CARBON MECHANISMS REVIEW

VOL. 12 | NO. 1 SPRING 2024

The Silent Heaters

Non-CO_2 greenhouse gases in market-based climate action

Policy crediting under Article 6

How to make it work in practice

content

Spring

editorial

Dear Reader!

'It will take an Olympian effort over the next two years to put us on track to where we need to be in 2030 and 2050', UNFCCC executive secretary Simon Stiell recently said at preparatory meeting in Azerbaijan, underlining once more the critical role of international cooperation in closing both the implementation and the ambition gap.

Based on this notion, we have decided to dedicate this issue of the Carbon Mechanisms Review to non-CO_2 greenhouse gas mitigation and to the role international market-based climate action can play to foster it. Colleagues from GIZ report on promoting the global shift to sustainable refrigerant management, complemented by a portrait of an Art. 6.2 pilot programme promoting the introduction of climate-friendly air conditioners in Southern Africa. We also take up the rising interest in the role carbon markets can play in methane abatement and look at the transition towards more sustainable synthetic fertilizers. SF6 mitigation in the electricity sector and the global carbon market, a topic in the previous magazine, will be taken up again in the next issue of CMR.

Outside the cover feature, we look at policy crediting and how its potential can be harnessed for Article 6 activities, once again underlining the need for an all-encompassing, holistic approach required for achieving the Paris long-term goal.

On the behalf of the editorial team, I wish you an inspired read!

Christof Arens, Editor-in-Chief

Wuppertal Institut

Carbon Mechanisms Review (CMR) is a specialist magazine on cooperative market-based climate action. CMR covers mainly the cooperative approaches under the Paris Agreement's Article 6, but also the broader carbon pricing debate worldwide. This includes, for example, emission trading schemes worldwide and their linkages, or project-based approaches such as Japan's bilateral offsetting mechanism, and the Kyoto Protocol's flexible mechanisms CDM/JI. CMR appears quarterly in electronic form. All articles undergo an editorial review process. The editors are pleased to receive suggestions for topics or articles.

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Combining Paris and Montreal

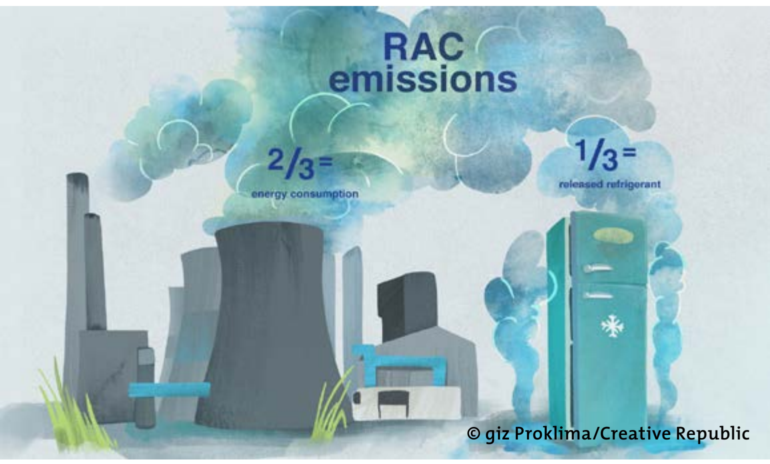
Carbon finance for the transformation of the global cooling sector

by Lydia Ondraczek, GIZ; Joachim Schnurr, GFA; Philipp Denzinger, GIZ; Martin Burian, GFA

Due to global warming and economic growth, the demand for cooling will increase sharply in the coming years, leading to increased GHG emissions from the cooling sector. This creates a significant link between the Montreal Protocol (MP), its Kigali Amendment (KA) and the Paris Agreement, offering new opportunities to align climate policies and achieve their objectives.

In 2018, the US Energy Information Administration (EIA) forecast a tripling of energy use for cooling, reaching 2,000 TWh globally, mainly from fossil fuels. UNEP's 2023 "Keeping it chill"[1] report confirmed this trend, projecting a tripling of cooling capacity by 2050. This surge will more than double electricity consumption by the sector, resulting in 6.1 billion tons of CO_2eq emissions by 2050. Adding to the energy consumption issues (indirect emissions), most cooling technologies rely on refrigerants (F-gases) that range from 771 to 4728 times[2] more potent (IPCC AR6) than CO_2 in causing global warming. These direct emissions occur when the refrigerant leaks or is fully released during operation, maintenance, replacement and equipment disposal. Inadequate decommissioning of refrigerants can also release substances into the atmosphere over long periods of time.

Figure 1: indirect and direct RAC Emissions



Without intervention, direct and indirect GHG emissions from cooling are forecast to increase by 90% by 2050 with severe impacts on Sustainable Development Goals (SDGs). The need for sustainable cooling solutions is evident across various sectors, including food and pharmaceutical supply chains, healthcare facilities and transportation.

Accelerating the phase-down of F-Gases is crucial as recent studies indicate that emission reductions under the Montreal Protocol (MP) and its Kigali Amendment (KA) are not aligned with the Paris Agreement goals. Efforts to address these cooling-related challenges were evident during COP 28, with initiatives like the Global Cooling Pledge aiming to reduce greenhouse gas emissions, improve energy efficiency and enhance access to sustainable cooling solutions.

