9%	+10%	+21%	$30.81
CANADIAN STANDARDS ASSOCIATION (CSA)	0.062	$177,190	$2.84	0.161	620,400	$3.85	+159%	+250%	+36%	-
UK PEATLAND CODE	-	-	-	11,416	351,696	$30.81	-	-	-	-

Figure 15: Issuance and price variability among different registries for the years 2021, 2022, and 2023. Source: Ecosystem marketplace.

Offsets generated through different voluntary carbon standards lie in their respective criteria and methodologies, which can impact the credibility, environmental integrity, and market acceptance of the offsets. While every standard should aim to verify emission reduction or removal projects, they may differ in their approaches to project eligibility, additionality assessment, baseline setting, leakage prevention, and MRV requirements [50]. These differences result in variations in the stringency, transparency, and robustness of the certification process, influencing stakeholders' perceptions of the offsets' quality, reliability, and value [51]. Consequently, stakeholders seeking to purchase or invest in carbon offsets may carefully consider the standards' reputations, methodologies, and track records to ensure alignment with their sustainability objectives and risk tolerance.

Given this variability, some standards may work for a specific project type but may not for a slightly different one or even for a very similar project located in a different jurisdiction. Then, the available options could be quite restricted or even non-existent in some cases, and the market built by the voluntary buyers ends up judging the price at which these reductions are traded.

According to Air Carbon XChange [52], as of February 20, 2024, the emission reduction certificates accredited in their registry (contributing to any SDG) have reached a price of 1.5 USD/tCO2e. It is worth noting that the prices coming from traders and retailers are the result of grouping similar projects under criteria established by the platform itself.

The "State and Trends of Carbon Pricing 2023," published by the World Bank and based on S&P Global Platts data, indicates that by mid-2023 the average value of credits associated with removal was close to 4 USD/tCO2e removed, which represented a decrease compared to the 8 USD/tCO2e that this type of credit reached in Q3 of 2022.

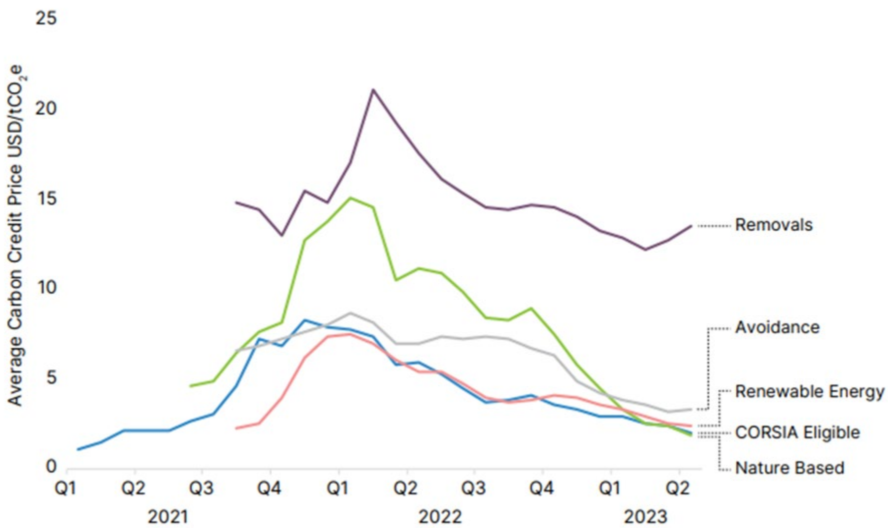

Figure 16: Prices of standardized carbon credits contracts 2021-2023[7]. Source: World Bank.

The price differences could have appreciated throughout the years and among different project types, as Ecosystem Marketplace published in 2023 [51]. It is worth mentioning that waste disposal projects, where the FLW projects likely fit, appear on the top three highest price levels:

