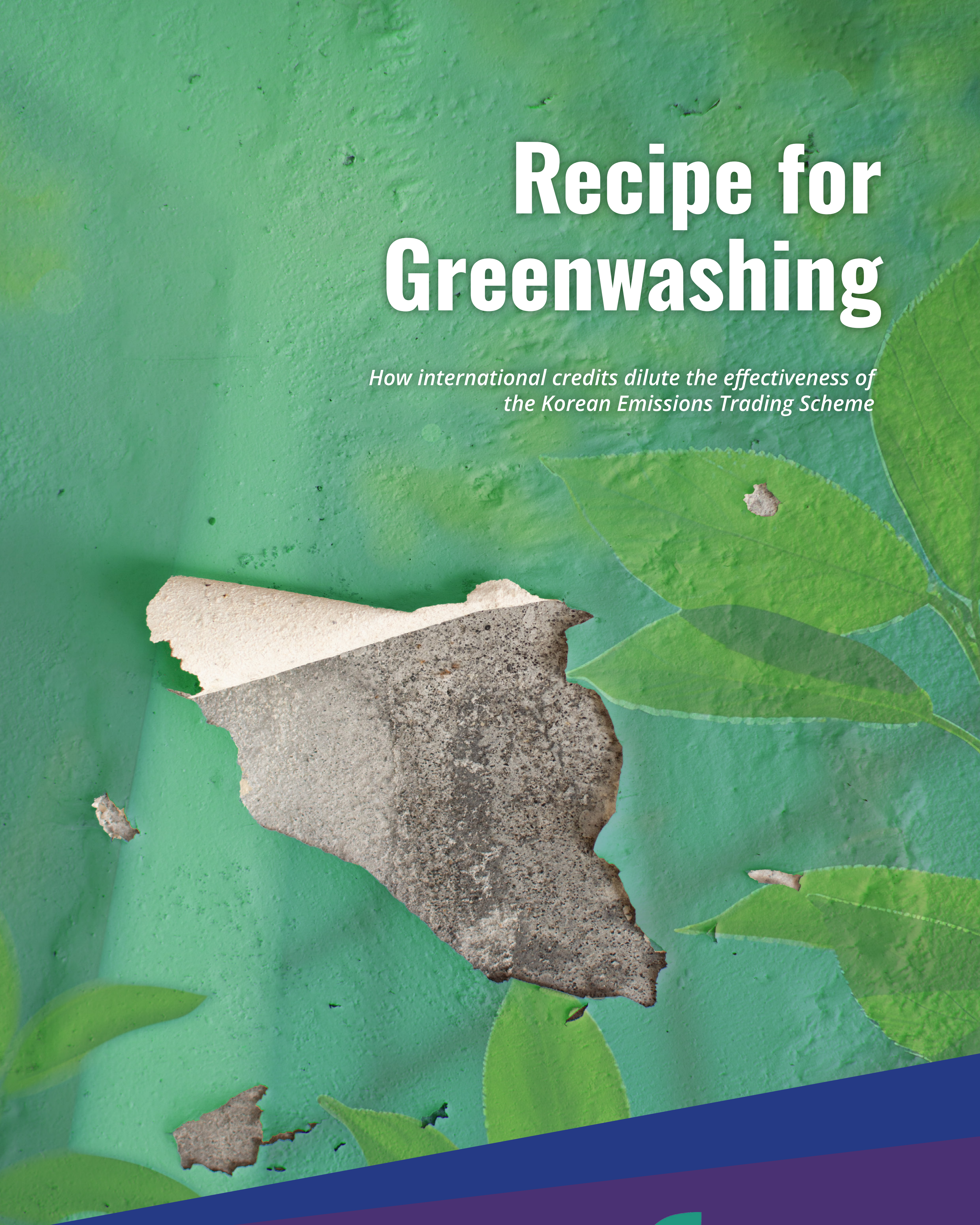
# Recipe for Greenwashing

*How international credits dilute the effectiveness of the Korean Emissions Trading Scheme*



Plan 1.5

CARBON MARKET WATCH

UC Berkeley
Goldman School of Public Policy
Carbon Trading Project

# Recipe for Greenwashing

## How international credits dilute the effectiveness of the Korean Emissions Trading Scheme

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FAQ prepared by Barbara K Haya with input from Annelise Gill-Wiehl

# Executive summary

The Korean Emissions Trading Scheme (K-ETS) covers 73% of South Korea's emissions and is critical to achieving its climate targets, including a 40% reduction in greenhouse gas emissions from 2018 levels by 2030. Despite its importance as a climate policy tool, the effectiveness of the K-ETS is dogged with concerns about lax emissions ceilings, low allowance prices, and reliance on international carbon credits.

This report evaluates the role of international credits in compliance carbon markets, focusing on the European Union Emissions Trading System (EU ETS) as a benchmark, and provides policy recommendations for K-ETS's next phase.

Chapter one examines the integration of international credits in the EU ETS, the world's first large-scale cap-and-trade system. While international credits from such mechanisms as the Kyoto Protocol's Clean Development Mechanism (CDM) initially played a significant role, they led to oversupply, depressed carbon prices, and delayed domestic decarbonisation efforts. By 2021, the EU had excluded the use of international credits, focusing on domestic emission reductions, improving the environmental integrity of the targets. The chapter also discusses the Carbon Border Adjustment Mechanism (CBAM), which prevents the use of international credits while incentivising global decarbonisation through border tariffs on carbon-intensive imports.

Chapter two shifts focus to the quality of the international credits under the K-ETS, particularly from cookstove, hydropower, and gas leak reduction projects. These credits, many originating from the CDM, have been associated with significant over-crediting. Our analysis of the cookstove projects — the largest source of credits in the K-ETS — finds that they overestimate by a factor of 18.3 emission reductions due to faulty assumptions about project baselines, stove use, and other reasons. Hydropower and gas leakage projects face challenges in demonstrating additional benefits that would not have otherwise occurred (i.e. additionality) and accurately measuring emissions reductions, undermining their credibility.

Chapter three provides policy recommendations for the fourth planning period of K-ETS. It emphasises the need to strengthen caps, maintain the current 5% limit on international credits, and avoid increasing reliance on the questionable practice of offsetting. The chapter recommends that South Korea ban international credits from its ETS. In addition, the Korean government plans to actively utilise the Article 6 mechanism of the Paris Agreement to achieve its 2030 nationally determined contribution (NDC). In relation to this, it is necessary to establish standards that can strictly verify the quality of international credits.

In summary, the report calls for a phased reduction in international credit use within K-ETS, increased focus on domestic emission reductions, and alignment with best practices from systems like the EU ETS. Strengthening the environmental integrity of K-ETS is essential to achieving South Korea's climate goals and ensuring the global credibility of the country's climate action by putting in place and implementing robust and effective policies.

## Disclaimer

This report is the property of Plan 1.5. Carbon Market Watch was commissioned to produce chapters one and two while Plan 1.5 wrote chapter three. The annex includes an FAQ which is authored by Barbara Haya, PhD, director of the Berkeley Carbon Trading Project at the University of California, Berkeley. The views and opinions expressed in each chapter of this report are those of the respective authors and do not necessarily reflect the views or positions of other involved organisations.

## Data and code availability

All data and code are publicly available online at
https://github.com/Plan-15/K-ETS_Cookstove

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# International credits in the EU ETS

# International credits in the EU ETS

## 1. The EU ETS: overview

### a. History and functioning

The EU Emissions Trading System (ETS), launched in 2005, is the first cross-border cap-and-trade carbon pricing system. It covers EU member states, the European Economic Area (the EU, Norway, Iceland, and Liechtenstein) and is linked with the Swiss carbon market. The EU ETS places a progressively declining ceiling on the total emissions allowed by the sectors and installations it covers. This total is divided into individual tradeable units each representing a single tonne of emissions. These units are known as allowances.

Over the years, it has evolved through four trading phases.

#### Phase 1 (2005-2007)

This pilot phase tested the system's infrastructure and allowed businesses to familiarise themselves with it. The ETS only covered the power sector and energy-intensive industries. Nearly all allowances were given away for free, with national caps aggregated into an EU cap. Over-allocation and the fact that allowances could not be used for compliance after 2007 caused the allowance price to fall to zero at the end of this pilot phase.

#### Phase 2 (2008-2012)

The cap was reduced based on actual emissions data from Phase 1. About 90% of allowances were still free. The first auctions of allowances were held and international offsets were initially allowed. This led to a massive oversupply of allowances, a glut which was further exacerbated by the financial crisis. This resulted in low prices (below €15 per tonne) and low effectiveness in terms of climate impact. However, during this phase, the aviation sector came under the wings of the ETS, the first auctions were held by member states, and the geographical coverage extended to the European Economic Area.

### Phase 3 (2013-2020)

Major changes during phase 3 included a single EU-wide emissions cap, auctioning was meant to become the default allocation method, and the supply of free allowances for the electricity sector was severely restricted (only allowed to support modernisation of the sector in a few, fossil-based countries). However, free allowances continued to cover almost all of the emissions from heavy industry. The inclusion of more sectors and greenhouse gases, along with harmonised allocation rules marked this phase. International credits continued to heavily increase oversupply and put downward pressure on carbon prices (which remained between €5 and €10 a tonne for most of this period). The Market Stability Reserve was created in 2015 and launched in 2018 to address oversupply and help stabilise prices.

### Phase 4 (2021-present)

This trading phase started operating in 2021, while significant adaptations to the EU ETS were finalised in 2023. These changes were needed to align the EU ETS cap with the new target of reducing the bloc's greenhouse gas emissions by a net amount of 55% by 2030 (as part of the 'Fit for 55' legislative package), up from the 40% target to which the EU had initially committed itself.

These changes can be summarised as:

- A more ambitious target of a 62% emissions reduction within EU ETS sectors by 2030 compared to 2005 levels. This will be achieved through a more ambitious Linear Reduction Factor (the percentage by which the cap decreases every year) that will go from 2.2% up to 4.4%, bringing the total cap for stationary installations to zero by 2039.
- The introduction of the Carbon Border Adjustment Mechanism, which is a levy on imports from parts of the world that have less stringent $CO_2$ emissions standards than the EU, to gradually phase out free allowances in sectors covered by CBAM from 2026-2034. This means that free emission allowances will continue to be available until 2035, reducing the incentive for heavy industry to invest in cleaner alternatives before that time. In addition, indirect emissions are not currently covered by CBAM and many high polluting sectors, such as petrochemicals and plastics, are excluded, limiting the environmental impact of the new mechanism.
- The creation of ETS2, a separate emissions trading system for fossil fuels used in buildings and road transport, and the accompanying Social Climate Fund. The Social Climate Fund will aim to address the financial burden on vulnerable citizens and small businesses that are least able to cope with energy price rises in heating and transport resulting from the new carbon price.
- The expansion of the EU ETS to cover maritime shipping emissions.

- The earmarking of 100% of ETS revenue to climate action.
- Revision of the Market Stability Reserve.
- Increased funding allocation for the Innovation Fund from 450 million allowances to 575 million allowances from 2020-2030.

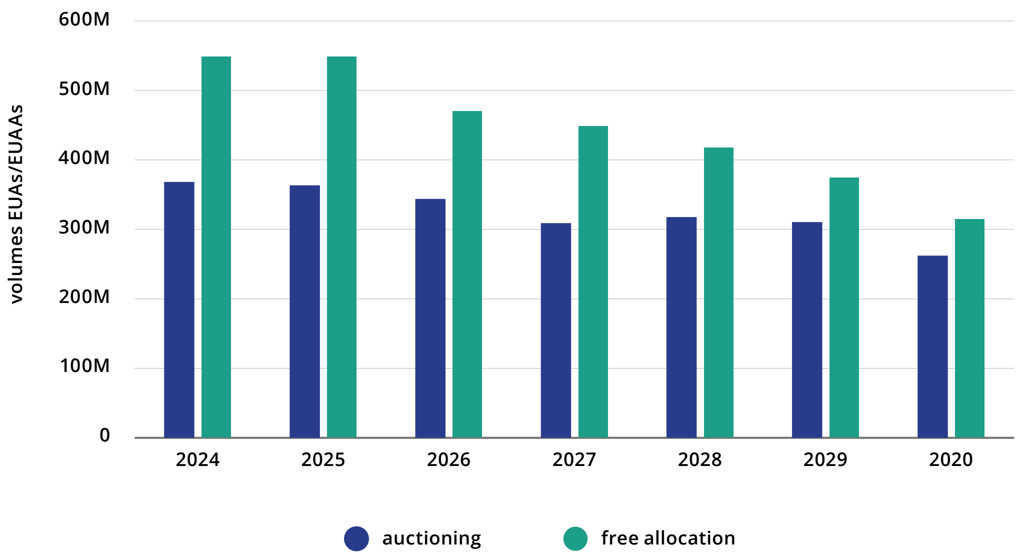
## b. Are polluters truly paying their dues?

The EU ETS initially covered the power sector, industrial manufacturing (through gradual inclusions over the years), and aviation. As of 2024, it started including maritime transport, and could potentially cover waste incineration in the coming years. As mentioned above, an "ETS2" system will start operating in 2027, covering road fuels and energy use in buildings.

Under the Emissions Trading System, auctioning of allowances by member states is supposed to be the default allocation method from Phase 3 (starting 2013). However, in reality, only the power sector, and partly aviation, have been paying for their pollution.

Free emissions allowances are the key mechanism for shielding heavy industry from the hypothetical risk of carbon leakage (meaning, the risk that companies relocate their polluting activities outside the EU due to climate-related costs). As a consequence of this system, approximately €200 billion worth of allowances were handed out for free to heavy industry over Phases 2 and 3. Despite auctioning being the default rule in Phase 4 (2021-2030), it remains the exception for industrial installations: more than 90% of industrial emissions are covered by free allowances. The 566 million free allowances distributed by the EU in 2022 alone were worth approximately €47.6 billion (based on an average carbon price of €84). The phase out of these subsidies for sectors that will be covered by the CBAM will conclude in 2034, which is still a decade away. This means tens of billions of euros in foregone revenue for member states, and major polluters not bearing the cost of their emissions and effectively passing it on to society.

**Auctioning and free allocation volumes in EU from 2024 to 2030 (in million EUAs/EUAAs)**



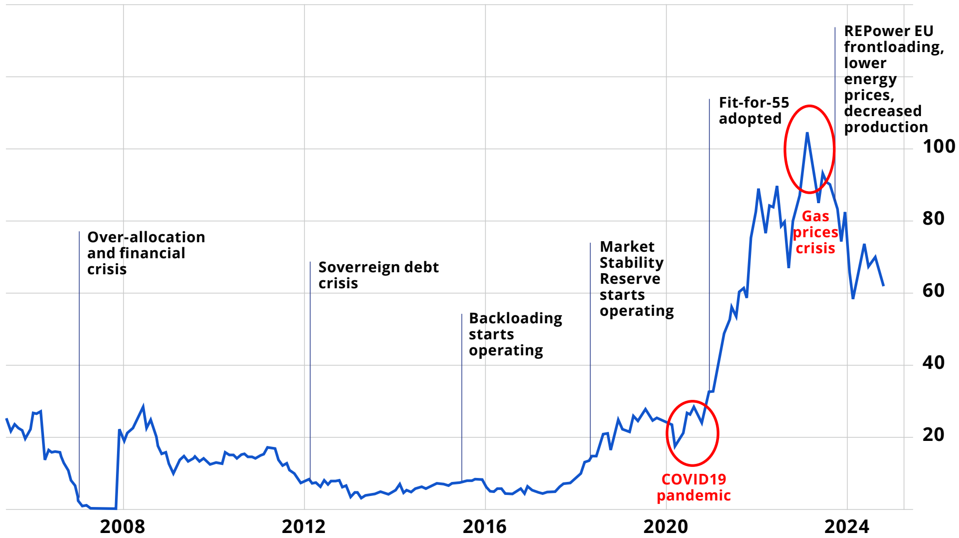

Source: EU ETS Revenue Simulator (Carbon Market Watch)

## c. (Over)supply and demand

### i. Causes of oversupply (incl. the role of international credits)

The EU ETS has been subject to chronic oversupply since its inception. This was due to several factors, and led to years of low prices, undermining the effectiveness of the system.

**EU Carbon Permits**




Source: tradingeconomics.com (edited by Carbon Market Watch)

As shown in the graph, the low prices were inherent to the system in its early stages. The EU cap was set by summing up the separate national caps set by each of the member states (with European Commission oversight), which were called National Allocation Plans (NAPs). These early NAPs were extremely problematic. They were based on conservative emissions estimates and allocated most allowances for free or based on coal benchmarks for the power sector, thereby incentivising the most polluting technology.

Moreover, a large supply of cheap and low-quality international offset credits, with only minimal quality criteria for projects, could be used to comply. Absurdly, the resulting cap was so high that the total number of allowances issued actually exceeded the emissions of the covered sectors in 2006. As the allowances from the pilot phase could not be used after 2007, unsurprisingly, their price dropped to zero. During Phase 2, the cap was adjusted based on data from Phase 1, but the vast majority (90%) of allowances were still dispersed for free, and international credits were still allowed onto the market. Over a billion of these credits would enter the EU ETS by 2012.

These international credits, an overgenerous cap and the effects of the financial crisis (when less economic output depressed emissions but the supply of allowances remained the same) led to an enormous oversupply (reaching nearly 2.1 billion units in 2014). After the start of Phase 3, ad hoc measures, such as the 'backloading' or deferring of allowances, and the creation of the Market Stability Reserve (see below) would start the process that is currently keeping oversupply in check.

## ii. What is the Market Stability Reserve?

In 2015, the Market Stability Reserve (MSR) was established to address the structural oversupply in the EU ETS market. During phase 3, 900 million ETS allowances that had been 'backloaded' (deferred on the auctioning calendar) were placed in the MSR. The MSR began actively removing surplus carbon credits from the market in 2018, which first helped stabilise prices and then led to a net increase, which helped strengthen the investment signal towards cleaner technologies.

The MSR operates as a supply control mechanism that limits the number of carbon credits in circulation on an annual cycle. Each year, the European Commission calculates the 'total number of allowances in circulation' (TNAC), representing the net oversupply in the EU ETS. If the TNAC exceeds 833 million, 24% of the excess is transferred to the MSR. For 2022, the TNAC totaled 1.13 billion allowances, significantly above the 833 million threshold. These surplus allowances are held by private entities that acquired them through auctions, free allocation, or the secondary market. The Commission could not directly recall these allowances, so the MSR limits supply by reducing the number of future allowances available for auctioning.

Starting in 2023, the MSR also began invalidating (cancelling) carbon credits. Any allowance held in the MSR and exceeding the volume auctioned the previous year is automatically cancelled. As of 31 December 2022, there were 3 billion allowances in the MSR. On 1 January 2023, 2.5 billion of these allowances were invalidated, leaving 486 million allowances, equivalent to the volume auctioned in 2022. Between September 2023 and August 2024, over 272 million allowances were removed as the MSR continues to mitigate oversupply, with auctioning volumes decreasing in line with the cap. Moreover, two cap reductions (rebasing) have also been scheduled in the latest reform – by 90 million allowances in 2024 and by 27 million allowances in 2026. However, at the same time, to account for emissions from maritime transport (which is under the scope of the EU ETS as of 2024), the cap was increased by 78.4 million allowances.

The MSR is also designed to address a potential shortfall of emission allowances. If the TNAC falls below 400 million, the market is considered 'too tight,' prompting the release of an additional 100 million allowances from the MSR the following year. Since its operation began in 2018, the MSR has effectively supported the carbon price by addressing oversupply and it never released allowances back into the market.

## 2. The role of international credits in EU carbon pricing

The EU's current emissions reduction target for 2030 (as specified in the EU Climate Law[1]) is exclusively domestic and excludes the use of international credits. However, up to 2021, the EU ETS allowed the use of international credits created by climate change mitigation projects established under the United Nations Framework Convention on Climate Change. These so-called 'international offsetting credits' were generated through two mechanisms set up under the Kyoto Protocol: the Clean Development Mechanism (CDM) and Joint Implementation (JI).