1 Keeping it chill, UN environment programme, 2023
2 Referring to R32 and R404A respectively

Figure 2: CooPSA project phases

Phase I
PROJECT PREPARATION PHASE

Main objectives:
- Assessing the feasibility of implementing a national cooling programme
- Confirming partner participation in Phase II

Funding volume:
EUR 1 million

→

Phase II
PILOT IMPLEMENTATION PHASE

Main objectives:
- Pilot Art. 6 under the CooPSA programme
- Top-up the incremental costs of around 20,000 Green AC/HPs in the partner countries

Funding volume:
EUR 6 million

→

Phase III
IMPLEMENTATION PHASE

Main objectives:
- Rollout national Art. 6 based CooPSA programmes in the participating partner countries
- Crowd in additional carbon/climate finance

Funding volume:
To be determined

However, these aims must be translated into concrete policy action and financial support to overcome existing barriers. Practical action hinges, for example, on the availability and accessibility of technological solutions such as green cooling solutions that are highly energy-efficient and utilise natural refrigerants with low global warming potential (GWP) such as R-290, which has a GWP of only 0.02 kg CO_2eq./kg. This refrigerant boasts excellent thermodynamic properties, making it more efficient than conventional refrigerants. Split air conditioning units (AC) using this refrigerant typically require less refrigerant charge and can also be used as heat pumps (AC/HP). However, their availability falls short of demand as these solutions are often more expensive or unavailable on national markets.

To address this challenge, financial support for large-scale market launches of Green AC/HPs using climate and carbon financing instruments offers a promising solution.

The potential and relevance of the nexus between the Paris Agreement and the Montreal Protocol is already being explored in practice. Funded by the International Climate Initiative, the German government is supporting the development of an Art. 6.2 pilot promoting the introduction of Green AC/HPs to the market in Southern Africa (Botswana, Eswatini, Namibia, South Africa). A two-phased implementation approach, the “Cooling Program for Southern Africa (CooPSA)” which started in 2021, shall assess the opportunities and challenges for rolling out this innovative concept on a large-scale, i.e., nationally, regionally or even on a global scale (see figure 2). After the first phase is completed in June 2024, the Pilot Implementation Phase will begin, which is intended to test the conditions for large-scale implementation in the region and in other countries by 2026.

Figure 3: Leapfrogging in the Cooling Sector

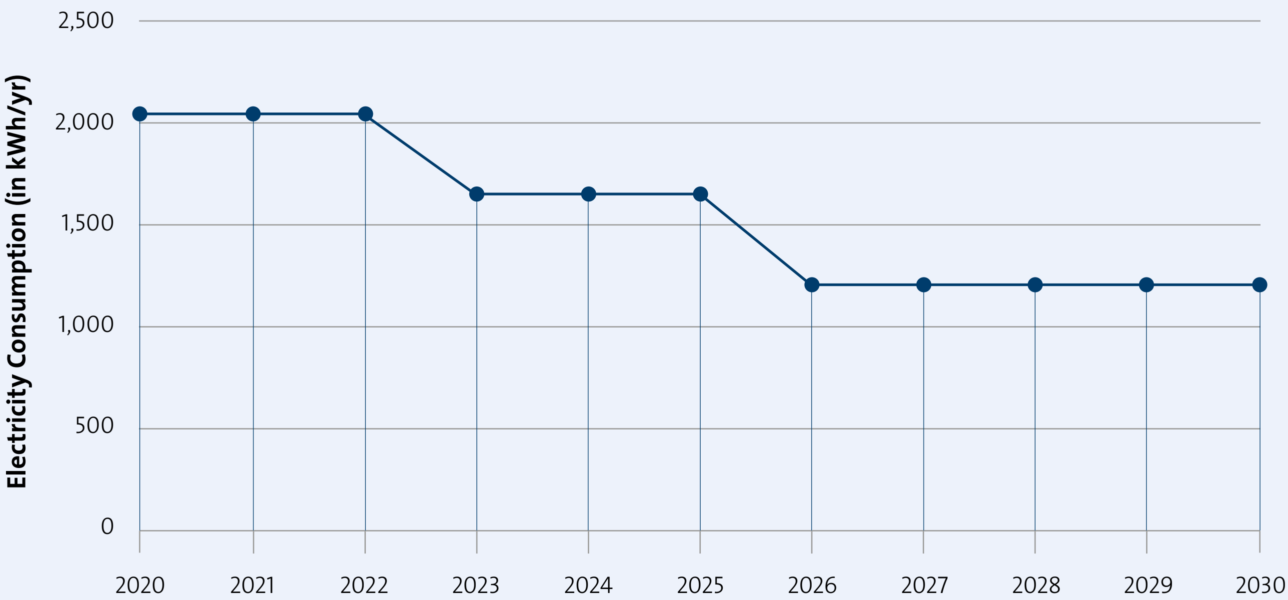
CooPSA's intervention design aims to support selected countries in preparing national conditions to accelerate the market introduction of Green AC/HPs by implementing Minimum Energy Performance Standards (MEPS) for cooling nationwide while also promoting the use of natural refrigerants by supporting development and implementation using a push-and-pull approach.