	2021			2022			2021-2022 PERCENT CHANGE			2023 (YTD)
CATEGORY	VOLUME ($MtCO_2e$)	VALUE (USD)	PRICE (USD)	VOLUME ($MtCO_2e$)	VALUE (USD)	PRICE (USD)	VOLUME	VALUE	PRICE	PRICE (USD)
FORESTRY & LAND USE	242,339,151	$1,401,461,426	$5.78	113,253,651	$1,148,848,783	$10.14	-53%	-18%	+75%	$11.21
RENEWABLE ENERGY	214,508,581	$463,950,451	$2.16	92,477,042	$386,054,729	$4.16	-57%	-17%	+93%	$3.97
CHEMICAL PROCESSING & INDUSTRIAL MANUFACTURING	17,253,275	$53,877,016	$3.12	13,338,781	$68,531,895	$5.14	-23%	+27%	+65%	$4.69
HOUSEHOLD / COMMUNITY DEVICES	8,687,821	$46,606,814	$5.36	9,070,331	$77,590,244	$8.55	+4%	+66%	+60%	$7.33
ENERGY EFFICIENCY / FUEL SWITCHING	10,936,656	$23,583,132	$2.16	6,601,354	$35,577,952	$5.39	-40%	+51%	+150%	$3.69
WASTE DISPOSAL	11,647,530	$42,292,142	$3.63	6,207,615	$44,870,139	$7.23	-47%	+6%	+99%	$9.00
AGRICULTURE	987,026	$9,525,119	$9.65	3,783,393	$41,700,362	$11.02	+283%	+338%	+14%	$6.43
TRANSPORTATION	5,405,466	$6,257,391	$1.16	176,338	$770,485	$4.37	-97%	-88%	+277%	-

Figure 17: Issuance and price variability among different project types for the years 2021, 2022, and 2023. Source: Ecosystem marketplace.

[7] "CORSIA Eligible" carbon credits refer to carbon offset credits that meet the criteria set by the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). CORSIA is a global market-based measure established by the International Civil Aviation Organization (ICAO) to address greenhouse gas emissions from international aviation. Eligible carbon credits under CORSIA must meet specific standards and criteria, including additionality, permanence, transparency, and avoidance of double counting. These credits can be generated from a variety of emission reduction or removal projects, such as renewable energy, forest conservation, and methane capture initiatives and are used by airlines to offset their emissions growth above 2020 levels.

5.4. Insetting mechanisms

Insetting is another financing mechanism whereby an intervening company promotes projects aimed at reducing its emissions profile. This can be perceived as project-based financing for improving or expanding activities within food banks, with the condition that all environmental benefits associated with the intervention must be transferred back to the company funding the project.

In this context, food banks can upgrade or enhance their equipment and processes, avoiding associated costs. In return, they allocate the GHG emission reductions to their "clients," such as restaurants or supermarkets, which utilize the donated food in their marketable products.

As stated in the Gold Standard's Scope 3 Value Chain Interventions Guidance [53], a set of specific conditions must be applied to the insetting practices for the project proponent to claim impact on Scope 3 GHG inventories, safeguarding the integrity of the climate outcomes and its traceability:

- The food bank must supply the insetting project proponent or its tier one or above supplier(s). This commercial relationship must be demonstrable[8].
- The food bank should not claim reductions from this project in its carbon footprint report.

Despite the above, there is still no official consensus whether insetting may apply for uses outside a Scope 3 emission reduction context and if insetting projects must be only developed inside boundaries of a specific company and its own supply chain.

Depending on the context of the situation in which an insetting project is developed, this strategic collaboration allows businesses to align environmental stewardship with financial incentives and its value chain, while promoting sustainable practices within the food industry. For instance, ReFED, a national nonprofit organization based in the United States, systematically collects data related to various initiatives addressing food waste, with a specific focus on recovery efforts [54].

Within this context, ReFED categorizes food recovery activities into eight financially viable initiatives, which are economically modeled:

1. Education for recovery incentivization: Educating stakeholders to promote food recovery practices.
2. Donated food transportation: Efficient transportation of donated food from sources to recipients is crucial for successful recovery.
3. Handling and storage capacity: Proper infrastructure for handling and storing recovered food enhances efficiency.
4. Value-added processes for recovered food: Implementing value-added processes (such as repackaging or enhancing quality) increases the utility and expiration date of recovered food.
5. Donation reverse logistics: Streamlining the logistics of food donation ensures efficient flow from donors to recipients.
6. Donation coordination and matching: Effective coordination ensures that surplus food reaches those in need.

This modeling approach allows ReFED to determine the number of food portions recovered per USD invested in these initiatives, providing an indicator of return on investment.

Furthermore, based on calculations presented by the same platform, it is possible to quantify the equivalent CO2 reduction achieved in the environment for every million USD invested in any of these initiatives. This reduction can be translated into the number of insetting credits obtained by the funding company, acknowledging the risk of overlooking many complex factors that could impact the reliability of the results:

[8] Depending on the nature of the insetting project (as intervening natural sources impacting positively many companies or communities) there may be cases when it's not feasible to demonstrate which specific upstream suppliers or producers provide the goods and services. It should be demonstrable that that sourcing comes from a group of suppliers within a geographical area/market from which the company sources. It also allows some flexibility for the coming and going of individual suppliers within that market, while maintaining overall integrity of accounting.