The Clean Development Mechanism (CDM) allows industrialised countries to invest in GHG emissions reduction projects in developing countries and earn Certified Emission Reductions (CERs), which can be used to meet their own climate targets. Joint Implementation (JI) enables industrialised countries to earn Emission Reduction Units (ERUs) by investing in offsetting projects in other industrialised countries.

**Info Box: Transition from CDM to Article 6 credits**

Less relevant for the EU ETS but important for other emissions trading systems are the developments around the CDM transitioning to the Article 6.4 system. The Kyoto mechanisms (CDM and JI) have meanwhile been superseded by the Paris Agreement's Article 6 mechanism, which allows, like the CDM and JI did, country-to-country trading of mitigation options under Article 6.2, and the exchange of conventional carbon credits for individuals, organisations and countries under Article 6.4.

As of November 2024, 70% of Programme of Activities (PoAs) currently listed under the CDM have applied for transitioning to the Article 6.4 mechanism,[2] which received the green light at the climate negotiations at COP29 in Azerbaijan. The deadline for the application to transition passed at the end of 2023. Now, the decision to allow projects to continue with the same (or revised) methodologies under Article 6.4 lies in the hands of the host country of each project. For projects to transition, approval has to be given by 31 December 2025, after which the Article 6.4 Supervisory

1 European Commission, European Climate Law, 2024.

2 UNEP-CCC, Article 6 Pipeline - UNEP-CCC, 2025.

Body will conduct extra checks before final rejection or approval.[3] However, recent analysis by Carbon Market Watch of PoA 10415 - the first CDM project approved for transition - highlights serious concerns. Using methodologies from the peer-reviewed Gill-Wiehl et al. (2024) study, the review found the project likely over-credited emissions reductions by a factor of 27 during the 2021–2022 transition period. This exposes major flaws in existing calculation methods.

These findings signal an urgent need for rigorous methodological reforms under Article 6.4 to prevent systemic over-crediting. Without such reform, the rebranding of up to more than 900 million low-integrity credits from legacy CDM projects risks undermining environmental goals and the credibility of carbon markets relying on these credits.

## a. History of Kyoto credits in EU ETS

In 2004,[4] the European Commission amended the EU ETS Directive to include the credits established by the Kyoto protocol. According to the European Commission Regulation[5] that allowed for the introduction of international credits into the EU ETS, each operator of a stationary installation was allowed to cover a maximum of either 4.5% or 11% of their verified emissions in the period up to 2020. The proportion depended on how many allowances these installations were allowed to surrender in the 2008-2012 period: the lowest cap was allocated to operators who originally weren't allowed to surrender international credits.

As these international credits were available for a substantially lower price than the cost of EU ETS allowances, the operators of EU ETS installation had a strong economic incentive to maximise their use. About 98% of the maximum possible international credits were used for compliance under the EU ETS system, which amounted to about 1.6 billion units[6] by the end of

3 UNFCCC, FAQs on the transitioning CDM activities to the Article 6.4 mechanism, 2024.

4 Official Journal of the European Union, DIRECTIVE 2004/101/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, 2004.

5 Official Journal of the European Union, COMMISSION REGULATION (EU) No 1123/2013, 2013.

6 European Commission, Report from the Commission to the European Parliament and the Council on the functioning of the European carbon market in 2020 pursuant to Articles 10(5) and 21(2) of Directive 2003/87/EC (as amended by Directive 2009/29/EC and Directive (EU) 2018/410), 2021.

2020. The vast majority of international offset credits came from projects in a small group of countries.[7] Over 650 million units came from projects in China, 360 million from Ukraine, 162 million from Russia and 129 million from India.

Almost 85 million CERs from the Republic of Korea were used by companies under the EU ETS. The vast majority of those originate from two projects; an $N_2O$ emission reduction project in Onsan[8] and an HFC decomposition project in Ulsan.[9]

## b. Removal of international credits from EU ETS

Qualitative limits were initially put in place on the international credits that could be used under the EU ETS. For example, nuclear energy projects and forestry projects were excluded. Moreover, only credits from eligible projects created after 2012 were allowed, except for projects in least-developed countries. Still, the majority of credits originated from China and Ukraine, effectively keeping allowances supply way higher than demand.

The EU tightened the limits by banning, in May 2013, CDM offsets from HFC-23 and nitrous oxide destruction from adipic acid plantsThese two project types were excluded[10] because they led to windfall profits, a shift in production and subsequently to an increase in overall emissions.

The use of international offset credits hampered the functioning of the EU ETS by inflating the oversupply of emission allowances, thereby lowering the incentive for European industry to decarbonise. In addition, confidence in the climate benefits of these often cheap credits plummeted due to their lack of environmental integrity and the harm some of these projects caused[11] to local and indigenous communities.

In addition, EU industry has profited from using cheaper international offset credits to meet their obligations under the EU ETS. As the price of these credits was substantially below the price

7 European Commission, Commission staff working document [...] Accompanying the document Report from the Commission to the European Parliament and the Council on the Functioning of the European Carbon Market in 2020 pursuant to Articles 10(5) and 21(2) of Directive 2003/87/EC (as amended by Directive 2009/29/EC and Directive (EU) 2018/410), 2021.

8 UNFCCC, Project: 0099 N2O Emission Reduction in Onsan, Republic of Korea - Crediting Period Renewal Request, 2024.

9 UNFCCC, Project: 0003 HFC Decomposition Project in Ulsan - Crediting Period Renewal Request, 2024.

10 European Commission, Commission staff working document - Accompanying document to the Commission decision on applying use restrictions on international credits (from HFC-23 and N2O projects) pursuant to Article 11a(9) of Directive 2009/29/EC, 2010.

11 Carbon Market Watch, THE CLEAN DEVELOPMENT MECHANISM: LOCAL IMPACTS OF A GLOBAL SYSTEM’, 2018.

of an EU emission allowance, companies used international offsets for compliance, while selling their free ETS allowances on the market. In energy-intensive sectors in the EU, this process created additional profits worth €3 billion between 2008 and 2019[12] that came at the expense of the taxpayer.

Stakeholders in the EU had diverging views on whether or not international credits should remain a part of the ETS. Business organisations and energy-intensive companies were in favour because, they claimed, these would allow flexible and cost-efficient solutions and would help to prevent the risk of carbon leakage. On the other side, NGOs and trade unions called for limiting or eliminating international credits. NGOs argued that international credits did not benefit the climate, prevented domestic action, and had a negative impact on the carbon price. Trade unions argued that international credit entitlements should be removed to incentivise emission reductions and investments in the EU.

Apart from the need to prevent a re-emerging oversupply of emission allowances on the EU carbon market, the European Commission cited several problems[13] associated with the credits generated by the Clean Development Mechanisms (CDM) and Joint Implementation (JI) as reasons to propose a domestic emission reduction target without relying on those credits. More specifically, the proof of additionality and credible baselines[14] are notoriously difficult to establish. There were also serious concerns about transparency. The European Commission also found[15] a potential for excessive rents and perverse incentives, in addition to concerns about the unequal geographical distribution of projects and human rights. Finally, the EU developed a domestic target with no additional access to international credits to create investor certainty towards the level of reduction that will need to be achieved within the EU.

Since 2021, international credits may no longer be used for EU ETS compliance. This ensures that emissions are reduced domestically, safeguarding the environmental integrity of the system, and that oversupply is curbed, ensuring a more accurate carbon price.

**12** Carbon Market Watch, Additional profits of sectors and firms from the EU ETS 2008-2019, 2021.

**13** European Commission, COMMISSION staff working document accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A policy framework for climate and energy in the period from 2020 up to 2030', 2014.

**14** Öko-Institut e.V., How additional is the Clean Development Mechanism? Analysis of the application of current tools and proposed alternatives, 2016.

**15** EC DG Environment and Climate Action, Study on the Integrity of the Clean Development Mechanism (CDM), 2011.

## c. The CBAM and international credits

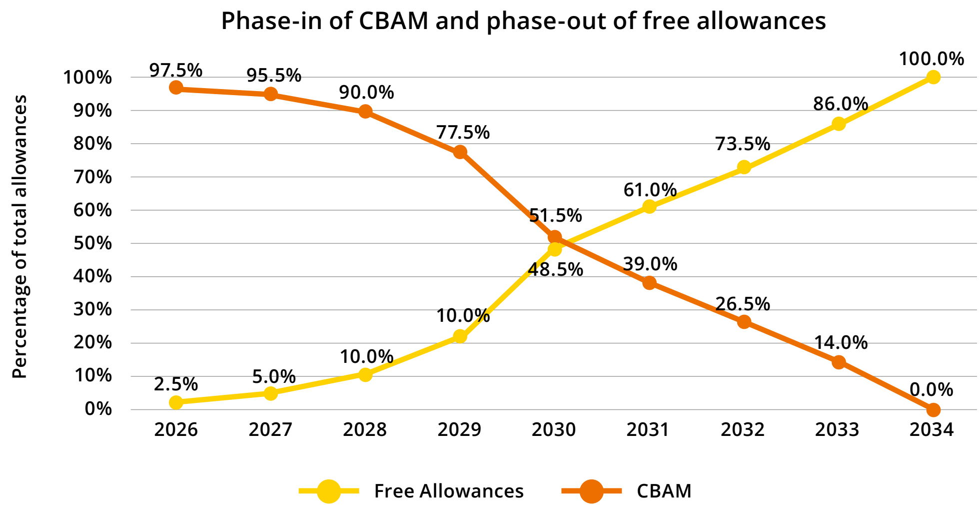
### i. Brief explanation of CBAM

The Carbon Border Adjustment Mechanism (CBAM) is a regulatory tool that applies a price at the EU border on the greenhouse gas content of imported products, matching the carbon price paid for similar products produced in the EU. CBAM will cover imported cement, iron and steel, aluminium, fertilisers, electricity and hydrogen, arriving from outside the EU.

The introduction of the EU CBAM is in response to concerns that rising internal EU carbon prices risk creating a competitive disadvantage for EU producers compared to non-EU producers that don't have to pay a carbon price. This might result in decreasing EU production or causing relocation to a country with laxer climate standards. Although this would reduce domestic emissions, it could result in increased emissions elsewhere. This potential outcome is known as "carbon leakage", and its prevention was the primary reason for the introduction of CBAM within the Fi -for 55 package.

The prevention of carbon leakage in the EU ETS has historically been addressed, as outlined above, by the instrument of free allocation of allowances. However, no proof of carbon leakage has been presented by EU policymakers to justify the introduction of these rules. Free allocation will be gradually phased out as the CBAM covers an increasing share of emissions for the selected products.

The figure below shows the agreed time plan for the phasing out of free allowances and the phasing in of CBAM.




Source: EU ETS 2023 reform model (Climact for Carbon Market Watch)

A second key reason for the introduction of CBAM is its potential positive influence on climate action beyond the EU. In the case of countries with carbon pricing, an importer will be able to deduct the carbon price already "effectively paid" in other jurisdictions from their CBAM requirements. To avoid their industry having to pay for CBAM, countries exporting to the EU can introduce their own carbon pricing system (with price rates matching the EU ETS), or direct investments to decarbonise their own production.

Starting in October 2023, a transitional two-year monitoring period required importers to submit quarterly reports for CBAM goods: the monitoring period provides an opportunity for policymakers to fine tune the regulation to avoid circumvention, plan future scope enlargement, and build capacity at national level for the definitive phase in during 2026.

### ii. CBAM's treatment of international credits

As the CBAM mirrors the functioning of the EU ETS, international offsetting credits are not going to be accepted as "allowances" during the pricing period, starting 2026. While several stakeholders are pushing towards international credits being taken for consideration under the mechanism, especially after the Article 6 of the Paris Agreement has been agreed upon, the current legislation only allows for CBAM certificates purchased through EU national authorities to be accepted.

A different issue is to what extent they will be "indirectly" accepted into the CBAM through the exception that will be granted to products that will be proven to have paid a carbon price in the country of production. Draft legislation due before the end of 2025 will outline the parameters to assess non-EU countries' carbon pricing systems. Some systems, such as the Korean ETS (K-ETS) or the South Africa carbon tax, allow for international and/or domestic carbon credits. If costs for such credits will be accepted under the “carbon price effectively paid” exception, outlined in Article 9 of the CBAM Regulation, this could lead to offsets being indirectly accounted for in the carbon border scheme.

As explained above, the EU ETS does not accept such international credits. However, recently the EU has been investigating more the functioning of offsets and removals and tried to put boundaries to their developments, such as through the EU Carbon Removal Certification Framework (CRCF), and establishing a dedicated task force to investigate domestic compliance systems and voluntary markets. The EU was also heavily involved in the Article 6 of the Paris Agreement negotiations. It will be essential for the environmental integrity of the CBAM that if a carbon pricing system accepts or partially accepts international credits, that this is deducted by

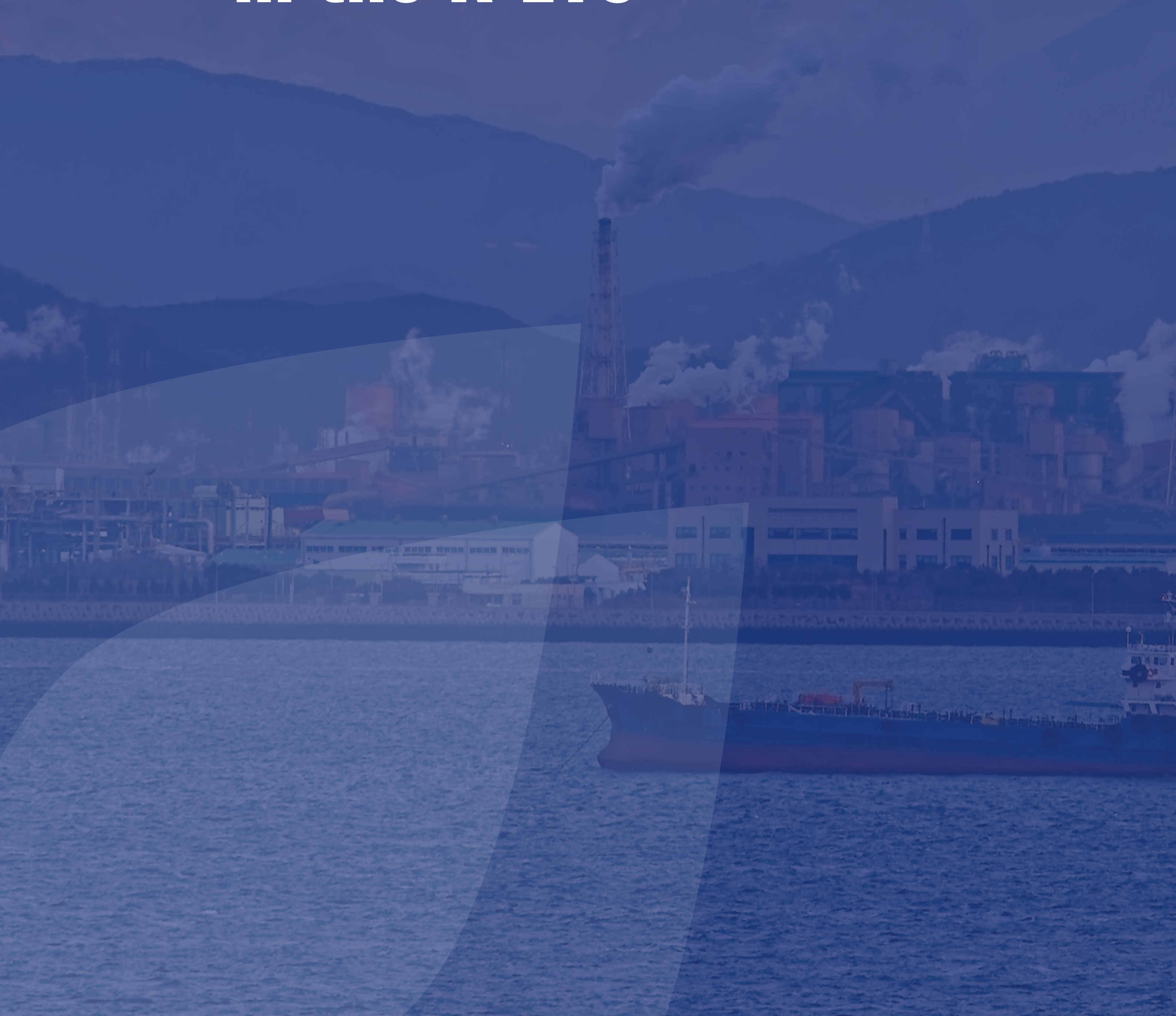
EU national authorities when calculating the "carbon price effectively paid" by a product in the country of production - as international credits price do not provide enough guarantees in terms of reliability and additionality.

## 3. Recommendations for international credits

- International offsetting has no place in emissions trading systems like the EU ETS because they weaken the market, undermine climate targets, and distract from necessary investments.
- Do not include international offsetting credits under the CBAM, not even indirectly. EU secondary legislation for the CBAM needs to properly account for the percentage of international credits entering a country's carbon pricing system, and subsequently exclude that percentage from the amount to be deducted from the payment of the border carbon levy. This should discourage inclusion of international credits under a domestic ETS, on top of preserving the environmental integrity of the CBAM.

Chapter TWO

# Credit quality of international credits in the K-ETS



# Credit quality of international credits in the K-ETS

## 1. Cookstove projects

### a. Introduction

Cookstove projects are designed to reduce greenhouse gas (GHG) emissions that arise from the combustion of fuels to prepare food. These projects can also often have social and environmental co-benefits, such as reducing the time and expense needed to collect fuel, not to mention smoke reduction.

Reduced GHG emissions are delivered by replacing inefficient cookstoves with more efficient ones, and sometimes replacing the type of fuel being used, such as switching biomass stoves for fossil gas or electric stoves. This reduces emissions by reducing the amount of tree and forest degradation from fuel wood collection and lowering the emissions of non-$CO_2$ gases from fuel combustion.

Traditional stoves in many parts of the world emit harmful pollutants, which are linked to severe respiratory problems and high premature mortality rates, especially in low-income communities. While most improved cookstoves reduce time and money spent on fuel and increase comfort from reduced smoke, only the clean stoves, only fossil gas or electric stoves reduce smoke enough to improve respiratory health.

Cookstove projects often struggle to be economically viable, and the sale of carbon credits provide critical funding. Cookstove projects entered the carbon crediting domain under the Clean Development Mechanism (CDM). Today many cookstove projects generate carbon credits which are sold on the voluntary carbon market. The standards certifying these projects include the Verified Carbon Standard (VCS) by Verra, Gold Standard (GS), and the CDM. While Verra and Gold Standard have developed their own methodologies, both registries also allow project developers to use CDM methodologies, which are the most widely used to date. The emission reduction benefits are measured in so-called "tonnes of $CO_2$ equivalent" ($tCO_2e$), a widely-applied metric for emission reduction units sold on the voluntary carbon market (VCM) and other international carbon pricing systems. It is a metric that merges the several greenhouse gases on the basis of their potential to heat up the atmosphere, i.e. their global warming potential.[16]

Cookstove projects are a fast-growing project type that constitute almost 8% of all projects on the voluntary carbon market.[17] They have been subject to serious scrutiny with regards to the underlying quantification methods used to generate emission reduction certificates. Concerns have arisen regarding the accuracy of emissions reductions claimed by cookstove projects. A recent study led by Annelise Gill-Wiehl,[18] which appeared in Nature Sustainability, examined multiple methodologies, including those from Gold Standard and the CDM. As of October 2024, most projects on the VCM  used the AMS-II.G methodology (see box) to certify their emission reductions.[19] Many CDM projects have simultaneously applied to transition to the Article 6.4 mechanism under the Paris Agreement to continue their projects under the same CDM methodologies the project used before. A separate analysis has shown that the first batch of credits approved to transition are likely over-credited by a factor of 27. This does not set a good precedent for the environmental integrity of the Article 6.4 mechanism.[20]

With the South Korean government reviewing the role of international credits in the Korean emissions trading system (K-ETS), it has become evermore important to understand the implications of allowing their use in the compliance scheme at all. The biggest project type that could inflate the K-ETS is cookstove projects.