Initiative	Costs [MUSD]	Net Benefit [MUSD]	Net Benefit-Cost ratio [-]	GHG reduction per million USD invested [tCO2e/MUSD]
Food transport	$ 465	$ 2,845	6.1	2,000
Storage capacity	$ 332	$ 1,038	3.1	943
Added value	$ 20	$ 1,030	50.7	1,350
Matching and coordination	$ 67	$ 649	5.7	6,100
Education	$ 520	$ 5,270	10.1	2,060

Table 6: Financial and environmental indicators for improvement projects on food banks. Source: Adapted from ReFED.

Given these results, through the implementation of an MRV system and following the guidelines of a specific quantification methodology, the insetting project could add value to the increased amount of food recovered through the issuance of GHG reductions that may be transferred to the respective donors or even kept by the food bank for additional finance streams, depending on the agreements with donors, sponsors, and stakeholders. It is worth noting that if the return on investment is solely assessed from the insetting point of view, the carbon credit issued must be traded with a price between USD 164 and 1,188 per tCO2e, where the amplitude of that range is explained by the different impact of the initiatives on the amount of food recovered. Also, the range is solely based on the data gathered from the ReFED modeling, which is subject to data quality parameters (rated between 2 and 3 in a scale of 5) and may not represent a broad spectrum of projects that could increase the amount of food recovered or preserved at lower costs, as seen in the many examples that can be derived from the methodology detailed in Section 4.2.5; more specific case studies must be made to determine a more representative cost of reducing a tCO2e in an insetting project context.

Notwithstanding the uncertainties of these results and in some specific cases, the range of carbon prices are not far apart and may be consistent with some values of ETS under the 2030 corridor for carbon pricing, as is stated in Section 5.2, and with companies with internal carbon pricings[9] over 100 USD/tCO2e, as is presented in Figure 18.

[9] Some organizations voluntarily use different kinds of internal carbon prices (ICPs) to manage climate-related business risks and prepare for the transition to climate neutrality. Shadow pricing assigns a theoretical price per unit of emissions, which is then factored into the organization's decision-making processes. Through internal carbon fees, organizations allocate "fee"revenues to fund emissions reduction activities. Other types of ICPs include implicit carbon pricing, offset purchasing, and internal carbon trading [26].

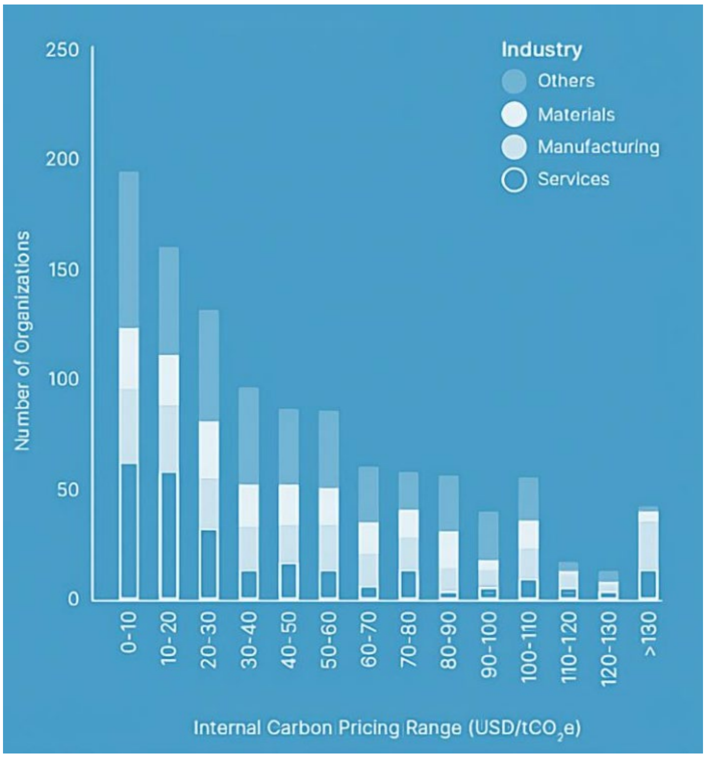

Figure 18: Internal carbon prices applied across industries. Source: World Bank.

5.5. Green bonds

Green bonds offer an opportunity to engage a broader pool of investors, including those with a vested interest in environmental sustainability and social impact, while accessing better financial conditions. By highlighting the environmental and social benefits of investments in food banking, issuers of green bonds can attract socially responsible investors seeking to align their investment portfolios with sustainability goals. This expanded investor base could provide additional capital and liquidity to support the scaling up of food banking operations and the implementation of innovative solutions to address food insecurity.

Overall, leveraging green bonds as a financing mechanism for food banking growth and operations presents an opportunity to mobilize capital towards addressing social and environmental challenges while promoting sustainable development and resilience in communities.

At the same time, applying green bonds to fund food banks presents several challenges that must be addressed to ensure the effectiveness and credibility of such financing mechanisms [55]. One primary challenge lies in monitoring, reporting, and verification (MRV) processes associated with green bonds. Unlike traditional green projects such as renewable energy or sustainable infrastructure, the impact of funding food banks may be more difficult to quantify and verify. Establishing robust MRV mechanisms to track the emission reductions and social benefits of investments in food banks is essential to demonstrate the effectiveness and accountability of green bond proceeds.

The scale and complexity of debt incurred through green bonds also poses challenges when applied to food banks. Food banking operations typically require ongoing funding to support day-to-day activities, including food recovery, storage, transportation, and distribution. Green bonds may involve long-term debt commitments with fixed repayment schedules, which may not align well with the short-term and variable funding needs of food banks. Managing the debt incurred through green bonds while ensuring sufficient liquidity and flexibility to respond to changing demands and emergencies represents a significant challenge for food bank operators.

Additionally, the unique nature of food banking operations and the diversity of stakeholders involved may present challenges in structuring and marketing green bonds. Unlike traditional green projects, which may have clear revenue streams or cost savings associated with environmental benefits, the financial returns on investments in food banks may be less tangible or direct, as the main beneficiaries are the consumers and communities [56]. Convincing investors of the social and environmental value of funding food banks through green bonds requires transparent communication, stakeholder engagement, and innovative financing models that balance financial sustainability with social impact objectives.

Addressing these challenges requires collaboration and innovation across multiple stakeholders, including food bank operators, investors, financial institutions, regulators, and civil society organizations. Developing standardized MRV methodologies tailored to food banking operations, designing flexible financing structures that accommodate the unique funding needs of food banks, and building investor confidence through transparent reporting and impact measurement are essential steps to unlock the potential of green bonds as a financing mechanism for food bank growth and operations.

6. Innovative financial instruments: real cases

6.1. Brightly - Reducing Food Loss and Waste [57]				
Country	**Project Proponent**	**Registry**	**Methodology**	**Estimated annual reductions [tCO2e]**
USA	Brightly	Verra's VCS	VM0046	367,544

This initiative consists of a grouped project that is led and coordinated by Brightly, a company that carries quantification and characterization of FLW and their respective methane avoidance related to the operation of six anonymous Food Rescue Organizations (FROs) in the USA. These FROs recover surplus food from a variety of sources and deliver it to food banks and food pantries around the country, securing its return to the value or consumer chain.

Brightly handles the verification and audit of all data, as well as the marketing and sales of all Verified Carbon Units (VCUs) originated, given that Brightly keeps ownership of the credits. On the other hand, the FROs are responsible for carrying out the primary project activity, receiving most of the revenue from the sale of credits. This is in accordance with their contractual conditions that also manages the procedures for the double counting and double claiming avoidance.

Given the policies and government initiatives that incentivizes food recovery, the baseline scenario includes the reductions of recovered food that does not meet the additionality requirements under VM0046 methodology and CDM additionality criteria applicable for this typology of project (being already financed by the government). In this case, only the extra recovered food is recognized as additional.

The emissions for transportation activities are calculated by a distance-based method using the latest DEFRA GHG conversion factors and eventual food discards due to project operation are approximately 11% of the FLW recovered.

6.2. GHG emissions avoidance by recovering unsold goods through the Mexican Food Banking Network connected to an emission reduction quantification platform provided by CoreZero [32]				
Country	**Project Proponent**	**Registry**	**Methodology**	**Estimated annual reductions [tCO2e]**
Mexico	Core Zero	GHG CleanProject Registry	ACM0022	149,770

The project recovers unsold food items that are suitable for use or consumption, commercializing and/or donating it through a network of social organizations that provide food assistance to communities in need. The project activity is connected to CoreZero's digital platform, which serves as a quantification platform addressing the MRV processes from data gathering to the emission reductions which are calculated under the ACM0022 methodology.