In this chapter, we draw from existing peer-reviewed analysis to assess the risk of over-crediting in cookstove projects that were approved by the Korean government for use under the K-ETS.

We have applied Gill-Wiehl's methodology for the analysis of over-crediting in cookstove projects to the sample of cookstove projects that have supplied credits to companies under the K-ETS and are eligible for trade under the scheme. Understanding the risk of over-crediting in these projects will shed light on the potential threats low-quality credits pose to national emissions trading schemes, such as the K-ETS.

Here, we examine the over-crediting risks of cookstove projects. We explain the possible issues that arise with the quantification of emission reductions in cookstove projects, the methodology

16 Eurostat, Glossary: Carbon dioxide equivalent - Statistics Explained, 2024

17 Berkeley Carbon Trading Project, Voluntary Registry Offsets Database, 2024.

18 Gill-Wiehl et al., Pervasive over-crediting from cookstove offset methodologies, 2024.

19 Berkeley Carbon Trading Project, How methodologies estimate emissions reductions, 2024.

20 Carbon Market Watch, Results Over-crediting analysis PoA 10415, 2025.

and approach we used to analyse the likelihood of over-crediting in our sample, and outline the results of our analysis, followed by the implications thereof for the K-ETS.

## b. How the methodologies work

The present analysis focuses on two CDM methodologies: AMS-I.E and AMS-II.G. These are the methodologies used by the projects which have sold credits to Korean companies under the K-ETS.

AMS-I.E focuses on projects that switch from non-renewable biomass to renewable energy sources. AMS-II.G targets the use of more efficient biomass-based devices, such as improved cookstoves and ovens, to reduce fuel consumption.

Even though these methodologies differ in scope and emission reduction calculations, their risk for over-crediting is influenced by the same factors. In the following, the two methodologies are summarised. For more detail on the underlying equations and options for the determination of values, please refer to the official methodology documents for AMS-I.E[21] and AMS-II.G.[22]

### AMS-I.E

AMS-I.E replaces non-renewable biomass with renewable energy (e.g., renewable biomass, biogas, bioethanol, electric stoves).

Emission reductions are calculated by subtracting project and leakage emissions from baseline emissions, as visible in equation (1).

$$ER_y = BE_y - PE_y - LE_y \qquad \textbf{Equation (1)}$$

Both project and leakage emissions are straightforward values. Clear guidance is provided on how project emissions need to be determined, (and many projects claim to have no project emissions given the renewability of the project's fuel). Leakage emissions are either determined by location-specific surveys, or by applying a leakage adjustment factor (LAF) of 5%, in which case no survey is needed.

**21** UNFCCC, Small-scale Methodology Switch from non-renewable biomass for thermal applications by the user, 2022.

**22** UNFCCC, Small-scale Methodology Energy efficiency measures in thermal applications of non-renewable biomass, 2024.

The baseline emissions calculation, on the other hand, is important to unpack. Baseline emissions are calculated as follows:

$$BE_y = B_y \times f_{NRB,y} \times NCV_{biomass} \times EF_{projected\_fossil\_fuel} \quad \textbf{Equation (2)}$$

Baseline emissions are the factor sum of the saved biomass which is replaced by the project ($B_y$), the fraction of non-renewable biomass in the project area (fNRB), the net calorific value of the biomass ($NCV_{biomass}$), and an emissions factor of a fossil fuel ($EF_{projected\_fossil\_fuel}$).

$B_y$, referred to as $B_{savings}$, is defined as the "*Quantity of woody biomass that is substituted or displaced in year y (tonnes)*". To determine this value, projects can either

- Back calculate baseline fuel consumption from project fuel use assuming the equivalent energy would have been used in the baseline by the less efficient baseline stove. Projects can establish project fuel by conducting kitchen performance tests (KPT), survey use or use a CDM approved location-specific value, or

- Multiply the number of households[23] *using the new cookstoves by the average amount of wood each household would have used in a year if they weren't part of the project*. The project also should subtract out of $B_y$ any continued use of woody biomass used in pre-project devices.

  Once $B_y$ is established, the value is multiplied by the other values in equation (1) to determine the baseline emissions. From these, project emissions and leakage emissions are deducted to determine the emission reductions generated by the project.[24]

23 This calculation can also be done on the per capita level, where the amount of people that are part of the same household, or the amount of people served by an institution (e.g. a restaurant) is multiplied by the total number of households or institutions.

24 Equation (1) and Equation (2) are based on Equation (11) and Equation (1) of 'Small-scale Methodology Switch from non-renewable biomass for thermal applications by the user' published by UNFCCC in 2022, respectively.

### AMS-II.G

This methodology awards credits to projects that substitute traditional cookstoves with improved biomass cookstoves (using wood, charcoal, pellets, etc.), ovens, or dryers, and is tailored for smaller-scale projects.

Emission reductions are calculated by subtracting leakage emissions from emission reductions, as visible in equation (1).

$$ER_y = \sum_i \sum_j ER_{y,i,j} - LE_y \qquad \text{Equation (1)}$$

As under AMS-I.E, applying a LAF of 5% eliminates the need for a survey to determine leakage emissions.

Emission reductions are determined as follows:

$$ER_{y,i,j} = B_{y,\text{savings},i,j} \times N_{\text{o},i,j} \times n_{y,i,j} \times \mu_y \times f_{\text{NRB},y} \times NCV_{\text{biomass}} \times EF_{\text{projected\_fossil\_fuel}} \qquad \text{Equation (2)}$$

Emission reductions are the factor sum of the saved biomass replaced by the project ($B_{y,savings}$), the number of cookstoves in the project (N), the proportion of operational cookstoves in the project (n), an adjustment for the continued use of pre-project devices (μ), the the fraction of non-renewable biomass in the project area (fNRB), the net calorific value of the biomass ($NCV_{biomass}$), and an emissions factor of a fossil fuel ($EF_{projected\_fossil\_fuel}$).

To calculate $B_{y,savings}$, projects can choose between four options:

1. **Establishing the Thermal Energy Output**, where the thermal output of new cookstoves is converted into saved biomass with the efficiencies of old and new stoves and the nominal caloric value of biomass.
2. **Conducting a kitchen performance test (KPT)**, where By,savings constitutes the difference between the biomass consumption before the project and the total biomass consumption after the project (from all stoves) determined through a KPT
3. **Conducting a water boiling test (WBT)**, where $B_{y,savings}$ is the product of old and new efficiencies and the biomass consumption of either project or pre-project devices.

4. **Conducting a controlled cooking test (CCT)**, where $B_{y,savings}$ is the product of the biomass consumption in a pre-project setting and the ratio of the specific consumptions of the project and baseline stove.

Once $B_{y,savings}$ is established, the value is multiplied by the other values in equation (2) to determine the emission reductions. If no LAF is applied (to $B_{y,savings}$), leakage emissions are then deducted to determine the emission reductions generated by the project.

## c. Quantification issues

Overcrediting occurs when more credits are issued than actual emissions reductions achieved, thus undermining the climate benefits of the credits sold on the carbon market.

For cookstove projects, as mentioned above, the risk of over-crediting is influenced by the same factors for both AMS-I.E and AMS-II.G. In the following, we outline some of the factors that increase the risk of over-crediting. A more detailed explanation of how methodologies use these factors to calculate emission reductions is provided in both the academic paper and on a website.[25]

### i. Fuel consumption scenarios

Permissible methods for obtaining both baseline and project scenario fuel consumption can result in over-crediting. AMS-II.G and AMS-I.E allow projects to estimate the baseline fuel through a default value of 0.4 to 0.5 tonnes of firewood per person per year, the project developer's own survey, national survey or literature data, or a kitchen performance test (KPT), which is rarely chosen. While the default value of 0.4 to 0.5 tonnes of firewood per person per year remains within a range deemed reasonable according to the academic literature,[26] many projects apply values exceeding this reasonable range of fuel consumption through other means of determination, such as project or national survey data. Project-led and national fuel

**25** Berkeley Carbon Trading Project, How methodologies estimate emissions reductions, 2024. and Berkeley Carbon Trading Project, Results & Quality Factors, 2024.

**26** Daioglou et al., Model projections for household energy use in developing countries, 2012.

consumption surveys are vulnerable to biases as individuals struggle to estimate kilograms of biomass, resulting in estimates outside typical ranges.

For project fuel consumption (i.e., the fuel consumption after the introduction of the improved or clean stove), AMS-II.G allows projects to conduct KPTs (rarely chosen) or multiply the baseline consumption by the difference in efficiencies between the project and baseline devices and survey for any usage of the baseline stove. In AMS-I.E, projects can conduct KPTs (never chosen) or survey for project fuel usage. The simple surveys prescribed by the methodologies and commonly used by project developers have limitations that can lead to a smaller value for the project scenario fuel consumption. This can be a factor in over-crediting.

The ideal means to determine baseline fuel consumption under the CDM methodologies would be KPTs in a sample of households in the project area that takes account of the Hawthorne effect, where users change their fuel consumption choices while under observation. The overestimation of the baseline fuel consumption results in over-crediting because estimated fuel savings increase with a higher baseline.

To capture fuel consumption in the project scenario, the best practice is to measure fuel consumption directly, with fuel purchase receipts or meters. Ethanol projects under AMS-I.E could easily take this approach. It is harder for biomass projects under AMS-II.G, as firewood and charcoal is collected, made at home, or purchased in various unweighed quantities. In this case, AMS-II.G should also pursue discounted KPTs.

### ii. Stove efficiencies

Under both AMS-I.E and AMS-II.G, laboratory tests can be undertaken to determine the efficiency of improved cookstoves, and default values may be used to determine the efficiency of baseline cooking systems. According to Gill-Wiehl, default values for baseline stove efficiencies are lower than those typically reported in the literature. Additionally, the efficiencies of project stoves in the real world are seldom as high as laboratory results suggest. Both of these factors would hence contribute to over-crediting.

### iii. Adoption, usage and stacking

Efficient cookstove initiatives achieve emission reductions based on three key factors, all of which can lead to over-crediting if misapplied. First is the extent of 'adoption', which refers to the proportion of distributed stoves actively being used. Second is the level of 'usage', which measures the extent to which adopted stoves are used, often as the percentage of meals prepared with the project stove. Third is the extent of 'stacking', which refers to the continued use of baseline stoves alongside the project stove. This can occur, for example, to prepare meals faster by using multiple pots simultaneously.

If reduced usage of project cookstoves or drop-outs are not considered, the likelihood of over-crediting increases. The same is true for stacking, especially in cases when old stoves continue to be used for 100% of meals cooked. We need to account for the emissions from the baseline stove to accurately estimate emission reductions.

AMS-I.E and AMS-II.G require the project developer to conduct cross-sectional surveys for monitoring adoption and stacking, and allow the surveys to also be used to monitor usage rates. These surveys are prone to bias, such as “desirability bias”, where households claim that they use stoves more than they actually do because they do not want to be perceived negatively by the distributor of these stoves. In addition, survey results are sometimes simply not taken into account in the final calculation. All of which can result in over-crediting.

### iv. Rebound effect

Some households increase their overall energy consumption when they acquire a more efficient stove. This is called the “rebound effect”, which occurs when cost savings, time savings, or convenience from a more efficient device results in increased use of that device, undoing some of the gains from improved efficiency. This can happen if households use their stoves more frequently or less carefully due to the perceived efficiency and lower operating costs.

Only projects that track fuel usage through kitchen performance tests (KPTs) can directly monitor rebound effects, as this is the sole method currently in use that measures fuel consumption from every stove in a household. Other monitoring methods fail to capture the rebound effect and this omission is a likely source of over-crediting. As projects under AMS-I.E and AMS-II.G are not required to conduct KPTs and rarely chose to, projects under these methodologies rarely capture this rebound effect.

### v. Fraction of non-renewable biomass

Another important quality factor for the calculation of emission reductions in cookstove projects is the fraction of non-renewable biomass (fNRB). Credits should only be generated for reducing emissions from cookstoves if the biomass they save would not have naturally decayed and released carbon dioxide into the atmosphere without the cookstove project. Fallen branches, dead wood, or agricultural waste (such as corn husks) on the forest floor are examples of “renewable” biomass whose $CO_2$ emissions should not be credited. “Non-renewable” biomass, the creditable portion of biomass, constitutes the fraction of biomass collection that does not grow back at the current rate of collection. The CDM only generates credits from the portion of biomass collection that would not grow back. Note that fNRB only applies to $CO_2$ emissions; the CDM issues credits for any reduction in non-$CO_2$ gases regardless of whether the biomass is renewable.

fNRB values vary widely between project areas, since they depend on geographical and physical conditions. The choice of fNRB value directly impacts credits generated under AMS-I.E and AMS-II.G. The bigger the fNRB value (i.e. the more "non-renewable" biomass the project area entails), the more credits the project will issue.

Currently, projects under AMS-I.E and AMS-II.G may calculate their respective fNRB values with a CDM tool,[27] which, unfortunately, is likely to overestimate the value compared to the scientific literature, due to an overestimation of forest degradation inherent in the CDM tool. The best practice is to use the latest literature-derived fNRB values from Modeling Fuelwood Sustainability Scenarios (MoFuSS), a dynamic landscape model that provides fNRB values for different regions. If the project location isn't listed on the MoFuSS map, Bailis's[28] "Scenario B-Low Yield" values should be used. Where MoFuSS or Bailis values are unavailable, project developers should opt for a conservative 30% fNRB value, which is rarely chosen by project developers.[29]

### vi. Leakage

To issue carbon credits to cookstove projects, emission reductions are adjusted to account for leakage. When project households reduce their biomass consumption for cooking, that unused biomass may become available for use by non-project households. If the project indirectly causes increased emissions elsewhere, such as through higher biomass use by neighbouring households, this effect is known as leakage, and will reduce the overall climate benefit of the project.

Projects under AMS-I.E and AMS-II.G may choose between surveys and the application of a default factor of 5%, referred to as a 'leakage adjustment factor' (LAF). In other words, the default factor assumes that 5% of achieved emission reductions are offset by an increase in emissions outside of the project. Many projects apply the default factor, whereas real leakage might be higher (or lower) than the default factor suggests. As suggested by Gill-Wiehl, this factor requires further research. The use of the default factor could hence be a source of over- or under-crediting.

**27** UNFCCC, Calculation of the fraction of non-renewable biomass, 2024.

**28** Bailis et al., The carbon footprint of traditional woodfuel, 2015.

**29** Berkeley Carbon Trading Project, Results & Quality Factors, 2024.

### vii. Emission factors (EFs)

All cooking fuels emit both $CO_2$ and non-$CO_2$ gases during use, and all,except for collected firewood, also generate upstream emissions. To calculate the emission reductions from more efficient cookstoves, it's necessary to convert the differences between baseline and project fuel consumption into greenhouse gas (GHG) emissions by applying emission factors (EFs) specific to each fuel type. EFs play a crucial role in these calculations, meaning that how each methodology applies them can significantly affect the number of credits a project can generate.

The CDM approach to EFs (both AMS-I.E and AMS-II.G) is somewhat counterintuitive. Instead of using the EFs from the biomass fuel being reduced by the project, the CDM applies a proxy value representing the emissions that would have occurred if fossil fuels had been used as cooking fuel in the baseline scenario. This baseline factor, called a "projected fossil fuel" emission factor, is based on the assumption that households might transition to fossil fuels down the line. The emission factor of fossil fuels, which is a regional average for kerosene, liquefied fossil gas, and coal, is lower than that of non-renewable biomass. Therefore, the CDM, in this instance, actually takes a conservative approach that ultimately reduces the total credits a project can receive (under-crediting).

### viii. Charcoal firewood conversion

Under the AMS-I.E and AMS-II.G methodologies, projects can convert charcoal into firewood in order to calculate the emission reductions with one value. This is done mostly to simplify calculations, but it means that the final result will be less accurate and representative of the real project impact. This is done with a conversion factor that is determined by either national or regional surveys, a default value found in the CDM methodological TOOL33, or based on a sample of tests of kilns.

When this conversion factor is set too high, the actual amount of charcoal used in the baseline scenario is converted into an excessive equivalent of firewood. This overestimation can result in inflated values, potentially leading to over-crediting within the project.

## d. Methodology and approach

We employed the methodology used by Gill-Wiehl's team to assess the over-crediting of cookstove projects and credits that have been purchased by Korean companies and which are eligible under the K-ETS. Since the project sample utilised the studied methodologies (AMS-II.G and AMS-I.E), we used the University of California, Berkeley (UCB) analysis to calculate the extent of over-crediting in these cases. By following this scientific approach, we ensured that our findings are robust and can be confidently applied to inform real-world policy scenarios, particularly as they pertain to the integrity of credits within the K-ETS.

### i. Sample

We analysed 310 component project activities (CPAs) generating credits under 21 programmes of activities (PoAs) registered with the Clean Development Mechanism (CDM) that have supplied South Korean companies with credits for use under the Korea Emissions Trading Scheme (K-ETS). Within the CDM framework, projects are organised as PoAs, which are further divided into CPAs. This structure is particularly advantageous for multiple smaller projects that - if bundled under PoAs - have a smaller administrative and financial burden. The total credits issued for a PoA are the aggregated credits from all of its CPAs.

Credits are generated for each monitoring period. Project developers can choose how often they request credit issuance. To request credit issuance, the developer must calculate the greenhouse gas reductions achieved by the project since the last monitoring period or the start date of the project, according to its monitoring plan, and have its calculations verified by a third party verifier. The monitoring plan is defined in the initial project description document and outlines how all data and methods used to calculate project emissions reductions are collected and reported,  following the requirements of the chosen methodology.

We analysed the risk of over-crediting in 310 CPAs from different monitoring periods. We only included monitoring periods for credits that were purchased by South Korean companies and were eligible under the K-ETS.

Almost all (20 out of 21) PoAs in our sample have applied to transition to the Article 6.4 mechanism with the same methodology as before.[30] The decision on their transition is pending (see Info Box in chapter one in procedure of transition).

### ii. Analysis

Our first step in assessing over- or under-crediting in project emissions reductions (ERs) was to recalculate the credits using data points from project documentation. Once we successfully recreated the project credits, we systematically adjusted all factors contributing to potential over- or under-crediting, replacing them with the best-available literature values used by Gill-

30 UNEP-CCC, Article 6 Pipeline - UNEP-CCC, 2024.

Wiehl's research team. We estimated each PoA's over-crediting across CPA's monitoring reports, then applied that to their total issued credits and compared our total ER estimate with their total issued credits. That is, we calculated the total amount of over-crediting, weighted by issued credits, rather than a straight average.

For example, in AMS-II.G projects, the ER calculation formula is:

$$ER_{y,i,j} = B_{y,\text{savings},i,j} \times N_{\text{o},i,j} \times n_{y,i,j} \times \mu_y \times f_{\text{NRB},y} \times NCV_{\text{biomass}} \times EF_{\text{projected\_fossil\_fuel}} \quad \textbf{Equation (2)}$$

The factors for this are, in the order in which they appear in the formula:

- fuel savings: the saved biomass or fuel which is substituted by the project
- the number of stoves distributed in the CPA
- the adoption rate: the proportion of distributed stoves actively being used
- the stacking rate: the continued use of baseline stoves alongside the project stove
- the fNRB value: the portion of biomass collection that would not grow back
- the net calorific value of the non-renewable woody biomass
- the emissions factor of a projected fossil fuel
- the fraction of year the monitoring period constitutes to determine the exact amount of emission reductions in the monitoring period

Following Gill-Wiehl's methodology, we adjusted each of these factors to align with the most recent science. As an illustrative example, the fNRB value in a hypothetical project could be listed as 0.9 in the project documentation, while the scientific literature might determine a more accurate estimate of 0.45. This adjustment alone would indicate a notable likelihood of a twofold over-crediting of the $CO_2$ portion.

We conducted an aggregate analysis to determine total over-crediting for the projects. Additionally, we ran separate analyses to isolate the influence of specific factors (such as only adjusting the fNRB value to match published literature) to quantify each factor's contribution to total over-crediting.