The Mexican Food Banking Network, a non-profit civil society organization (CSO) consisting of 53 facilities across Mexico, is dedicated to recovering goods and food with no commercial value, such as items with short expiration dates, production surpluses and products with defective packaging. These consumable goods are then distributed to people who suffer from food insecurity. By doing so, The Mexican Food Banking Network prevents wasting hundreds of thousands of tons of food and goods that would otherwise have released large amounts of CO2e emissions into the atmosphere.

The baseline emissions are calculated through an emission factor that averages the landfill local characteristics of every country and the degradable organic carbon average estimation of every group of assets listed on IPCC 2006 Guidelines, according to the ACM0022 methodology. Based on the project design document, the only FLW that falls in the category of "food product" are fruits and vegetables, since any other FLW is considered miscellaneous and is associated with a waste average emission factor, which could lead to an underestimation of the reductions.

The project is certified under the GHG CleanProject Registry, which is valid but does not confer the same level of credibility as certifications from the more widely recognized and established standards, such as Verra and Gold Standard. This disparity in recognition could potentially influence the market value of the carbon offsets generated by the project, potentially leading to lower prices compared to offsets certified by the higher-profile standards.

6.3. GHG emissions avoidance by recovering unsold goods through the Food Bank of Peru connected to an emission reduction quantification platform provided by CoreZero [58]				
Country	**Developer**	**Registry**	**Methodology**	**Estimated annual reductions [tCO2e]**
Peru	Core Zero	GHG CleanProject Registry	ACM0022	19,181

Despite being developed by Peru Food Bank, the project reduces GHG emissions by diverting unsold food and personal care products from disposal, opening its operations to discarded items that differ from FLW.

The current scenario for this project is similar to the Mexico project, given that both projects share its proponent. As expected, the same assumptions and criteria are applied in the Peru project, only differing in the emission factor, which is corrected by different factors associated with local conditions.

The project's financial prospects are hindered by the limited issuance of carbon credits, impacting its ability to attract funding. It is essential to seek alternative financing methods, such as grants and strategic partnerships, to ensure the project's sustainability and progress.

6.4. Recycled/transformed foodstuffs intended for animals, process by Prorec inc. [59]				
Country	**Developer**	**Registry**	**Methodology**	**Estimated annual reductions [tCO2e]**
Canada	Prorec inc.	GHG CleanProject Registry	ISO14064	14,870

This emission reduction project led by Prorec Inc. was operating between 2003 and 2014, based in Quebec, Canada. The project originated GHG emission reductions by transforming food residues to animal food. This waste diversion project avoids a large quantity of organic residues being buried in a landfill and consequently releasing methane to the atmosphere.

Working with agricultural nutritionists to transform food byproducts and grain feed mill into animal foods that respect the nutritive needs established by the agrifood industry, Prorec collects dry, packaged, or unpackaged food products including dough or liquids from bakeries, chocolate, brewer's grains and yeast, nuts and peanuts, and vegetable oil and byproducts. This implies that the emissions from the project come from transportation, value added to the products due to post processing operations and emissions of products like fertilizers.

The emission factor of the baseline scenario is based on the average landfill emission factor of Quebec, which estimates its gas capture ratio in a range between 35% and 57% depending on the reporting year (specific yearly ratios are communicated by environmental authorities of Canada) and activity data of the FLW is mostly sensitive to the availability of the goods needed for fabrication of its products, averaging the carbon degradation following the 2006 IPCC Guidelines.

6.5. Reduction of GHG emissions associated with diverting unsold assets from final disposal by commercializing and donating them through digital platforms connected to an Emission Reduction Quantification Platform provided by Globechain [60]				
Country	**Developer**	**Registry**	**Methodology**	**Estimated annual reductions [tCO2e]**
USA, UK	Globechain (UK) Limited	GHG CleanProject Registry	ACM0022	77,428

Globechain is a digital solution that connects enterprises from various industrial sectors, letting them offer their unneeded assets through a marketplace, diverting them from their disposal in landfills or any kind of waste treatment facility. No emissions from transportation, storage, or any kind of post-production are applied for the project scenario, only accounting for reductions from the diverted assets.

Globechain owns all the GHG reductions originated through activities of diversion of undesired assets and material donated through the marketplace from final disposal, and companies donating or selling its products on the marketplace must report its waste disposal emissions as landfilling.

As with other ACM0022 methodology-based projects reviewed, the baseline emissions are calculated through an emission factor that averages the landfill local characteristics of every country and the degradable organic carbon average estimation of every group of assets listed on 2006 IPCC Guidelines.

6.6. Reduction of GHG Emissions Associated with Diverting Unsold Items from Final disposal by Commercializing and Donating them Through Online Platforms Connected to an Emission Reduction Quantification Platform Provided by Neutral Ways in Peru [61]				
Country	**Developer**	**Registry**	**Methodology**	**Estimated annual reductions [tCO2e]**
Peru	Neutral ways LLC	GHG CleanProject Registry	ACM0022	366,819

Neutral Ways LLC proposes a project of emission reductions from the diversion of unsold products to final disposal. These unsold products will be commercialized with any off-price retailers such as e-commerce stores or similar platforms that will connect to the project's online platform, providing a framework for the quantification of emission reductions of such diversion.

This project stands out due to the substantial volume of carbon credits it generates and the diverse range of products it recovers, presenting multiple opportunities for innovation and collaboration in the environmental sector. The project groups waste recovery into three categories, implying three different baseline emission factors per waste treatment, while the project emissions are reduced to zero given the transportation, distribution and end user transportation would still exist in the absence of the project.

Category	Items	Container composition
Food products (Primary production)	Produce (raw food) for local and export markets	Organic/compostable matter, plastic, glass, cardboard
Textile	Clothing and footwear (Children's, women's and men's apparel)	Fibers, plastics
Products (Miscellaneous)	Cosmetics, personal care, pharma, disinfectants, liquor, Toys, stationary, books, food products (processing and distribution/commercialization), among others.	Plastic, glass, liquids Glass, cardboard, liquids Paper, wood, plastic, rubber, metal, inorganic matter

Figure 19: Categories of waste recovered by the Neutral Ways' project. Source: Neutral Ways.

The significant issuance of credits not only underscores the project's impact on GHG reductions but also enhances its appeal to investors and partners interested in substantial and verifiable environmental benefits.

This diversity could facilitate the bundling of this project with other initiatives, potentially attracting more significant investments, fostering collaborative efforts across sectors, and amplifying its overall environmental impact, making this project a pivotal player in the push for sustainable development.

7. Barriers for results-based financial instruments

Based on the information presented in this document, carbon pricing mechanisms open a window for food recovery initiatives to access an additional source of financing by generating intangible assets in the form of GHG emission reductions and/or carbon credits, trading them with companies requiring carbon footprint reductions. Thus, the issuance of these reductions emerges as a flexible alternative to finance projects according to the environmental impact of the initiative, proportionally to the type and quantity of food recovered, along with the correct modeling of waste treatment in the geographic area applicable to the project.

In order to effectively enable this financing mechanism, various barriers must be overcome:

- Regulation and requirements: National regulation, international agreements, and technical guidelines and protocols may restrict some specific operations and the amount of reductions to be potentially claimed.
- Scale: Projects may not have sufficient scale to generate the number of credits that justify the costs, investments, and logistics necessary for the validation and verifications for issuing credits.
- Monitoring and technologies: Tracing and tracking the operation of the FLW may not be as simple and straightforward as expected, especially if sophisticated baselines are set (based on food types, nutrients, usages, and avoided food production).
- Time: In this context, time is also an important factor, as the time between the execution of activities that result in reductions and the issuance of credits may reach several months or even years.
- Liquidity: The generation of assets for subsequent sale does not assure that there will be enough demand, or that the buyers will clearly express their intention to purchase from the moment of issuance.
- Price volatility: As detailed in Section 5.3, there are different markets and sales channels that can critically influence the selling price of the reductions. The choice of standards and access to markets with higher carbon prices is critical for the cost-benefit equation of the project.

In the absence of proper planning of the GHG reductions issuance process and a robust commercial-communication strategy, carbon pricing mechanisms do not represent a secure option for financing a food recovery project on their own. Additionally, the political environment plays a fundamental role in both imposing barriers and enabling mechanisms such as climate finance. Primarily, public incentives and commitments surrounding food recovery can pose a risk to the additionality of projects or even definitively close the possibility of generating or trading credits within a specific region as is described in the following cases:

- When public incentives are allocated based on the GHG emission reductions generated by certain activities, it can be inferred that such reductions are financed. This has direct repercussions on the demonstration of additionality since, in this case, the justification for the need for financing is complicated. Nevertheless, CDM, and Verra methodologies keep spaces open to argue whether this financing is sufficient for the activity, without failing to mention that these incentives could disable or reduce the amount of generated credits.
- The particular case of Indonesia (See Section 5.1) may represent a precedent for how individual countries' commitments to achieve their NDCs and their plans for emissions trading under the Paris Agreement can limit financing to credits issued in independent standards in the short term, providing high levels of uncertainty to long-term projections.
- It is still unclear whether this kind of barrier can be compensated by internal incentives for emission reduction in the context of the achievement of the country's NDCs [45].
- Regardless of the outcome of this decision, it may happen that more countries adopt similar measures regarding voluntary carbon markets, as they become a strategic part of national commitments against climate change.

The case of Indonesia also demonstrates the low carbon prices in developing countries compared to some national pricing schemes in developed countries, where prices are expected to range between

USD 61 to 122 per tCO_2e by the end of the decade (see Section 5.2). From this point of view, the eventual recognition of FLW under a national or subnational carbon pricing scheme, with the corresponding homologation of credits issued under voluntary carbon standards for compliance purposes, represent an opportunity to access a stable mechanism to finance food banks.

8. Enabling strategies and recommendations

As has been reviewed throughout the document, there are several alternative mechanisms, beyond debt acquisition and funding requests, that would allow food banks to access additional financing based on their contributions to the environment in terms of GHG emission reductions.

While these alternatives are directly based on the accreditation of GHG reductions due to the operation of food recovery projects, their financing potential still relies mostly on the calculation established in Section 4.2:

$$Financing = [Amount\ of\ emission\ reductions] * [Price] - [Project\ costs]$$

For each of the three variables involved on the financing potential calculation, there are several factors and tradeoffs that should be considered depending on specific context and conditions of the food banking project.

8.1. Price

In general terms, the sale of carbon credits in regulated markets exhibits the most favorable price signals due to the presence of jurisdictions with highly competitive carbon prices. As shown in Figure 14, there are many national or subnational jurisdictions with carbon prices over the USD 40 per tCO2e, with a few reaching values in the range of the carbon corridor (USD 61 – 122 per tCO2e).

For food banks not located within such jurisdictions, the ability to export carbon reductions will depend on enabling mechanisms by the Nationally Designated Authority (NDA) to facilitate the sale of these reductions under Article 6.2 or Article 6.4 of the Paris Agreement. For this purpose, the host country must recognize food banks as a legitimate emission-reducing activity and allow the export of their emissions to foreign jurisdictions.

Thus, the commercialization of credits under Article 6.2 requires a bilateral agreement between countries to enable the export of emissions in the form of Internationally Transferred Mitigation Outcomes (ITMOs).

Conversely, under Article 6.4, credits become eligible for commercialization simply with the approval of the host country's NDA, allowing them to be issued in the corresponding mechanism's registry. However, additional conditions may arise as they are defined in subsequent Conferences of the Parties (COPs).

In cases where access to attractive national or subnational regulated markets is unavailable, food banks may explore the option of selling their GHG reductions in voluntary markets or within its local jurisdiction, whichever brings higher price signals.

In national or subnational markets, the price is primarily determined by local jurisdiction, and adjusted by market dynamics such as supply, demand, private interests, and negotiation power. On the other hand, voluntary markets' price signals exhibit greater variability over time and depend on the aforementioned market dynamics, along with factors such as standard reputation, corporate environment trends, project types (See Figure 16 and Figure 17), and the presence of intermediaries like brokers and retailers.

Finally, in the context of financing by insetting, a commercially related entity may support part of the operation of a food bank through acquiring the emission reductions that are being generated though its intervention. While this could be mainly driven by the intervening entity's corporate goals, the financial benefit for the food banking activity will be directly related to an increase in the amount of recovered food and/or a reduction on their operational costs.

8.2. Quantity

The quantity of carbon credits sold directly relates to the number of credits issued and access to the demand for the emission reductions. In this regard, the methodology and the additionality requirements play a pivotal role in the issuance volume and can be assessed at various levels.

Primarily, each carbon accounting methodology establishes additionality assessment criteria tailored to the operational reality and economic environment of each project type, where only additional emissions can be issued as certificates.

On the other hand, some carbon reduction certification programs may impose admissibility conditions, based on the decision-making moment to opt for these programs, or conditions over the operational lifespan of the project without the need for an additional revenue stream.