As outlined in the Gill-Wiehl study, to maintain academic rigour, we present over-crediting as a "likely" outcome. Since direct ground measurements of these past emissions were impossible, the analysis relies on literature values as the most realistic evidence available. These literature-based adjustments suggest that project X is likely to over-credit by Y.

The code we used to run the analysis (and all the data used for the Gill-Wiehl study) are publicly available online.[31] Please also refer to the supplemental information[32] for further details of their analysis.

## e. Results

Our analysis finds that, together, the analysed projects likely issued 18.3 times more credits than the actual emissions reductions they caused.

The projects in our analysis issued a total of 9,740,302 credits, representing some 9.7 million $tCO_2e$, while our analysis finds a total impact of only ~531,979 $tCO_2e$. Across our sample, simple and biased methods to establish fNRB and stacking rates emerged as the primary driver of over-crediting. In descending order of impact, the other contributing factors were usage, fuel consumption, and adoption. Conversely, emissions factors produced under-crediting in the AMS-I.E and AMS-II.G methodologies.

The detailed findings are outlined below, beginning with an analysis of the likelihood of total over-crediting across the entire sample. This is followed by a country-level breakdown to assess regional differences in total over-crediting and concludes with an examination at the programme of activities (PoA) level to identify project-specific factors.

### i. Overall assessment of over-crediting

- **Fraction of Non-Renewable Biomass (fNRB)**

fNRB values higher than the latest modelled values were a significant contributor to over-crediting, accounting for an average 2.4-fold increase when isolating the factor. While projects either used their own fNRB values or relied on the CDM Tool, our analysis applied the most robust fNRB approach available: the MoFuSS model (Modeling Fuelwood Sustainability Scenarios),[33] which accounts for dynamic landscape changes. At the time of the Gill-Wiehl study,

**31** Gill-wiehl, GillWiehl_et_al_Pervasive_over_crediting, 2024.

**32** Gill-Wiehl et al., Supplemental Materials for Pervasive over-crediting from cookstove offset methodologies, 2024.

**33** Ghilardi et al., Spatiotemporal modeling of fuelwood environmental impacts: Towards improved accounting for non-renewable biomass, 2016.

only a few MoFuSS values were available. They therefore used the WISDOM model, an earlier model of MoFuSS. However, they suggested any future work should use the MoFuSS analysis.

Historically, methodologies used default fNRB values from the CDM which have now expired. In the absence of these defaults, projects had the option to calculate fNRB using the CDM tool or assume a 30% default value, which is rarely selected. However, both the earlier defaults and the tool overestimate forest degradation compared to values found in published literature, leading to over-crediting.

- **Stacking**

Stacking ratios contribute the second-most significant cause of over-crediting, with an average likelihood of over-crediting of 2.4 times. Projects report stacking rates of 4.03% on average, compared to an average of 68% observed in empirical studies. Stacking, where households continue to use baseline stoves alongside improved stoves, is significantly under-reported due to simple surveys that do not factor in social desirability and recall biases. In an effort to not disappoint project staff that gave them a free or subsidised stove, households may understate or fail to disclose their continued reliance on traditional stoves. To align stacking rates with more reliable evidence, the Gill-Wiehl study prescribes that we substitute the reported values with literature-based data using a triangular distribution with a mean stacking rate of 68% (ranging from 19.3% to 100%). This adjustment better reflects the persistence of baseline stove usage in real-world conditions.

- **Usage**

When singling out usage rates, we discovered that projects were likely issuing 1.8 times more credits than their actual climate impact. Project-reported usage rates are 86.95% on average, which contrasts sharply with the average usage rate found in the research studies. The methodologies' default surveys attribute 100% stove usage to any household that reports using the improved stove at all during the survey period, disregarding the actual proportion of meals cooked on the improved stove versus alternative cooking methods. These simplistic methods lead to inflated usage rates and fail to reflect real-world behaviour, such as inconsistent or partial use of project stoves, which is well documented in the literature. To correct for this, Gill-Wiehl and her team adjusted usage rates to align with the literature's more conservative and empirically derived values, using a triangular distribution with a median value of 52% (ranging from 16% to 85%).

- **Adoption**

Our analysis indicates that adoption rates contribute to over-crediting of 1.6 times the actual climate impact of the sample projects. This stems from inflated adoption rates reported, with many projects claiming rates on average of 98.71%, compared to the 58% average documented in independent empirical studies. The methodologies they employed rely on infrequent surveys prone to social desirability and recall biases, often asking households whether they used the improved stove in the last week or month. These simplistic questions fail to account for partial or inconsistent use of the stoves over the entire crediting period. To address this, the Gill-Wiehl study replaced the self-reported adoption rates with a range of more realistic values drawn from rigorous empirical studies (58% (min: 40%, max: 92%).

- **Fuel consumption**

Inaccurate baseline or project fuel consumption values likely lead to overestimations of fuel savings from the introduction of cookstoves by a factor of 1.8. The two methodologies we examined (AMS-II.G and AMS-I.E) use different approaches to estimate the difference between baseline and project fuel consumption. As outlined earlier, AMS-II.G estimates baseline fuel use first and calculates savings based on stove efficiency differences and surveyed adoption and usage rates. AMS-I.E starts with project fuel use and back-calculates the baseline consumption assuming the baseline stove would have used equivalent energy. Both methodologies provide projects with several options for determining key inputs, including default values, surveys, or national data, but these can be influenced by biases like social desirability and recall errors. As a result, baseline and project fuel consumption values may be inaccurately high or low. To address this, the Gill-Wiehl study prescribes that we adjust these values to fall within a more reasonable, literature-based range of 2-4 MJ of energy consumption per capita per day.

- **Rebound effect**

The rebound effect likely contributes to over-crediting by a factor of 1.3. Households often increase their overall cooking energy consumption when they gain access to an improved stove, as the stove reduces the ‘cost’ of cooking and provides an additional burner, which can encourage more frequent use of cooking energy. Only projects that use kitchen performance tests (KPTs) capture this increase in fuel consumption. AMS-I.E and AMS-II.G do not require projects to conduct KPTs and, thus, no project in our sample took this approach. For projects that do not use KPTs, the Gill-Wiehl study’s approach cuts the emission reduction estimates by 22%, based on published literature that tracks changes in total energy use before and after the adoption of an improved or clean stove.

- **Charcoal and firewood conversion**

Conversion factors for charcoal to firewood likely led to no overcrediting. Both methodologies in our sample allow projects replacing charcoal to use a firewood-to-charcoal conversion factor. This factor treats charcoal as if it were firewood and allows the projects to estimate the amount of firewood needed to produce the equivalent weight of charcoal. Historically, the methodologies set the default conversion factor to be 6, but updated the default to 4 in 2022, based on the scientific literature. Projects however are able to argue for the use of a higher conversion factor. Some projects used conversion factors of 4.8 or higher. However, conversion efficiency is highly dependent on location and charcoal production practices. Instead of using a fixed conversion factor, the Gill-Wiehl study's approach applies separate emissions factors for charcoal and firewood, using charcoal upstream and point-of-use EFs from Floess.[34] This factor has no overall effect on the total amount of over-crediting, as the projects that use the high charcoal conversion factors have proportionately less verified credits within our sample.

- **Emission factors (EFs)**

Notably, CDM cookstove methodologies apply a baseline emission factor that assumes future fossil fuel use instead of biomass, which contributes to total under-crediting (0.6x in our sample). AMS-I.E and AMS-II.G apply fossil fuel-based EFs to the biomass fuel used in cookstove projects, which does not accurately reflect the emissions reductions achieved. The Gill-Wiehl analysis corrects for this kind of error by using the latest, most comprehensive cooking fuel-specific EFs, including those for upstream emissions, and updating global warming potentials to the most recent IPCC values.

### ii. Country-level variations in over-crediting

The level of over-crediting in cookstove projects varies significantly by country due to differences in the fraction of non-renewable biomass applied. Table 1 below highlights the range across countries, with values expressed as the total amount of over-crediting. These variations underscore the importance of tailoring fNRB values to the best available data. Countries such as Guatemala, Fiji, and Cambodia exhibit the highest levels of over-crediting, while others like Kenya, Ghana, and Nigeria show comparatively lower, yet still significant, levels of misrepresentation. This analysis emphasises the need for more accurate fNRB values to reduce discrepancies in reported carbon savings.

34 Floess et al., Scaling up gas and electric cooking in low- and middle-income countries: climate threat or mitigation strategy with co-benefits?, 2023.

**Table 1 - Country-level total over-crediting results**

| Country | Times over-credited | Country | Times over-credited | Country | Times over-credited |
|---|---|---|---|---|---|
| Bangladesh | 20.2 | Guatemala | 67.9 | Myanmar | 21.8 |
| Burundi | 22.0 | Kenya | 11.3 | Nigeria | 16.3 |
| Cambodia | 36.1 | Lao | 36.1 | Uganda | 19.0 |
| Fiji | 54.1 | Madagascar | 47.3 | Viet Nam | 29.9 |
| Ghana | 14.4 | Malawi | 17.8 | Zambia | 17.1 |

### iii. Over-crediting in programmes of activities (PoAs)

When we evaluate the total over-crediting stratified by programme of activity, we find considerable variation, with some PoAs overstating emission reductions by a multiple of up to 67.9 times. Table 2 below highlights the variations in over-crediting, detailing the project developers, methodologies, total verified credits, the degree of total over-crediting we found, and the correct number of credits we found that should have been justifiably issued to the project. Projects in our sample were over-credited by a factor of 18.3, due to the difference between the total verified credits claimed by the project and the total credits derived from our analysis (9,740,302/531,979 = 18.3).

We reached similar results to the Gill-Wiehl study regarding ethanol projects (under the AMS-I.E). We found they were less over-credited (with over-crediting levels by a factor of roughly 5 to 10 times) than projects registered under AMS-II.G. This underlines how methodologies drive the discrepancies.

We also uncovered variations in PoA over-crediting within methodologies. PoAs such as 8480 Distribution of ONIL Stoves in Guatemala and 10497 Improved Cook Stove Programme in Fiji exhibit the highest levels of over-crediting. Others, like the Improved Cookstove Program in Bangladesh and Fuel Efficient Stoves in Zambia display comparatively lower levels. This discrepancy is due to several project specific factors, such as lower national or regional MoFuSS fNRB values, combined with inflated baselines and underestimated project fuel consumption values. Figure 1 depicts a breakdown of over-crediting by factor for the PoAs analysed.

**Table 2 - PoA level overview of over-crediting**

| PoA | Project participants | Project name | Protocol version | Total verified credits | Times over-credited | Total credits derived from analysis |
|---|---|---|---|---|---|---|
| 7359 | Samsung Electronics Co., Ltd., EcoEye Co., Ltd | PoA for the reduction of emission from non-renewable fuel from cooking at household level | AMS-I.E. ver. 4 | 335,266 | 9.6 | 34,757 |
| 8480 | EcoEye Co., Ltd., | Distribution of ONIL Stoves—Guatemala | AMS-II.G. ver. 11 | 253,768 | 67.9 | 3,738 |
| 10476 | EcoEye Co., Ltd., KOKO Networks Limited | KOKO Kenya – Ethanol Cookstoves Program | AMS-I.E. ver. 9 | 145,476 | 5.6 | 25,895 |
| 10497 | Korea Carbon Management Ltd. | Improved Cook Stove Programme in Fiji | AMS-II.G. ver. 10 | 81,289 | 54.1 | 1,502 |
| 10008 | International Carbon Portfolio | Installation of Energy Efficient Cookstoves in Myanmar | AMS-II.G. ver. 7 | 28,697 | 51.7 | 555 |
| 10443 | Korea Carbon Management Ltd. | Madagascar Improved Cookstove Project by KCM | AMS-II.G. ver. 9 | 421,788 | 47.3 | 8,914 |
| 10030 | EcoEye Co., Ltd. | Household energy appliance programme | AMS-II.G. ver. 6 | 45,067 | 36.1 | 1,248 |
| 10477 | Korea Carbon Management Ltd., | Vietnam Improved Cookstove Project by KCM | AMS-II.G. ver. 10 | 408,109 | 29.9 | 13,626 |
| 10415 | EcoEye Co., Ltd. | Clean Energy Program Supported by Republic of Korea CPA MM 02 | AMS-II.G. ver. 8 | 746,736 | 28.3 | 25,470 |
| 9265 | Korea Carbon Management Ltd. | Top Third Ventures Stove Programme | AMS-II.G. ver. 4 | 283,659 | 25.2 | 11,241 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7997 | International Carbon Portfolio | BioLite Improved Cook stoves Programme | AMS-II.G. ver. 11 | 101,116 | 22.1 | 4,582 |
| 10474 | EcoEye Co., Ltd. | Improved Cooking Stove Programme in Burundi supported by Republic of Korea | AMS-II.G. ver. 10 | 265,486 | 22.0 | 12,084 |
| 9956 | EcoEye Co., Ltd. | Up Energy Improved Cookstoves Programme, Uganda | AMS-II.G. ver. 12 | 295,982 | 18.4 | 16,082 |
| 10431 | EcoEye Co., Ltd., Korea Impact Canbon | Improved cookstove program in Bangladesh supported by the Republic of Korea | AMS-II.G. ver. 8 | 2,460,446 | 20.2 | 121,987 |
| 9007 | EcoEye Co., Ltd., Korea Impact Canbon | Distribution of Improved Cook Stoves in Sub-Saharan Africa | AMS-II.G. ver. 11 | 1,325,016 | 17.8 | 74,509 |
| 6864 | Korea Carbon Offsets Ltd., Korea Carbon Management Ltd. | Fuel Efficient Stoves in Zambia | AMS-II.G. ver. 11 | 73,463 | 14.1 | 5,208 |
| 5342 | CERPD | Improved Cooking Stoves Programme of Activities in Africa | AMS-II.G. ver. 3 | 180,099 | 16.3 | 11,024 |
| 10576 | Korea East-West Power Company. Co.Ltd., CERPD | Ghana Improved Cookstove Project by EWP in Republic of Korea | AMS-II.G. ver. 10 | 8,433 | 16.1 | 523 |
| 5341 | Envirofit International Ltd., CERPD | Improved Cooking Stoves Programme of Activities in Africa | AMS-II.G. ver. 3 | 166,265 | 14.6 | 11,385 |
| 10471 | Climate Change Center | The Project of CCC program of Activities (PoA) for Distribution of Improved Cookstoves (ICS) in Developing South and Southeast Asia Countries (Myanmar) | AMS-II.G. ver. 9 | 2,041,596 | 14.4 | 142,144 |
| 10430 | EcoEye Co., Ltd. | Man and Man Enterprise Improved Cooking Stoves CDM Programme in Ghana supported by Republic of Korea | AMS-II.G. ver. 8 | 72,545 | 13.2 | 5,505 |
| Totals | | | | 9,740,302 | 18.3 | 531,979 |

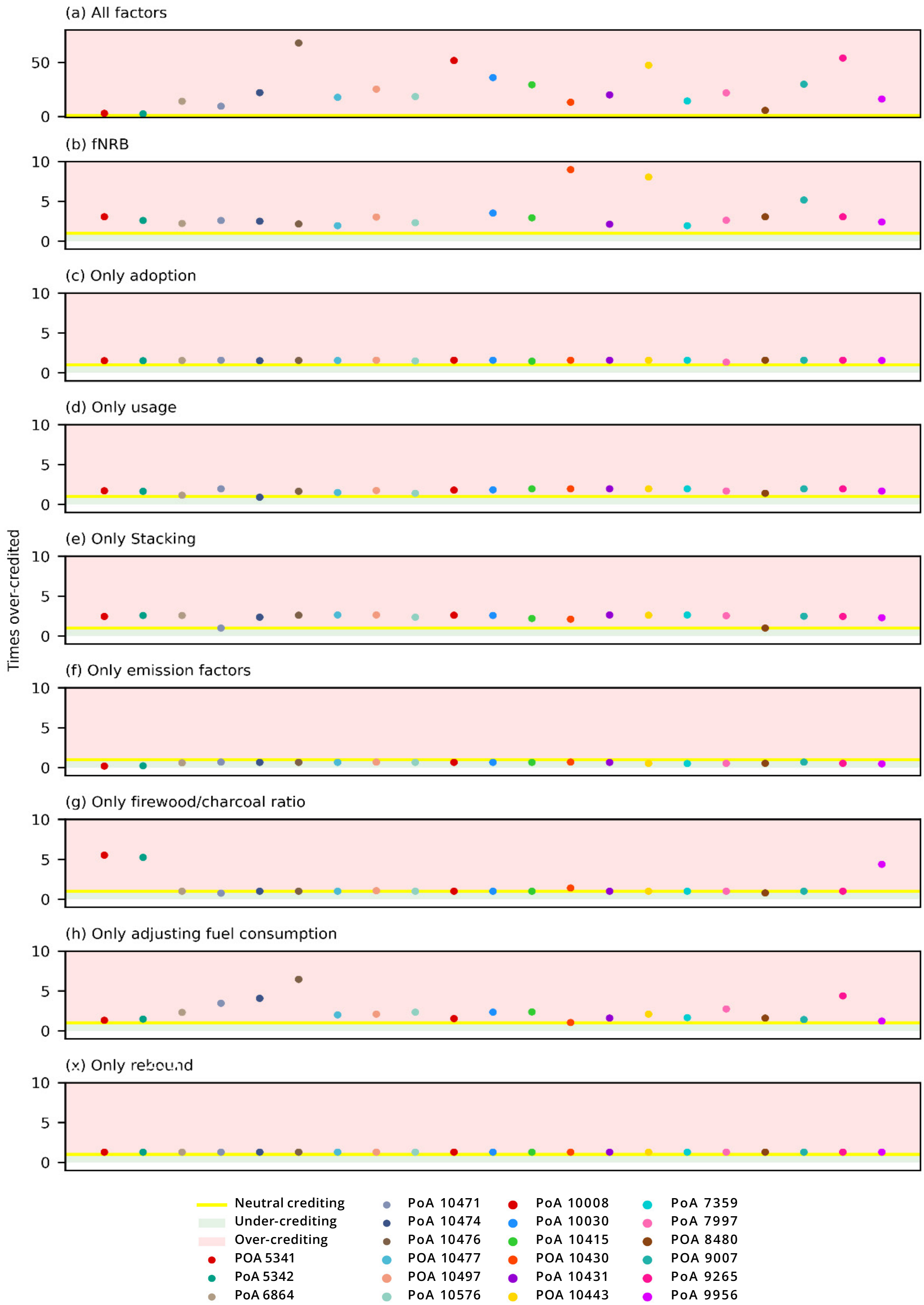



**Figure 1: Levels of crediting across factors**

The figure highlights the contributions of various factors to over-crediting in the PoAs under the AMS-II.G and AMS-I.E methodologies. The dominant driver of over-crediting across all PoAs is the fraction of non-renewable biomass (fNRB), with some PoAs experiencing extreme levels of over-crediting due to large differences between the project's estimated fNRB and the most recent MoFuSS value. Other factors, such as adoption, usage, and stacking, also contribute to over-crediting but to a lesser extent compared to fNRB values. Factors like emission factors, firewood/charcoal ratios, and adjustments to fuel consumption have minimal impact, with most PoAs remaining close to the baseline. Rebound effects show negligible contributions, suggesting they are very minor drivers of over-crediting. The results classify PoAs into categories of neutral, over-, or under-crediting, with the majority falling into over-crediting driven primarily by fNRB and stacking.

## 2. Literature review of hydropower and reducing gas leak projects

### a. Introduction

Despite its good intentions, the Kyoto protocol's Clean Development Mechanism (CDM) has faced considerable criticism due to its negligible climate impact. Most CDM credits, particularly those from large hydropower projects, which are widely regarded as "junk credits".[35] This label reflects the ineffectiveness of the carbon credits generated from this mechanism.

Currently, renewable energy projects constitute the largest proportion of CDM projects, making up more than 71% of total project activities.[36] Wind projects are most common, followed by hydropower projects, which represent 26% of the total project activities (PAs). However, the highest level of credit issuance for all CDM project types is hydropower, due to the typically larger scale of this type relative to others.

There are significantly fewer avoided gas leakage projects than hydropower projects, with only 21 projects currently listed on the mechanism, mostly located in Asia and Europe.

There has been widespread use of CDM credits in emissions trading schemes. For example, the K-ETS is one of Asia's largest markets incorporating CDM credits and focuses heavily on such projects as cookstoves, hydropower and reduced gas leakage. This review will explore the distribution and challenges associated with certified emission reductions (CERs) acquired under

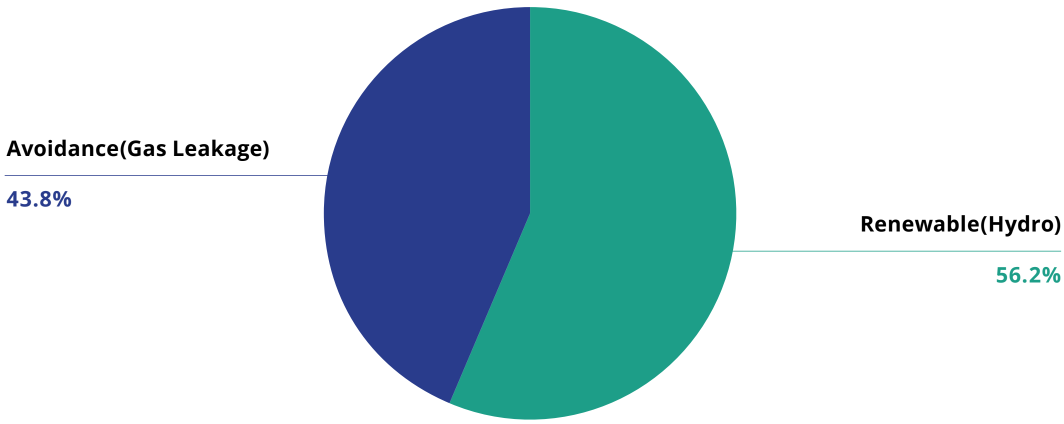
35 Haya, Carbon offsetting: An efficient way to reduce emissions or to avoid reducing emissions? An investigation and analysis of offsetting design and practice in India and China, 2010.

36 Carbon Market Watch, Hidden in plain sight: Flawed renewable energy projects in the voluntary carbon market, 2024.

the K-ETS, specifically from hydropower and gas leakage avoidance projects.

**Table 3 - Overview of certified emission reductions acquired under the K-ETS, by project type**

| Project type | Certified emission reductions (CERs) |
|---|---|
| Renewable (hydro) | 1,669,655 |
| Avoidance (gas leakage) | 1,302,731 |
| Total | 2,972,386 |




Source: CDM PoAs (Updated Oct 2024)

**Figure 2: Proportion of certified emission reductions acquired by project type**

Following cookstove, hydropower and avoided gas leakage projects are the second and third most purchased CDM project types by Korean companies participating in the K-ETS. Overall, nearly 3 million CERs were acquired, with the majority stemming from four hydropower projects located in Indonesia and Pakistan, and four gas leakage avoidance projects in Bangladesh (Table 2).

**Table 4 - Purchased Certified Emission Reductions (CERs) by Project**

| Projects | Certified emission reductions (CERs) |
|---|---|
| Wampu Hydro Electric Power Project | 617,710 |
| Semangka Hydro Electric Power Project | 360,836 |
| Hasang Hydro Electric Power Plant | 6,041 |
| Patrind Hydropower Project | 685,068 |
| Reducing Gas Leakages within the Pashchimanchal Gas Distribution Network in Bangladesh | 130,730 |
| Reducing Gas Leakages within the Karnaphuli Gas Distribution Network in Bangladesh | 291,902 |
| Reducing Gas Leakages within the Jalalabad Gas Distribution Network in Bangladesh | 378,078 |
| Reducing Gas Leakages within the Bakhrabad Gas Distribution Network in Bangladesh | 502,021 |

With the launch of the Paris Agreement's Article 6.4 mechanism, designed to replace the CDM, eligible CDM projects were given the opportunity to apply for transition last year. In total 1,424 project activities have applied for transition.

Notably, all eight projects purchased by Korean-based companies under the K-ETS have requested to transition. Under the Paris Agreement, host countries are responsible for ensuring that projects align with their national climate goals and the broader objectives of Article 6. It is now in the hands of these host countries to determine whether the projects can transition to the mechanism. This is despite the existence of scientific evidence that casts significant doubt on the ability of hydropower and avoided gas leakage projects to guarantee real emission reductions. Furthermore, recent developments in the ICVCM have assessed the eligibility of methodologies from these project types for the high-integrity Core Carbon Principle (CCP) label.

## b. Hydropower projects

Hydropower projects function by harnessing the energy from flowing or falling water to generate electricity. This process involves channelling water through turbines. As the water travels it spins the turbines, driving a generator that produces electrical power.

There are different varieties of hydropower projects. For example, run of river (RoR) hydropower projects rely on natural river flow without the need for a large reservoir or extensive damming, using the river's current to generate power and electricity. Storage hydropower projects utilise an already existing or newly constructed dam to store water in a reservoir, allowing for controlled release through turbines to generate electricity. Pumped storage hydropower uses excess electricity to pump water to an elevated reservoir during low demand, and releasing it to generate power during peak demand.

Currently, there are 2,198 hydro projects registered under the CDM. Most are RoR hydro projects including those purchased by companies under the K-ETS. Most of these CDM projects are located in China and India, while those purchased under the K-ETS are based in Indonesia and Pakistan.

### i. Challenges with Hydropower projects

- **Additionality**

Large-scale, grid-connected hydropower projects often find proving the additionality a challenge because the revenue they gain from carbon credits is so dwarfed by the total cost of these mega projects that they would almost certainly have been built without this source of finance.

A study by the Öko Institute, which was commissioned by the European Commission, shows that energy projects, including hydropower, are unlikely to be additional.[37] This in turn raises doubts about whether such projects truly lead to real emission reductions. In depth examination of this project type by director of the Berkeley Carbon Trading Project, Barbara Haya during the development years of the CDM highlights that this project type is likely to not be additional.[38]

A CDM 'tool for demonstrating and assessing additionality requires projects to prove their necessity based on criteria covering investment barriers and common practice analysis. However, Haya has argued that additionality testing for large hydropower projects is unreliable because government planning, rather than financial returns, is the main driver for project development in most countries. This suggests that national interests often outweigh the financial need for carbon credits, calling into question their role in genuine emissions reduction.

37 Öko-Institut e.V., How additional is the Clean Development Mechanism? Analysis of the application of current tools and proposed alternatives, 2016.

38 Haya, Carbon offsetting: An efficient way to reduce emissions or to avoid reducing emissions? An investigation and analysis of offsetting design and practice in India and China, 2010. Haya & Parekh, Hydropower in the CDM: Examining Additionality and Criteria for Sustainability, 2011.

Moreover, the study indicates how some project developers are able to manipulate financial data, such as capital costs, to make projects seem less viable than they are, thus qualifying them for CDM support. This finding has been echoed by other studies.[39] Hydropower projects boomed long before the CDM existed, highlighting how they are viable without carbon credits. Carbon Market Watch[40] and other civil society organisations reflect these concerns, by excluding the majority of CDM hydropower projects as non-additional.

The credits purchased from these hydropower projects commonly use the methodology for large-scale projects, which is known as 'ACM0002: Grid-connected electricity generation from renewable sources'.[41]

Recent research by Calyx Global,[42] a carbon market rating agency, indicated that this methodology does not guarantee quality of credits in the market. Additionally, the Integrity Council for the Voluntary Carbon Market (ICVCM) announced that after evaluating eight methodologies used to design and implement renewable energy carbon projects, including ACM0002, they failed to meet the Core Carbon Principle (CCP) Assessment Framework for high-integrity, due to their lack of additionality.[43]

- **Environmental social impact**

Large hydropower projects have been linked to cases of human rights abuses and environmental damage, often as a result of weak and improper safeguards against potential environmental and social harm, particularly concerning indigenous peoples and local communities .

This can include displacement of communities, loss of agricultural land, and biodiversity threats. To address potential social and environmental harm, the EU required that CDM hydropower projects meet the environmental and social guidelines set out by the World Commission on Dams (WCD) despite this not being an enforced requirement by the CDM.

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39 Bogner & Schneider, Is the CDM Changing Investment Trends in Developing Countries or Crediting Business-as-Usual? A Case Study on the Power Sector in China., 2011.

40 Carbon Market Watch, Hydro Power Projects in the CDM, 2012.

41 UNFCCC, Large-scale consolidated methodology: Grid-connected electricity generation from renewable sources, 2022.

42 Calyx Global, Insight into the rating factors for large-scale grid-connected renewable energy (ACM0002) projects, 2023.

43 ICVCM, Carbon credits from current renewable energy methodologies will not receive high-integrity CCP® label, 2024.

Despite the need for EU operators to comply with these rules and requirements, they have reportedly had minimal impact.[44] It should be clarified that this is a rule applicable only to credits under the EU ETS and was not directly relevant to other trading systems like the K-ETS.

Run-of-the-river (ROR) hydropower projects are often considered to be less environmentally damaging than large reservoir or dam-based power plants, primarily because they do not require the flooding of vast areas upstream. However, RoR projects can still cause significant environmental impact, particularly when they divert rivers over long stretches.

Such diversions can alter natural river flow, affect aquatic ecosystems, and disrupt the connectivity of the river, leading to serious ecological consequences. Such a drastic alteration in river flows can impact the structure of aquatic freshwater ecosystems, probably resulting in biodiversity loss.[45]

In addition, certain species use sediment build up as an environmental cue but change in river flow due to diversions can alter or affect the natural environment, impeding and potentially making it difficult for organisms to respond to these changes. Both types of hydropower projects can significantly impact freshwater and marine fisheries. If rivers are diverted or blocked by a dam this can damage essential spawning grounds for various fish species and obstruct the crucial transfer of nutrients to the sea and land.

Most of the social impact related to hydropower projects typically revolve around dam projects, due to the flooding of land to create a reservoir or lake, which can lead to the displacement and relocation of communities. In contrast, sometimes forcibly. Run-of-river (RoR) projects are less likely to create negative social repercussions, although changes in river water flow can still impact local livelihoods, especially agriculture and fisheries.[46]

- **Environmental and social concerns**

The Carbon Credit Quality Initiative (CCQI)[47] assessment of hydropower projects underscores these challenges mentioned above. The CCQI assessment deploys different methods[48] to

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44 Baird & Green, The Clean Development Mechanism and large dam development: contradictions associated with climate financing in Cambodia., 2019.

45 Kibler, Development and Decommission of Small Dams: Analysis of Impact and Context, 2011.

46 Egre & Milewski. The diversity of hydropower projects., 2002.

47 Carbon Credit Quality Initiative, Scoring Tool, 2024.

48 Carbon Credit Quality Initiative, Methodology for assessing the quality of carbon credits, 2022.

determine and weigh scores when evaluating the quality of different carbon credits. Specifically, it evaluates carbon credits against seven overarching quality objectives, ranking each based on confidence in guaranteeing high-quality. Assessment of hydropower projects in Indonesia and Pakistan, scored poorly across three key criteria for guaranteeing high-quality carbon credits.

The evaluation of considers key sub-criteria, such as vulnerability[49] and credit quantification[50] revealed a very low likelihood of credible emissions reductions. Similarly, under the criterion for avoiding double counting, which ensures the same emission reduction is not claimed more than once, the projects performed poorly across all sub-criteria; avoiding double issuance,[51] avoiding double use[52] and avoiding double claiming.[53] This reflected a lack of alignment between national accounting systems and international carbon standards.

Lastly, the environmental and social impact assessment revealed significant weaknesses. The projects scored poorly on sub-criteria for environmental and social safeguards and sustainable development, indicating minimal protection for local ecosystems and communities. The poor environmental impact of hydropower projects underscores the significant risks they pose to ecosystems and local communities.

Overall, the systemic gaps highlighted by the CCQI demonstrate why hydropower-derived carbon credits should be avoided.

**49** Hydropower projects are likely a non-vulnerable project type to continue GHG abatement, even without carbon credit revenues.

**50** Assesses how well a project establishes credible baselines, implements monitoring systems, and manages uncertainties.

**51** A situation in which more than one carbon credit is issued for the same emission reduction or removal. Double issuance leads to double counting if more than one of these carbon credits is counted towards achieving mitigation targets or goals.

**52** A situation in which the same carbon credit is counted twice towards achieving mitigation targets or goals (e.g., if two entities claim emission reductions or removals from the cancellation of one carbon credit).

**53** A situation in which the same emission reduction or removal is claimed by two different entities towards achieving mitigation targets or goals.

## c. Reducing gas leak projects

Reducing gas leak projects aim to prevent the escape of gases, like methane, from industrial operations, such as oil and gas extraction, and pipelines by capturing or sealing emission leaks. The AM0023[54] CDM methodology in particular, focuses on reducing physical leaks[55] through the implementation of advanced leak detection and repair (LDAR) programmes[56] across various segments of the natural gas value chain (both upstream and downstream).

These may include leaks that have not yet been detected or repaired under the standard implemented LDAR programme.This can happen when these programmes follow a set of specific guidelines but certain leaks sometimes fall out of their scope. Leaks may be also overlooked because regular monitoring of specific equipment or other factors is lacking. Some leaks are cheap to fix through re-tightening or applying lubricants. Others can be very expensive to fix, such as replacing faulty components or overhauling parts of the system, which can be difficult and complex, and these may be deferred as a result.

There are two main options proposed under the CDM to calculate detected emission leaks during the project activity. The first option involves applying default emission factors developed by the American Petroleum Institute (API). This method estimates methane leakage from specific types of equipment by multiplying the emission factor by the methane content in natural gas or refinery gas.

The second option uses direct measurement methods or other appropriate flow measurement technologies to quantify leaks.

Most projects running under this methodology tend to favour the second option. However, past analyses[57] have raised concerns about the accuracy of this equipment, as it tends to produce uncertain and inconsistent results.

**54** CDM Executive Board, Approved baseline and monitoring methodology AM0023 Leak detection and repair in gas production, processing, transmission, storage and distribution systems and in refinery facilities, 2011.

**55** CDM Executive Board, Approved baseline and monitoring methodology AM0023 Leak detection and repair in gas production, processing, transmission, storage and distribution systems and in refinery facilities, 2011.

**56** CDM Executive Board, Approved baseline and monitoring methodology AM0023 Leak detection and repair in gas production, processing, transmission, storage and distribution systems and in refinery facilities, 2011.

**57** Carbon Market Watch, Calibrated bags to measure gas leakage, 2009.

### i. Credibility of gas leak reduction projects

Gas leak reduction projects have both strengths and weaknesses. One major issue is the risk of undetected leaks, as standard leak detection and repair (LDAR) programmes can miss certain emissions. Limited monitoring and outdated detection technology means that some leaks go unaddressed, reducing the project's effectiveness to mitigate emissions.

Research by the Öko Institute,[58] highlights that this methodology can often overestimate baseline emissions. Basing calculations on an assumption that leaks go unrepaired for up to seven years and have a consistent output trajectory over that time is unrealistic. For example, a leak fixed in one year is counted in the baseline for all seven years, potentially inflating emission reductions claimed by the project.

The Öko report also highlights that regular monitoring of line pressure[59] in gas pipelines is lacking. Since leak rates are affected by the pressure in the lines, insufficient monitoring introduces uncertainty, which could result in an overestimation of baseline emissions. In addition, without consistent pressure monitoring, project developers may have a perverse incentive to increase line pressure during baseline surveys, which could inflate estimates.

Lastly, there seems to be a lack of granularity in the criteria for what particular leak is or is not eligible for inclusion in the baseline scenario, leading to uncertainty. This is particularly concerning for larger "super-emitting" leaks, which are not explicitly excluded and are unlikely to go undetected for extended periods. This lack of clarity creates uncertainty and risks an overestimation of emissions reductions.

Conversely, there are factors that can result in underestimation. For example, baseline emissions are set based on the first year's data. If new leaks are found and fixed in subsequent years, these reductions aren't reflected, causing actual reductions to be undercounted. To conclude, based on CCQI assessment of this project type, the uncertainty surrounding the accurate estimation of emission reductions lies in the range of 50%.

Finally, research suggests that the CDM framework may create warped incentives.[60] Some developers might avoid fully addressing leaks in order to continue earning credits. Studies on

**58** Öko-Institut e.V., Application of the Oeko-Institut/WWF-US/ EDF methodology for assessing the quality of carbon credits, 2022.

**59** Pipeline Safety Trust, Gas Transmission Pipelines, 2022.

**60** Schneider. Perverse incentives under the CDM: an evaluation of HFC-23 destruction projects., 2011.

the AM0023 methodology also suggest that developers sometimes delay maintenance to qualify for credits, which raises questions about additionality.[61]

In summary, this project type has a high risk of issuing unreliable "junk credits" due to the risk of overestimating emissions reductions.

## d. Conclusion

The development of large-scale hydropower projects (the most credited of all CDM projects) has raised a series of serious concerns about the lack of additional climate benefits and rights violations. Similarly, avoided gas leakage projects have been scrutinised for generally overestimating emission reductions and providing perverse incentives. These concerns with both project types point to deeper issues beyond the poor quality of credits. They reveal a fundamental systemic failure within the CDM to uphold high standards and ensure genuine emission reductions. For these reasons, these types of projects should be avoided.

**61** Korppoo & Moe, RUSSIAN GAS PIPELINE PROJECTS UNDER TRACK 2: CASE STUDY OF THE DOMINANT PROJECT TYPE, 2008.

Chapter THREE

# Recommendations for next phase of K-ETS


CO2
CO2

# Recommendations for next phase of K-ETS

South Korea introduced the Emissions Trading Scheme (K-ETS) in 2015. In 2022, the coverage of the K-ETS accounted for 73% of the country's total greenhouse gas emissions which makes K-ETS the most important policy tool for the Korean government to achieve its climate targets, including the 2030 NDC. Currently, K-ETS is in its third planning period (2021-2025). The total cap during the third period is 2.8 billion tonnes. According to the Emission Trading Scheme Act, companies with annual emissions of 125 kt$CO_2$e or more are subject to the scheme, and the criteria for emissions include not only direct emissions but also indirect emissions from electricity or heat use.

**Table 5 - An overview of K-ETS**

| Key element | Description |
|---|---|
| Planning period | 1st (2015-2017), 2nd (2018-2020), 3rd (2021-2025) |
| Total Cap | 584 Mt$CO_2$e (2021-2023), 567 Mt$CO_2$e (2024-2025) |
| Emission Coverage | Direct emissions ($CO_2$, $CH_4$, $N_2O$, HFC, PFC, $SF_6$), indirect emissions (electricity and heat) |
| Auction | 10% for the 'non-carbon leakage' sectors |

During the third period, the Korean government updated its 2030 NDC to the UNFCCC in 2021, which enhanced the greenhouse gas emission reduction target to 40% from 2018 levels by 2030, up from 24.4% from 2017 levels. The detailed implementation plan for the new NDC was announced through the Carbon Neutrality Basic Plan in 2023. However, the new administration made major changes in the sectoral and annual targets, including a significant decrease in the reduction burden of the industrial sector and increased proportion of CCUS and overseas reductions. These policy changes were intended to minimise the burden on the industrial sector and have received much criticism from civil society and experts for jeopardising the achievement of the enhanced 2030 target.

**Table 6 - Key changes in Korea 2030 NDC (Unit : $MtCO_2e$)**

| | 2030 emission target (previous) | 2030 emission target (current) |
|---|---|---|
| Industry | 222.6 | 230.7 |
| CCUS | - 10.3 | -11.2 |
| Oversee reduction | - 33.5 | -37.5 |

The current government's policy direction regarding Korea's NDC is also being reflected in the operation of the K-ETS. Despite the need to strengthen the reduction pressure by tightening the cap in accordance with the enhanced 2030 NDC, the current government has continuously delayed lowering the K-ETS cap for the third period. Some recent adjustments to the cap occurred in the second half of 2023. However, the government chose to reduce the cap from its reserves rather than cancelling free allowances, which means it did not contribute to greenhouse gas reductions and delivered no new revenue to the government to use for climate action.