It is expected that programs with more stringent conditions will only recognize emission reductions stemming from increased capacity of food banks and the retrofitting of equipment/processes that results in a decrease of the food bank's emission intensity. In such cases, reductions from the business-as-usual operation of the food bank might not be recognized as additional by these programs.

Regarding access to demand, in the case of national or subnational regulated markets, food bank operations must be recognized activities within the corresponding jurisdiction where the certificates will be issued and sold. Also, potential local additionality conditions must also be evaluated in parallel to those required within the methodologies.

For accessing regulated markets of foreign jurisdictions through Articles 6.2 and 6.4 of the Paris Agreement, only those reductions not intended to fulfill the Nationally Determined Contributions (NDCs) should be eligible. Then, food banks exceeding the compliance threshold of the local jurisdiction would be allowed export reduction certificates, impacting the availability of potential markets with more competitive prices.

From the perspective of voluntary markets, access to demand will directly depend on the chosen emission reduction program, project visibility, and strategic relationships that can be established with potential buyers and intermediaries.

Similarly, strategic relationships with companies that consider food banks within their supply chain are the most relevant factor for accessing a financing stream via insetting, where one of the most relevant characteristics of the reductions accounting is related to its measurability and being verifiable under the standards required by the insetting company to discount them from their Scope 3 GHG emissions inventory.

8.3. Methodologies and certification programs

As previously mentioned, methodologies and programs can significantly influence the proportion of reductions that are deemed admissible and additional for the issuance of certificates. In this context, specifically regarding the Gold Standard methodology analyzed in Section 4.2.4, the acknowledgment of reductions from projects addressing suppressed demand has the potential to maximize the number of emission reductions to be issued.

Furthermore, when comparing the ACM0022 methodology of the CDM with the VM0046 of the VCS, it can be stated that the requirements for baseline quantification and uncertainty management in the models proposed lead to differences in the quantified reductions. Even when both methodologies are applicable to food banks, the VCS methodology proves to be more specific and demanding in terms of MRV compared to its CDM counterpart.

Moreover, the choice of a program can be decisive for the admissibility of a project within a national or subnational market, as the programs must be previously recognized by each jurisdiction for subsequent ratification. This is relevant for both the marketing of certificates in a local market and their international sale under Article 6.2—and depending on definitions to be taken on forthcoming COPs, Article 6.4—of the Paris Agreement.

In the context of voluntary carbon markets, the choice of program and methodology can also have a direct impact on prices, as market trends regarding reputation, supply, and demand generate signals that favor the prices of certificates originated by programs with strong governance, environmental integrity, and successfully highlighting the co-benefits of the projects, its potential impact on the SDGs, and their recognition by other entities such as CORSIA, and ICROA, among others (Figure 15).

Moreover, the selection of programs emerges as a significant factor in costs, as each program has its fee schedule that may apply to activities such as project registration, accreditation, and verification of reductions, as well as the issuance and cancellation of certificates and maintenance costs. These costs are often related to the scale of the project and the number of certificates to be issued and canceled, potentially representing a barrier for small-scale projects or those with less liquidity, as several of these costs must be addressed in advance of the issuance and sale of the certificates.

8.4. Monitoring, Reporting, and Verification (MRV)

The requirements for MRV systems are applicable to all mechanisms, programs, and standards involved in results-based environmental finance. As a prerequisite for any emission reduction quantification, MRV costs must be integrated into the decision-making process when entering regulated or voluntary carbon markets.

The implementation costs of MRV systems will vary based on several factors, including consultancy (if outsourced), as well as the scale and sophistication of the models required in the chosen methodology.

Consequently, the strategic selection of MRV models is crucial as they become part of operational costs in terms of maintenance, operation, and training of the personnel, as well as digital platforms and equipment, where applicable. Therefore, proper planning of its implementation as well as food banking processes mapping are essential for minimizing costs due to inefficiencies in this area.

Since MRV is an unavoidable cost, the deployment of a high-standard MRV system may play a significant role in providing robustness for the obtained results, particularly aimed at private entities interested in reducing their carbon footprint or achieving their sustainability goals in a verifiable manner.

MRVs directly impact the management of uncertainties in sampled data and serve as the primary tool to prevent double counting and double claiming of reductions, ensuring confidence that such reductions will be correctly allocated to buyers, thereby avoiding scrutiny from authorities, potential clients, and society at large.

Ultimately, a robust MRV system is a key indicator of risk mitigation, and its use for quantifying environmental outcomes not only affects access to carbon markets but also extends to all types of financing that require accountability of results, such as green bonds.

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