During the third period, due to the government's lax allocation and economic recession, the price of allowance in the K-ETS stood at a mere $6-7, which is only a tenth of the price of EU-ETS. In fact, the K-ETS price is the lowest among the countries that operate emission trading schemes, such as the United States (California and RGGI), China, and New Zealand. Furthermore, recent research showed that large emitters, such as POSCO and Samsung Electronics, are selling their excess free allowances on the market and making huge windfall profits.[62]

Pursuant to the Emission Trading Scheme Act, the government is required to establish a basic plan for the fourth period (2026-2030) by the end of 2024, and an allocation plan, which includes the size of the total cap and specific allocation criteria, by June 2025. If the current government's policy direction to minimise the reduction burden on the industry continues, it is likely to miss its 2030 NDC target through the K-ETS. In particular, there is a real possibility that the government will try to allow greater use of international credits in the fourth period to ease the reduction burden on companies.

In the third period, international credit usage was limited to 5%. This reflects a downward adjustment from the 10% limit during the second period. Korean industry has consistently argued that the current level of the limit on international offset credit usage has increased

62 Plan 1.5, How to Fix a Broken ETS : A Korean Case Study, 2022.

compliance cost for companies and is demanding that the limit should be increased back to 10% in the fourth Period. It should also be noted that the government has planned to secure 37.5 million tonnes of international credits by 2030 through Article 6 mechanism of the Paris Agreement and use it to achieve the NDC .

However, as has been analysed in chapters one and two, the international credits generated from carbon markets are unreliable, and if these credits are indiscriminately introduced into the K-ETS, it can cause the increase of actual GHG emissions from Korea's industrial sector. Therefore, we suggest that the use of international offset credits be eliminated and, failing that, minimised in the basic and allocation plans for the fourth period.

## 1. Evaluation of international credits in the K-ETS

By November 2024, the international credit certified by the Korean government reached 13.5 million tonnes, of which approximately 80% are generated from cookstove projects. As previously discussed, even with the verification and certification processes within the UNFCCC CDM system, the problem of overestimation of emission reductions continues to occur. This is not limited to cookstoves but is also seen with other project types, such as natural gas leakage and hydroelectric power projects, and most of them are cases where the additionality could not be properly established or the baseline emissions were overestimated.

For this reason, the Korean government should ban international credits from entering its K-ETS. Or else, if international credits are allowed in, the Korean government should establish its own verification and certification process rather than simply importing the criteria and results for the crediting system under the UNFCCC CDM. It is fully capable of doing so because the Emissions Trading Act stipulates that the government may cancel certified UNFCCC credit if the project appears to have issues in terms of additionality, baseline, and monitoring.

Therefore, the Korean government should facilitate a new process to evaluate the international credits it had previously certified. This process should be overseen by a transparent and independent committee composed of experts, civil society representatives, and government officials in charge of evaluating the overestimation and additionality of existing certified international credits. If any overestimation is discovered, the government should cancel or discount the credit amount.

## 2. Credit usage in the fourth period

The Korean government plans to increase the limit international credits use from the current 5% to 10% during the fourth period due to pressure from the industrial sector, which will slow down industrial decarbonisation. The final decision on this matter is expected to be confirmed in the allocation plan which will be published in 2025.

The Emission Trading Scheme Act stipulates that the government should consider the impact on NDC achievement and the level of allowance price when deciding the limit of international credit use.

If the usage limit of international credits increases, it will inevitably result in an influx of cheap and low-quality international credits into the K-ETS, compromising the effectiveness of the scheme and lowering the price of allowances even further. This will also result in increased greenhouse gas emissions from the industrial sector as the corporate players will be able to comply with their cap with credits that likely overstate their climate impact, instead of actually reducing their direct emissions. All of this will result in a huge negative impact on the achievement of the NDC and the climate. Considering the poor reliability of international credits, the Korean government should ideally exclude them. Failing that, it should set the bar no higher than the current 5% standard. Furthermore, it is necessary to gradually abolish, as occurred in the EU ETS, the use of international credits.

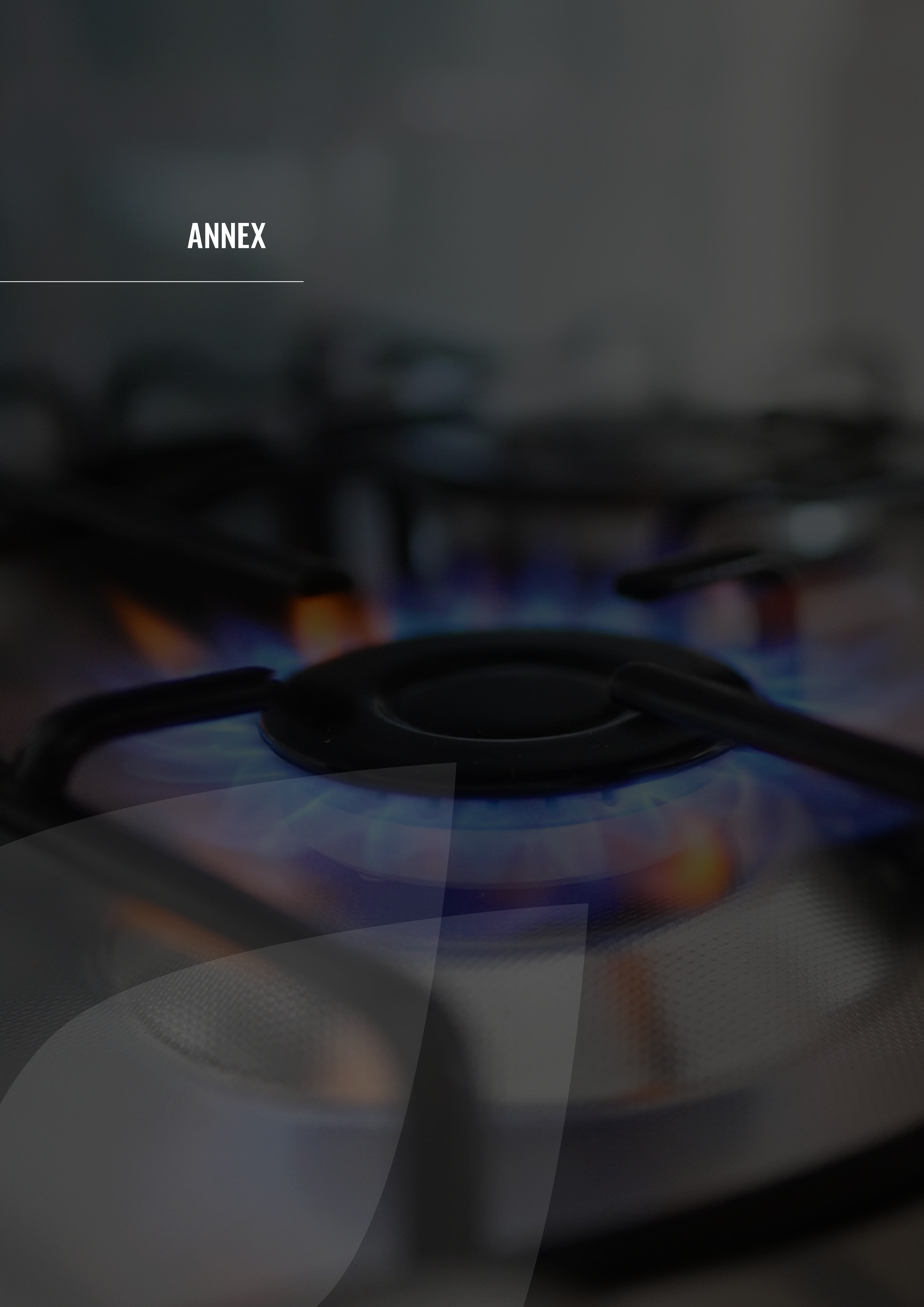
## 3. No false solutions for 2030 NDC

According to the 2030 NDC set by the Korean government, Korea plans to reduce emissions by 249.7 million tonnes by 2030, from the 2018 level of 686.3 million tonnes. The plan includes a reduction of 37.5 million tonnes using international credits, which accounts for approximately 13% of the total reduction. The Korean government plans to cover this amount of reductions through bilateral cooperation under Article 6.2 of the Paris Agreement, and to this end, it is currently promoting pilot projects by signing agreements with over 10 countries, including Vietnam, Cambodia, and Mongolia.

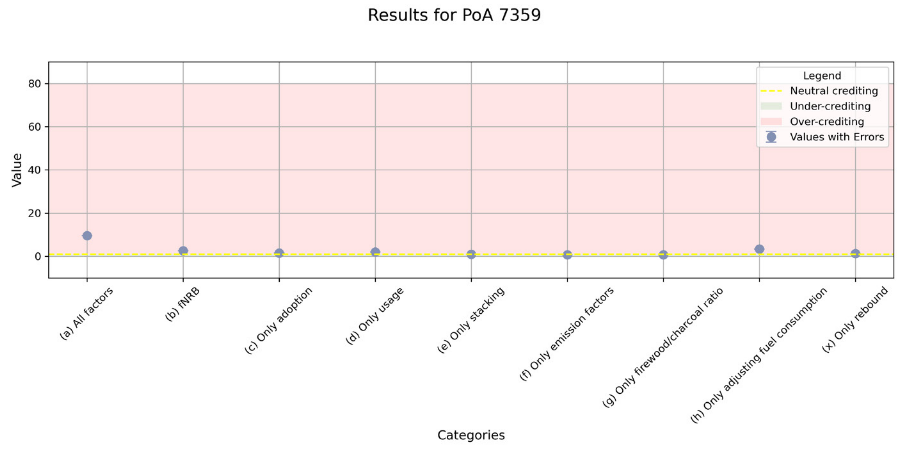
The types of projects that the Korean government is pursuing include conventional projects, such as improving energy efficiency in factories or buildings, switching fuels, and installing renewable energy, but they also include projects with negligible to no climate impact, such as REDD+. In general, since bilateral cooperation is more likely to apply looser methodology and validation processes than the UNFCCC system, we expect that the reductions from the Korean bilateral cooperation process are very likely to be overstated.

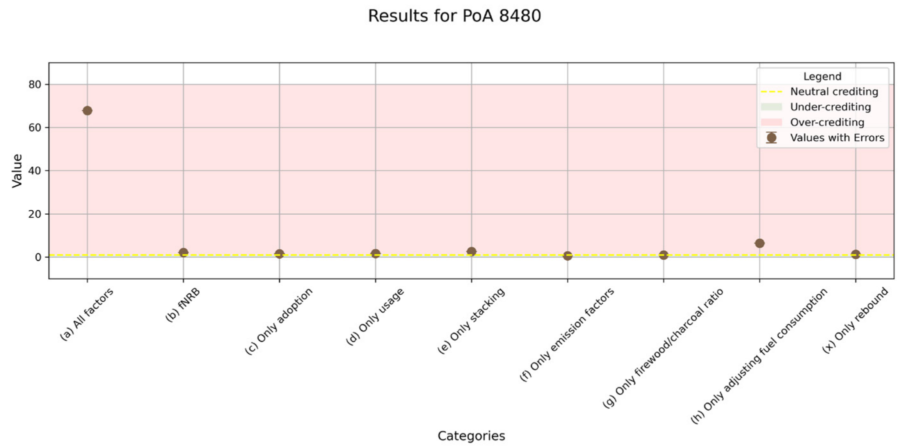
Ideally, South Korea should not engage in these bilateral deals. Failing that, it should do so in a robust and cautious manner. Although the Korean government has not yet established the criteria on the types of projects to be included in the bilateral cooperation process, it should be limited to project types that can deliver proven real, robust and durable emissions reduction and must exclude cookstoves and REDD+ projects, which have are known to exaggerate their climate impact.

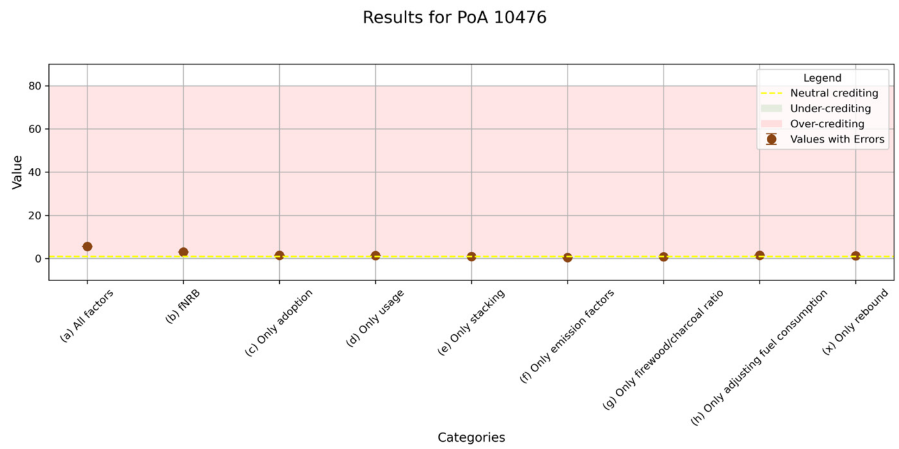
# ANNEX



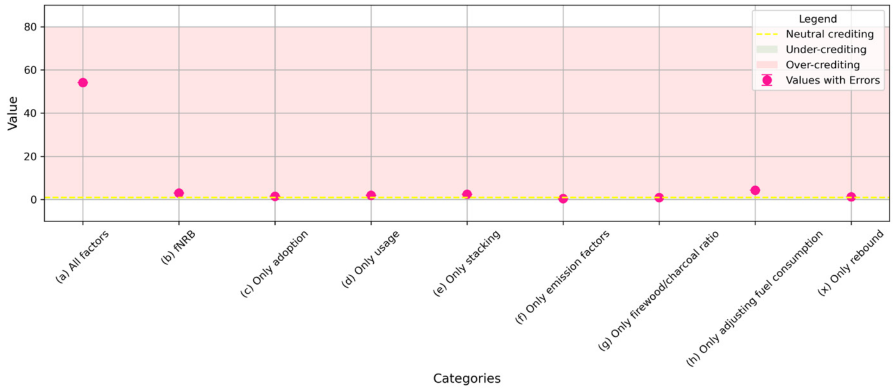
# 1. Factors for over-crediting per PoA



Results for PoA 10497

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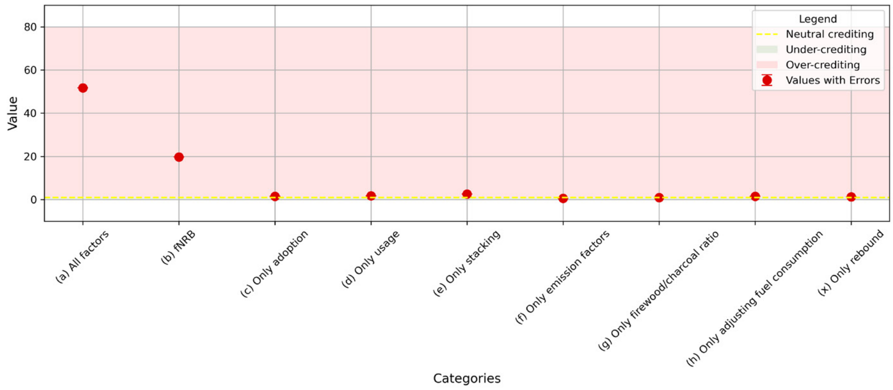


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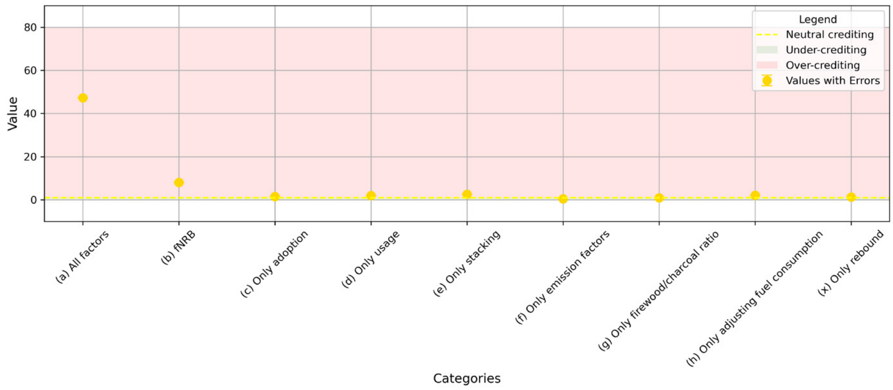

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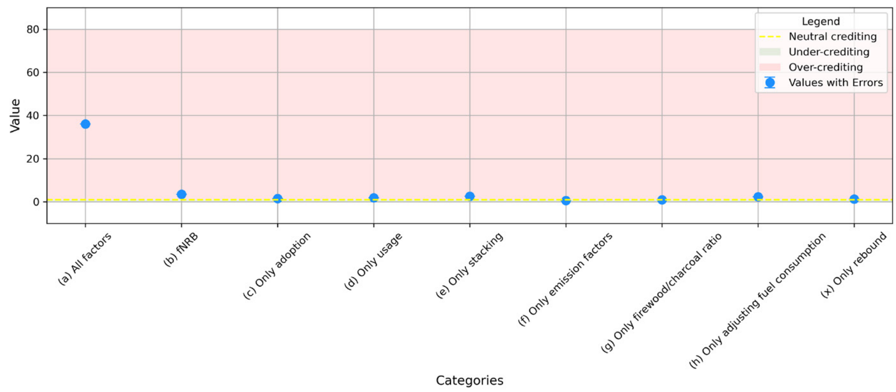
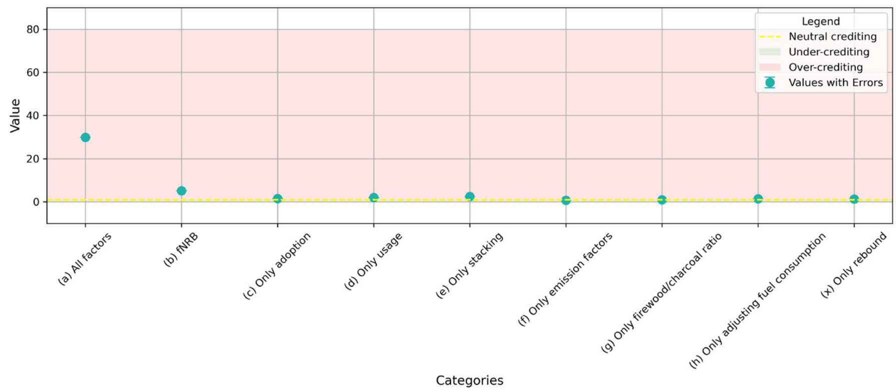
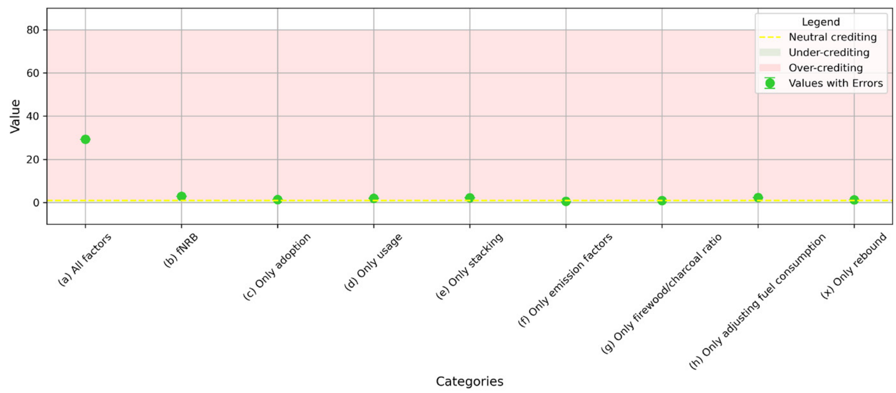


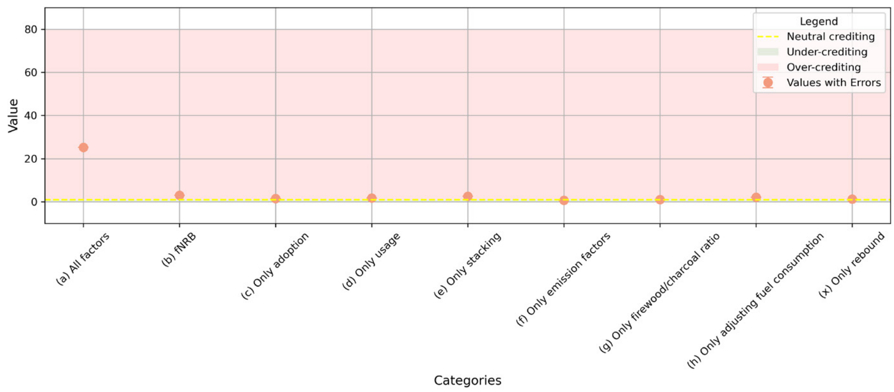

Results for PoA 10477



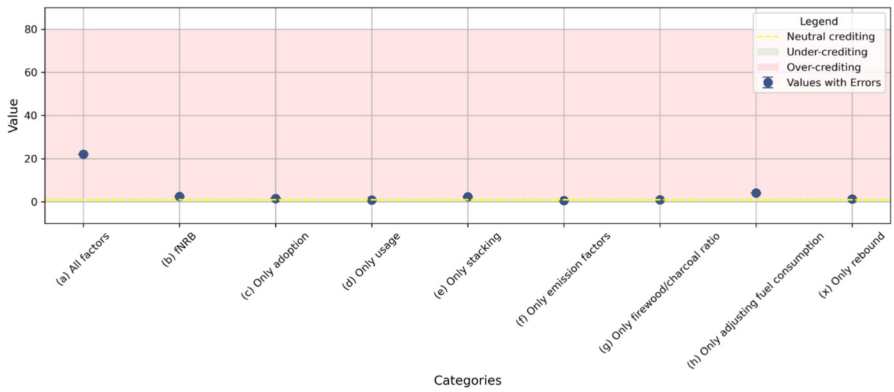

Results for PoA 10415



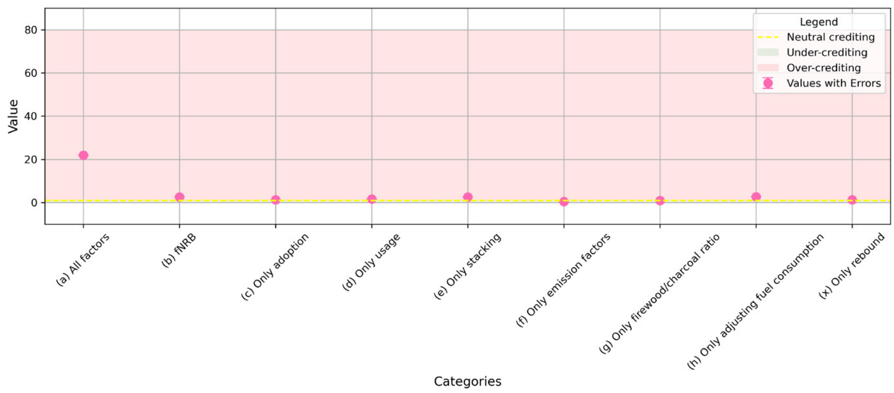
Results for PoA 9265

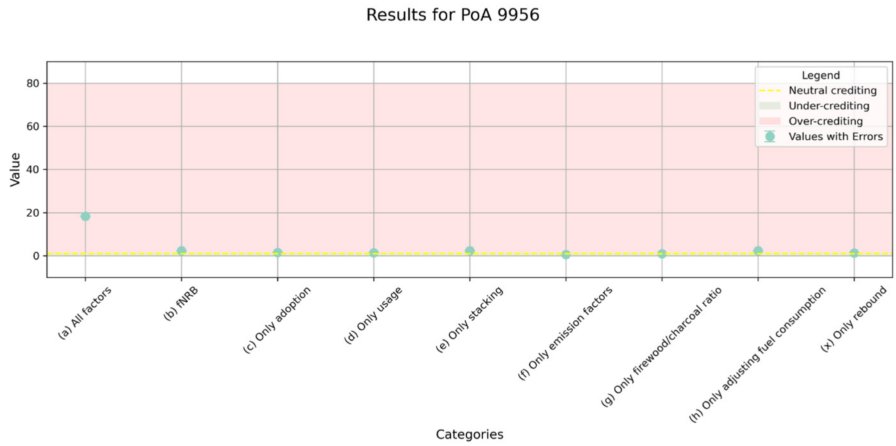



Results for PoA 7997

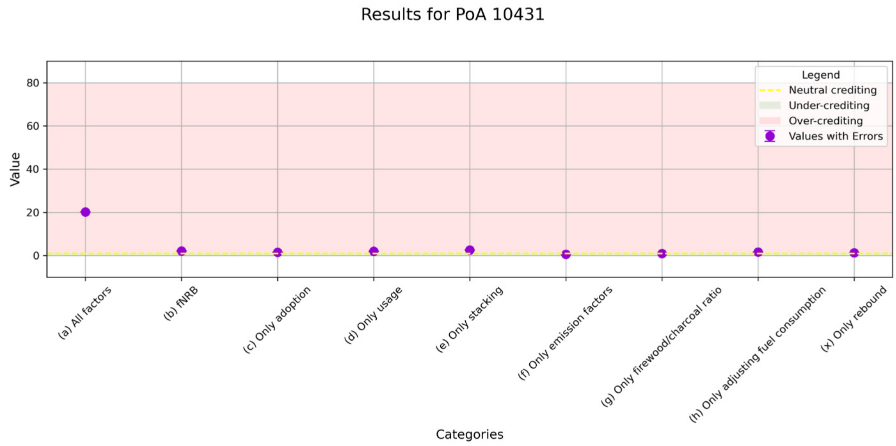



Results for PoA 10474

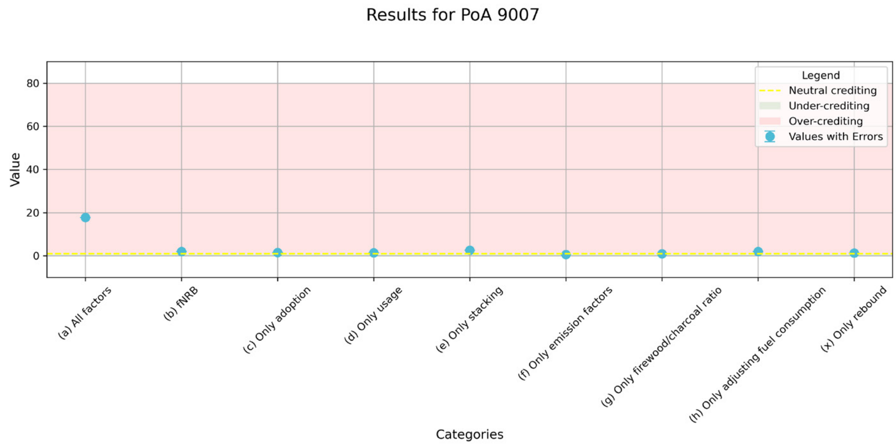




Results for PoA 9956
Legend
Neutral crediting
Under-crediting
Over-crediting
Values with Errors
Value
Categories
(a) All factors
(b) fNRB
(c) Only adoption
(d) Only usage
(e) Only stacking
(f) Only emission factors
(g) Only firewood/charcoal ratio
(h) Only adjusting fuel consumption
(x) Only rebound

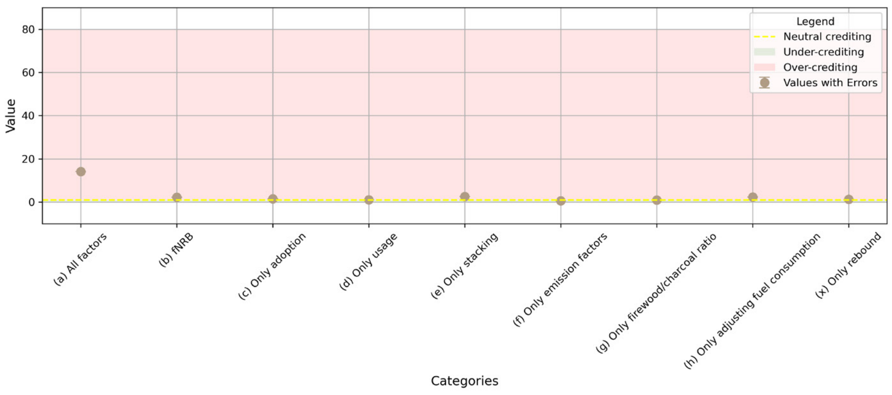



Results for PoA 10431
Legend
Neutral crediting
Under-crediting
Over-crediting
Values with Errors
Value
Categories
(a) All factors
(b) fNRB
(c) Only adoption
(d) Only usage
(e) Only stacking
(f) Only emission factors
(g) Only firewood/charcoal ratio
(h) Only adjusting fuel consumption
(x) Only rebound

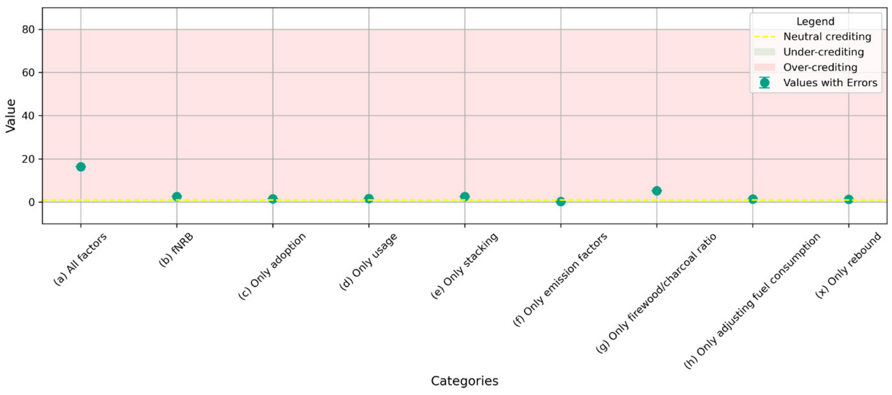



Results for PoA 9007
Legend
Neutral crediting
Under-crediting
Over-crediting
Values with Errors
Value
Categories
(a) All factors
(b) fNRB
(c) Only adoption
(d) Only usage
(e) Only stacking
(f) Only emission factors
(g) Only firewood/charcoal ratio
(h) Only adjusting fuel consumption
(x) Only rebound

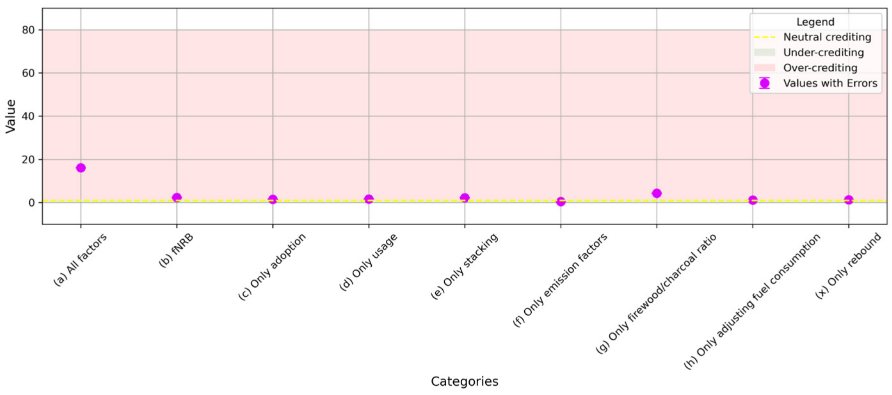
Results for PoA 6864

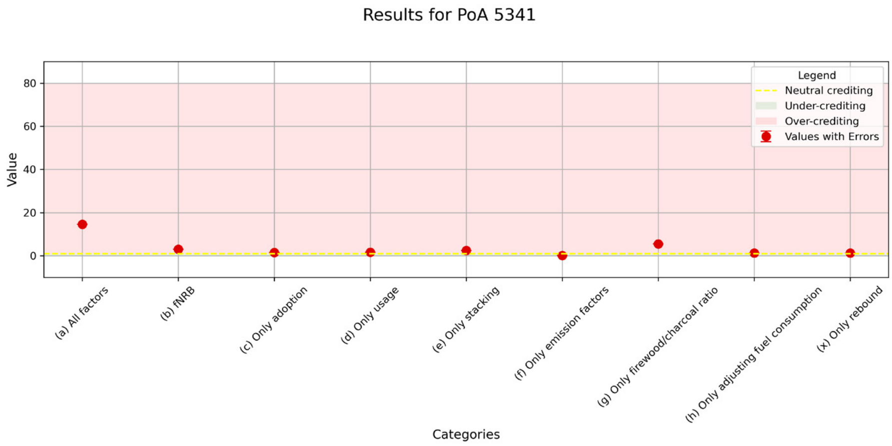


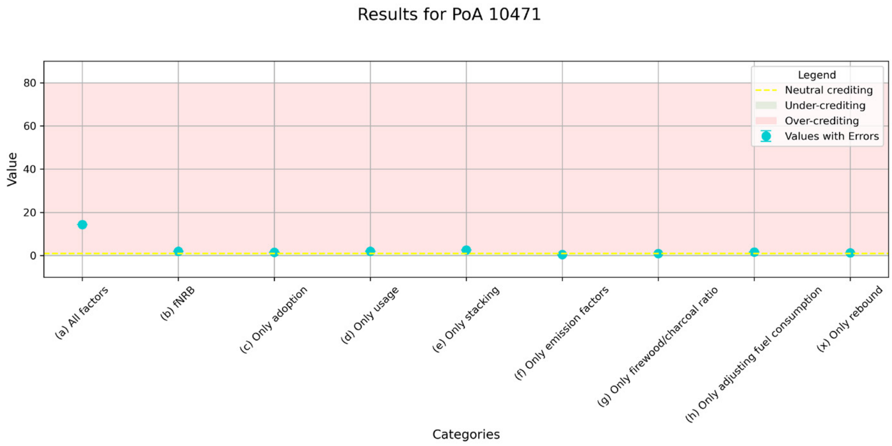

Results for PoA 5342




Results for PoA 10576




Results for PoA 5341
Value
Categories
Legend
Neutral crediting
Under-crediting
Over-crediting
Values with Errors
(a) All factors
(b) fNRB
(c) Only adoption
(d) Only usage
(e) Only stacking
(f) Only emission factors
(g) Only firewood/charcoal ratio
(h) Only adjusting fuel consumption
(x) Only rebound


Results for PoA 10471
Value
Categories
Legend
Neutral crediting
Under-crediting
Over-crediting
Values with Errors
(a) All factors
(b) fNRB
(c) Only adoption
(d) Only usage
(e) Only stacking
(f) Only emission factors
(g) Only firewood/charcoal ratio
(h) Only adjusting fuel consumption
(x) Only rebound

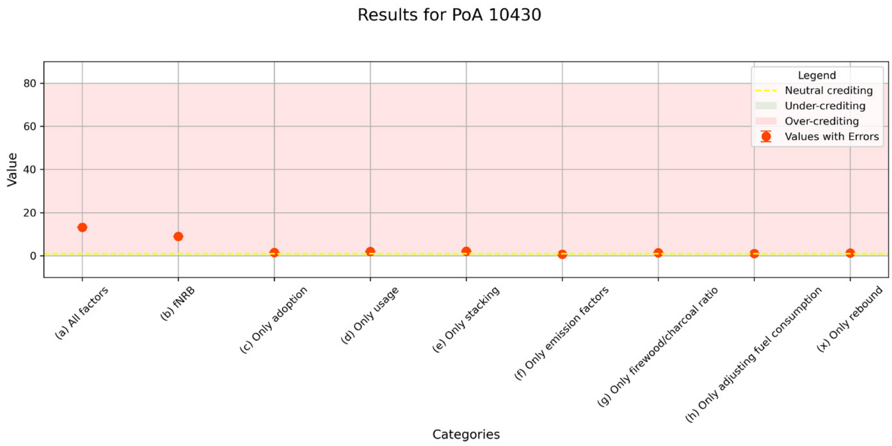

Results for PoA 10430
Value
Categories
Legend
Neutral crediting
Under-crediting
Over-crediting
Values with Errors
(a) All factors
(b) fNRB
(c) Only adoption
(d) Only usage
(e) Only stacking
(f) Only emission factors
(g) Only firewood/charcoal ratio
(h) Only adjusting fuel consumption
(x) Only rebound

**Figure 1: Outlining the amount of over- or under-crediting from each individual factor across the project sample**

The amount of over/under-crediting per PoA after quantifying all factors (a) and a breakdown of the individual factors fNRB (b), adoption (c), usage rates (d), stacking (e), emissions factors (f), firewood-charcoal conversion (g), consumption (h), and rebound (x). Note that the all factors (a) panel indicates the total over-crediting from the combination of each of the individual factors (b-x), which amplify when considered together. Panels (b-x) indicate the total over-crediting from each individual factor.

## 2. FAQ on cookstoves carbon crediting projects

**1. What was the background and initial purpose of cookstove interventions, and how did efficient cookstoves come to be approved as a type of CDM project?**

Roughly 2.4 billion people cook with smoky biomass or kerosene, contributing to 2 to 3 million premature deaths annually and roughly 2% of global greenhouse gas (GHG) emissions. Efficient stoves can reduce emissions by using less fuel, switching to a less GHG-intensive fuel, and emitting less methane and other pollutants through more complete combustion. They can also reduce time spent collecting fuelwood, which can be hours a day, or the cost of procuring fuel, which can be a substantial portion of household income. The cleanest stoves – liquified petroleum gas (LPG), electric, ethanol, natural gas/biogas/compressed natural gas, and some biomass pellet gasifiers – reduce smoke enough to substantially avoid negative health impacts.

In 2008, the United Nations' carbon offset program, the Clean Development Mechanism, or CDM, adopted two improved cookstoves offset methodologies: AMS-II.G : Energy efficiency measures in thermal applications of non-renewable biomass and AMS-I.E: Switch from non-renewable biomass for thermal applications by the user. Since then, the two methodologies have produced 34 million credits through the CDM and 60 million credits on the voluntary carbon market. Improved cookstoves is the fastest growing project type on the voluntary carbon market and in 2024 had the most issuances of any project type (see UC Berkeley's Voluntary Registry Offsets Database).

**2. Last year, a paper published in the journal Nature Sustainability found that the emission reductions from cookstove projects on the voluntary carbon registries, Gold Standard (GS) and Verified Carbon Standard (VCS), including those using UNFCCC-approved CDM methodologies, was likely overestimated by over 10 times. What are the fundamental reasons for this?**

The article, Pervasive over-crediting from cookstove offset methodologies,[1] performed a comprehensive assessment of five cookstoves methodologies that generating credits on the voluntary carbon market. The study found that the methodologies were likely generating over ten times more credit than the actual greenhouse gas benefits of the projects. The researchers found that the two CDM cookstoves methodologies, AMS-II.G and AMS-I.E, were over-crediting

1 Gill-Wiehl et al., Pervasive over-crediting from cookstove offset methodologies, Nature Sustainability, 2024; for a summary of the article and background information, visit the Berkeley Carbon Trading Project's cookstoves website.

by 22 and 5 times respectively.

The two most important sources of over-crediting were the use of biased methods to assess project stove adoption and use, and high estimates of one important variable – the fraction of non-renewable biomass (fNRB).

**Monitoring stove adoption and usage:** CDM methodologies track stove adoption and usage through short surveys on a sample of households. Surveyors go door-to-door to a subset of households to ask a set of questions.

All default household surveys used by the methodologies are infrequent, simple, and have well-documented biases. The surveys are vulnerable to social desirability bias, that occurs when respondents provide answers (such as inflated adoption and usage rates) which they believe the surveyors (hired by project developers) want to hear.[2-4] Social desirability bias is compounded by recall bias.[2,4] Surveys are typically infrequent and poorly worded, and respondents can struggle to remember how they cooked over a period of time. When asked about their stove use by someone from the stove company, respondents may say that they like and use a stove more than they do, and may be more likely to do so when it is hard to remember the actual amount that they used the stove.

AMS-II.G's default survey provides a good example of how survey simplicity exacerbates vulnerabilities to social desirability bias leading to over-crediting. The survey simply asks households if they used the improved stove in the last week or month. Developers can then assume a positive answer means that households used the stove 100% of the time during the one- to two-year crediting period, with a small discount if they also reported using the baseline stove in the last week or month.

Our sampled projects use surveys, and report adoption and usage rates much higher than rates documented in the literature. The average adoption rate (rate of distributed stoves that are regularly used) reported by our sampled projects is 86% and usage rate (the amount of cooking

2 Kar et al., The risk of survey bias in self-reports vs. actual consumption of clean cooking fuels, World Development Perspective, 2020.

3 Tourangeau & Yan, Sensitive questions in surveys, Psychological Bulletin, 2007.

4 Wilson et al., Comparing Cookstove Usage Measured with Sensors Versus Cell Phone-Based Survey in Darfur, Sudan, Technologies for Development, 2015.

performed with the new stove) is 98%, compared with 58%[5-13] and 52%[14] from our literature reviews. The average stacking rate (the amount of cooking performed by other stoves) for our sampled projects is 2%, compared with 68%[15-23] in the literature. The empirical studies we draw on from published literature were performed on cookstove projects very similar to those participating in the studied offset programs, and are designed to avoid bias with frequent, comprehensive, longitudinal surveys, triangulated with photos, field tests, and/or stove

5 Hanna et al., Up in Smoke: The Influence of Household Behavior on the Long-Run Impact of Improved Cooking Stoves, American Economic J ournal: Economic Policy, 2016.

6 Burwen & Levine, A rapid assessment randomized-controlled trail of improved cookstoves in rural Ghana, Energy for Sustainable Development, 2012.

7 Beltramo et al., The Effects of Fuel-Efficient Cookstoves on Fuel Use, Particulate Matter, and Cooking Practices: Results from a Randomized Trial in Rural Uganda, UC Berkeley: Center for Effective Global Action, 2019.

8 Rosa et al., Assessing the Impact of Water Filters and Improved Cook Stoves on Drinking Water Quality and Household Air Pollution: A Randomised Controlled Trial in Rwanda, PLoS ONE, 2014.

9 Bensch & Peters, The intensive margin of technology adoption – Experimental evidence on improved cooking stoves in rural Senegal, Journal of Health Economics, 2015.

10 Ruiz-Mercado, et al., Adoption and sustained use of improved cookstoves, Energy Policy, 2011.

11 Islam et al., Assessing the Effects of Stove Use Patterns and Kitchen Chimneys on Indoor Air Quality during a Multiyear Cookstove Randomized Control Trial in Rural India, Environmental Science & Technology, 2022.

12 García-Frapolli et al., Beyond fuelwood savings: Valuing the economic benefits of introducing improved biomass cookstoves in the Purépecha region of Mexico, Ecological Economics, 2010.

13 Adrianzén, Social Capital and Improved Stoves Usage Decisions in the Northern Peruvian Andes, World Development, 2014.

14 Jeuland et al., The need for policies to reduce the costs of cleaner cooking in low income settings: Implications from systematic analysis of costs and benefits, Energy Policy, 2018.

15 Shankar et al., Everybody stacks: Lessons from household energy case studies to inform design principles for clean energy transitions, Energy Policy, 2020.

16 Hanna et al., Up in Smoke: The Influence of Household Behavior on the Long-Run Impact of Improved Cooking Stoves, American Economic Journal: Economic Policy, 2016.

17 Burwen & Levine, A rapid assessment randomized-controlled trial of improved cookstoves in rural Ghana, Energy for Sustainable Development, 2012.

18 Beltramo et al., The Effects of Fuel-Efficient Cookstoves on Fuel Use, Particulate Matter, and Cooking Practices: Results from a Randomized Trial in Rural Uganda, UC Berkeley: Center for Effective Global Action, 2019.

19 Rosa et al., Assessing the Impact of Water Filters and Improved Cook Stoves on Drinking Water Quality and Household Air Pollution: A Randomised Controlled Trial in Rwanda, PLoS ONE, 2014.

20 Bensch & Peters, The intensive margin of technology adoption – Experimental evidence on improved cooking stoves in rural Senegal, Journal of Health Economics, 2015.

21 Ruiz-Mercado et al., Adoption and sustained use of improved cookstoves, Energy Policy, 2011.

22 Pine et al., Adoption and use of improved biomass stoves in Rural Mexico, Energy for Sustainable Development, 2011.

23 Pattanayak et al., Experimental evidence on promotion of electric and improved biomass cookstoves, Proceedings of the National Academy of Sciences, 2019.

monitors, and conducted by trained enumerators unaffiliated with the project.

**Fraction of non-renewable biomass (fNRB):** Projects that reduce biomass use can reduce emissions of $CO_2$ and other non-$CO_2$ greenhouse gases such as methane and nitrous oxide. For estimating reductions in $CO_2$ emissions, projects are only credited for the fraction of biomass used for cooking that exceeds the ability for trees to grow back, called the fraction of non-renewable biomass (fNRB). The argument is that projects should only earn credits from preventing the depletion of carbon storage in natural systems.

CDM methodologies allowed developers to calculate their own fNRB values from a CDM tool, or assume a conservative 30% default (rarely chosen).

A substantial effort has been put into developing global fNRB models to estimate the benefits of interventions that reduce biomass use. The most robust fNRB assessment to date is a dynamic landscape model commissioned by the United Nations called MoFuSS (Modeling Fuelwood Sustainability Scenarios), and described here. MoFuSS builds on the previous model, called WISDOM[24], which was used to estimate fNRB for 90 countries at village/district, state, and country levels, accounting for biomass regrowth and geographical, ecological, and land use heterogeneity. MoFoSS expands on WISDOM by adding a dynamic layer and an on-line mapping tool. The dynamic layer models biomass regrowth over time under different scenarios which can better assess the impacts of an intervention. The on-line mapping tool allows users to choose the spatial area for performing an fNRB analysis, which could be an administrative unit like a district or state, or a custom area such as the boundaries of a specific cookstoves project.

fNRB values used by projects under the studied methodologies differ substantially from WISDOM and MoFuSS. We found that on average across our 51 sample projects, the fNRB values used were 3 times WISDOM values. Bailis et al. (2017) estimated that if fNRB values from WISDOM had been used to estimate the emissions reductions from cookstoves offset projects, the projects would have generated 41-59% fewer credits.[25]

More fundamentally, over-crediting was a result of flexibility. All methodologies offer project developers significant flexibility in how they monitor and estimate each factor used to calculate project greenhouse gas benefits. Project developers, when offered flexibility, have a financial

24 Bailis et al., The carbon footprint of traditional woodfuels, Nature Climate Change, 2015.

25 Bailis et al., Getting the numbers right: revisiting woodfuel sustainability in the developing world, Environmental Research Letters, 2017.

incentive to make methodological choices that result in more credits. The very high levels of over-crediting found by the study were a result of the consistent lean towards choosing over-estimated values, and how over-crediting compounds when multiple over-estimated values are multiplied with one another.

(Please see the study's online factor-by-factor FAQ for more detail.)

3. **Cookstove project developers claim that they have no choice but to trust the UNFCCC scheme because all emission reductions should be verified and certified through the UNFCCC verification and certification processes. Can we trust all emission reductions which are approved by UNFCCC?**

The UNFCCC methodologies offer project developers significant flexibility in how they determine factors used to estimate project emissions reductions. While every project must undergo verification by a third-party auditor, auditors are only tasked with ensuring that project choices are allowed by the methodology, not that they are accurate or conservative.

Even if good practice in GHG quantification isn't required by the methodologies, project developers can still choose to estimate project impacts using good practice methods from the published literature, and credit buyers can choose to procure credits from projects that follow good practice.

Cookstove project developers can follow good practice to estimate the greenhouse gas benefits from their project:

**Monitoring stove adoption and usage:** To monitor stove adoption and usage, project developers can use meters or fuel purchase data on all participating households when possible. Otherwise, developers can follow good practice in survey design to reduce bias if surveys are used.

Current guidance on survey design to avoid bias suggests:

- Conducting repeat surveys with specific, randomly selected households over time (longitudinal surveys), instead of surveying random new households each survey. Longitudinal surveys are favored when social desirability biases are likely to be high, since respondents are more likely to be honest when asked multiple times, especially if rapport is developed with the surveyor.
- Using well-trained enumerators.

- Asking specific questions about stove use in the last week; for example, ask about specific days[26] rather than general behavior (yesterday, the day before yesterday, and within the last seven days), ask "when is the last time you used the project stove," and/or ask the respondent to walk through their day of cooking across stoves yesterday.
- Asking specifically when and what households cooked (i.e., what researchers call time-use strategies).
- Triangulating by asking similar questions in different forms.
- Triangulating with observation and documenting with photos. Observation of the project and baseline stoves can play a large role in monitoring stove use: for example, noting which stoves are present in the kitchen, warm, and contain embers or signs of use, as well as the location of ashes.
- Performing surveys in different seasons to capture seasonal variation.
- Following-up with a frequency used in robust research[27] which is at least annually, and twice a year for setting with seasonal variation.
- Performing surveys at different times in the reporting period since project stove use tends to decline over time.
- Outlining before monitoring how adoption, usage, and stacking rates will be calculated, leveraging all available and relevant survey and observation data. Although surveys can involve kitchen visits, offset projects often only use responses to one or two questions to calculate stove and fuel use rates. For example, projects should use the answers to multiple specific questions to support usage and the photos to confirm it.
- Having data analysts clean survey data at least every few days.

**Fraction of non-renewable biomass (fNRB):** Project developers should use recent rigorous published values. Currently, the most robust published values are from the dynamic landscape model, MoFuSS (Modeling Fuelwood Sustainability Scenarios). Project developers should use values from the smallest administrative level for firewood and country-wide values for charcoal, which can be found using the MoFuSS default scenario map. Alternatively a default value of 30% can be used.

**26** Stockwell et al., Estimating under and over reporting of drinking in national surveys of alcohol consumption: Identification of consistent biases across four English speaking countries, Addiction, 2016.

**27** Gill-Wiehl et al., The value of community technology workers for LPG use: A pilot in Shirati, Tanzania, Energy Sustainability and Society, 2022.

**4. Cookstove developers claim that emission reductions from cookstove projects may be overestimated to some extent, but the kinds of issues that resulted in overestimation are limited to early versions of the CDM methodologies, and have been resolved because the methodologies are continually being strengthened through version updates. Can we trust this?**

Unfortunately, current CDM methodologies continue to significantly over-credit. The two most important sources of over-crediting we describe above – the use of simple surveys to monitor stove adoption and usage, and the choice of fNRB value – are problems with current versions of CDM methodologies.

A new methodology, CLEAR, is being developed by a consortium led by the Clean Cooking Alliance for consideration by the UN under Article 6.4 of the Paris Agreement and by several major voluntary carbon offset registries. The current draft of this methodology is well-aligned with current best practice in the published literature. If adopted without significant changes, projects registering under this new methodology should be trusted. Further, projects currently registered under the Gold Standard Metered and Measured methodology that use a rigorous value of fNRB also use best practice methods and therefore can be trusted. At the end of March, the ICVCM announced its decision on cookstove carbon credit methodologies, rejecting several older ones (AMS-II.G, AMS-I.E, and the GS simplified) due to over-crediting concerns and conditionally approving others.

**5. Even if cookstove developers admit to the possibility that they have overestimated the amount of emissions their projects have reduced, they say that the criticism of cookstove projects is excessive since these projects can contribute greatly to improving the quality of life in least developed countries, and that it would be impossible to carry out cookstove projects without incentives from carbon offsetting. Is civil society against all types of incentives for cookstove projects?**

Improved cookstoves projects can have tremendous benefits to the lives of those using the stoves, especially if the stoves reduce smoke enough to meet World Health Organization health standards.

High levels of over-crediting are problematic for three reasons:

First, each credit claims to represent the reduction of one metric ton of carbon dioxide-equivalent (1 $tCO_2e$) emitted to the atmosphere. These credits are used by companies to meet carbon targets or to sell carbon neutral products. When companies use credits that actually represent a fraction of what they claim, those credits can take the place of direct emissions reductions and other more effective measures, and can falsely convince consumers that their purchases have no net impact on the climate.

Second, methodologies that do not accurately monitor actual stove use create a financial incentive for project developers to distribute low cost stoves that break or that users do not like to use, rather than more expensive stoves that are used for a long time. We have seen this happen in at least one project.[28]

Third, in response to findings about poor quality carbon offset projects across many major project types, companies are increasingly seeking high-quality credits that do not pose reputational and legal risks. In order for carbon finance to be a stable and lasting source of funding for cookstoves projects, benefit claims need to be accurate. There already exists a rich body of literature on the effectiveness of improved cookstoves projects and methods for estimating their greenhouse gas benefits. This means that there already exists a strong scientific basis on which to develop quality methodologies that carbon credit buyers can trust.

### 6. According to Article 6 of the Paris Agreement, existing CDM methodologies and projects should be reviewed by the UNFCCC for additionality and other environmental integrity issues. What does this mean for cookstoves projects?

The Paris Agreement includes three pathways for trading estimated emissions reductions from cookstoves projects.

First, Article 6.4, establishes a new offsetting program modeled after the CDM, called the Paris Agreement Crediting Mechanism (PACM). No methodologies have been accepted as of the writing of this FAQ, and so we do not yet know whether lessons learned from previous programs will be incorporated into new methodologies to ensure credit quality. Currently two efficient cookstoves methodologies do not over-credit: Gold Standards Metered and Measured methodology for projects that choose a literature-derived value for fNRB, and the draft CLEAR methodology developed by the Clean Cooking and Climate Consortium (4C). The PACM could adopt either or both of these methodologies for use under Article 6 of the Paris Agreement. The two existing CDM methodologies, AMS-II.G and AMS-I.E, both significantly over-credit but it is yet to be seen if those methodologies will be allowed to be used for new projects under the PACM.

28 Osman, Cookstove: Is the multibillion dollar carbon offset market flawed?, 2023.

Second, some CDM projects are allowed to "transition" to the Article 6.4 mechanism to be eligible to generate credits for use by countries to meet their Paris Agreement targets. To date, projects that applied to transition could produce close to one billion credits for use by countries to meet their Paris Agreement targets. If all projects generate the quantify of credits expected, cookstoves projects would generate 18% of all credits from transitioned CDM projects. Credits are allowed to transition with minimal environmental integrity assessment and no additionality assessment.

The first project accepted for transition is a cookstoves project. A recent analysis of this project found that it is likely over-crediting emissions reductions by a factor of 27 during its 2021–2022 monitoring periods.[29] This mirrors the 28-fold over-crediting observed in earlier monitoring periods detected in this report, highlighting a systemic risk: without stronger oversight and revised methodologies, the Article 6.4 mechanism risks replicating the same credibility issues that plague other offset programs.

Third, Article 6.2 of the Paris Agreement offers countries wide latitude to trade emissions reductions and removals. Unlike Article 6.4, Article 6.2 has no centralized set of quantification methodologies and requirements. This means that countries can write their own carbon accounting rules for activities supported under Article 6.2 with little quality enforcement.

### 7. What are the fundamental problems and limitations of the project-based offset mechanism such as cookstove or REDD+? And what can be an alternative scheme which is not 'market based solutions'?

Today, there is a vigorous debate about the future of carbon offsetting versus alternative "contributions approaches." These debates emerged out of growing concerns about carbon offset quality from both the supply and demand sides.

On the supply side, a shift away from carbon offsets is based on concerns about persistent and widespread over-crediting. Most major offsetting programs and many major offset project types have been found to substantially over-credit. One study of the UN's CDM found that 85% of projects had a low likelihood of being additional and not over-credited.[30] On the voluntary market, studies of major offset project types have also found high levels of over-crediting from

29 Faecks, Results: Over-crediting analysis PoA 10415, 2025.

30 Cames et al., How additional is the Clean Development Mechanism?, 2016.

multiple sources, including avoided deforestation (REDD+),[31-32] improved forest management,[33] [34] and US-based manure methane digesters[35].

The source of this over-crediting is inherent to the structure of carbon offsetting programs, which are uncertain, complex, and contain multiple conflicts of interest. Estimates of the outcomes of offset programs are significantly uncertain largely because the effects of mitigation projects must be measured against a baseline (i.e., counterfactual) scenario that never happened. This uncertainty and often complex GHG quantification methods are deliberated by a set of market actors that generally all benefit from more credits. The buyer seeks abundant low-cost credits; the project developer wants to earn more credits for less cost; the third party auditor is hired directly by the developer and has an incentive to judge leniently in order to be hired again, especially in the context of uncertainty and information asymmetries; and the registries adopting the standards and methodologies (often written by project developers) compete for market share and are paid per account and credit issued. Project developers and registries often write flexible quantification rules to accommodate a wide range of projects. That flexibility has resulted in systematic over-crediting since project developers faced with flexibility and uncertainty have incentives to make methodological choices that lead to more credits. Complexity, as well as opacity (registries often do not publicly release the carbon calculations), shields the market from scrutiny.

On the demand (credit use) side, a concern is that offset credits, which are often cheaper and easier than direct emissions reduction, can create a disincentive to reduce emissions directly. Further, when products use offsets to be called carbon neutral, consumers can be led to falsely believe that flying, driving a gas car, and using products associated with fossil fuel emissions have no impact on the climate. Also, when fossil fuel emissions are offset with carbon stored in nature, increased carbon storage does not undo fossil fuel emissions, but in the best case, shifts carbon from long-term storage as fossil fuels, into the short-term carbon cycle in trees and soil where they are at risk of disturbance and release, risks that are increasing due to climate change itself.

**31** Haya et al., Quality assessment of REDD+ carbon credit projects, 2023.

**32** West et al., Methodological issues with deforestation baselines compromise the integrity of carbon offsets from REDD+, Global Environmental Change, 2024.

**33** Coffield et al., Using remote sensing to quantify the additional climate benefits of California forest carbon offset projects, Global Change Biology, 2022.

**34** Stapp et al., Little evidence of management change in California's forest offset program, Communications Earth & Environment, 2023.

**35** Pierce & Strong, An evaluation of New York state livestock carbon offset projects under California's cap and trade program, Carbon Management, 2023.

Contributions approaches most fundamentally mean performing a climate mitigation action that is in addition to reducing one's own emissions while not claiming that mitigation as an offset. For example, a company can support a project, program, or organization by buying carbon credits or by making a direct donation but without using quantified emissions reductions towards an emissions reduction target or to sell carbon neutral products. Contributions made directly rather than through the carbon market can have other benefits, including making sure funds go to activities rather than consultants and brokers, and making it easier to provide funding at the project start when funds are generally most needed.

Governments can implement contributions approaches in place of offsets to meet emissions reduction targets. For example, in the state of Oregon in the United States, companies can pay a fee of USD129 per $tCO_2e$ into a fund as an option for meeting their obligations to reduce emissions under the state's emissions trading program. The state allots those funds to a vetted set of non-governmental organizations (NGOs) that have committed to using the funds to reduce emissions in the state with a focus on projects that benefit lower income communities. A stakeholder group decides together which NGOs and activities are funded, based on numerous criteria. The incentive structures are fundamentally different from offsetting. Decisions under offsetting programs are driven by sets of carbon accounting rules and market actors seeking the least cost reductions, which two decades of experience shows is vulnerable to gaming as described above. Fund-based programs, like Oregon's, can take a range of factors into account in program decisions, instead of just carbon, and can support a suite of activities that work together to reduce emissions cost effectively.

Plan 1.5

CARBON MARKET WATCH

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