Push component. MEPS shall regulate the energy efficiency of new AC systems. The programme aims to implement MEPS nationwide and then move towards economically optimal energy efficiency level in stages, e.g. 2,000 kWh/yr for a 9,600 BTU AC (single split) over a period of several years (BTU = British Thermal Units).

This shall minimise spending on cooling while generating energy savings and related GHG emission reductions. The figure illustrates such a possible minimum energy performance standard over time.

Pull component. The introduction and enforcement of MEPS must be supported by a sustainable and competitive, performance-based funding structure. An economic analysis by the project team evaluated the lifecycle costs of AC devices including electricity subsidies paid in the partner countries. Using current (high) interest rates, it indicated that consumers minimise their lifecycle costs when purchasing cheap and energy-inefficient devices. More energy-efficient devices become financially attractive if a financing instrument reduces the capital cost and offers a carbon-based top-up mechanism.

Figure 4: Example of a regulated Minimum Energy Performance Standard over time



The preparation phase comprised the following steps:

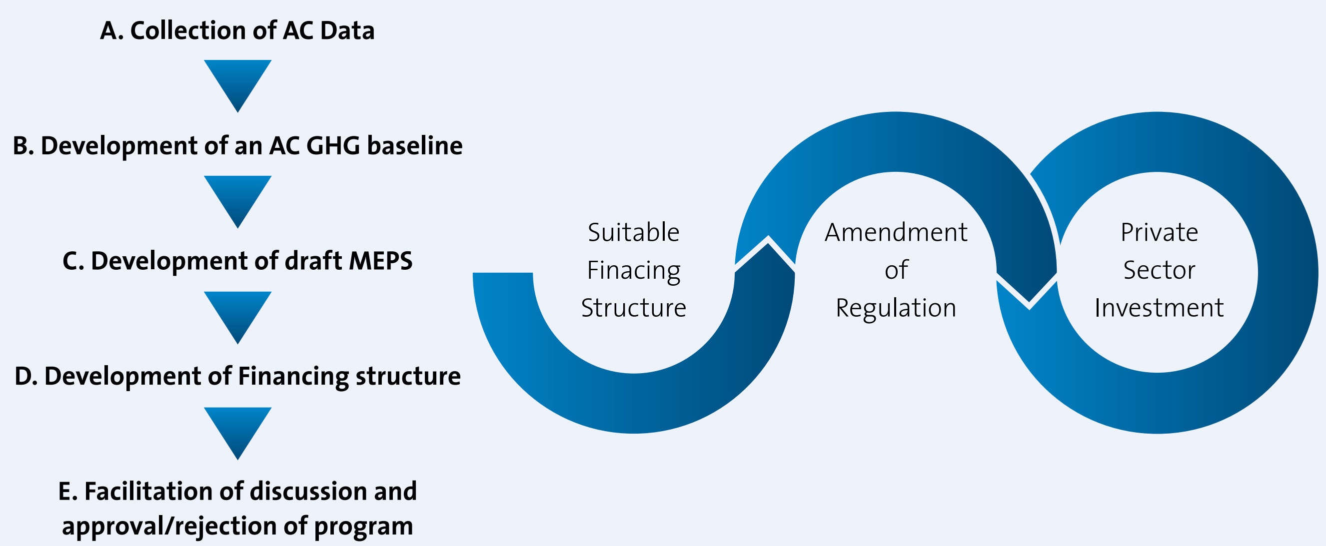
Step 1 involved preparing comprehensive project documentation on implementing the cooling programme under Article 6 (A6) of the Paris Agreement including baseline setting, taking into consideration the unconditional NDC of the partner countries as well as monitoring methodologies (for GHG and sustainable development impacts). The work required extensive and lengthy research to determine the baseline and included analysing databases to determine the current stock and different types of ACs/ HPs currently traded on the national markets. For each partner country, models were created using the available data to calculate the respective reduction potentials in detail. These served as the basis for preparing the country-specific Mitigation Activity Design Documents (MADDs) as part of the preparation phase.

Step 2 addressed policy and regulatory barriers by supporting the development of adequate policy instruments that support the accelerated market uptake of Green ACs. In the project context, the adoption of national Minimum Energy Performance Standards (MEPS) for split ACs and corresponding regulation is supported. These MEPS will be combined with an energy labelling scheme, which will provide a direct and effective way to inform consumers of the performance of certain equipment. In this way, MEPS and labels will encourage importers and retailers to import and sell more energy-efficient equipment. Once obligatory MEPS and labels are in place, market surveillance will be crucial to ensure their enforcement and support the accelerated market uptake of Green AC/HPs. In this context, measurement monitoring, validation and enforcement (MVE) processes will be established.

The third step, the actual AC/HP replacement programme aimed to introduce environmentally and climate friendly, energy-efficient equipment. Activities were also directed at ensuring that local and regional retailers and importers in the partner countries become aware of the benefits of importing such appliances and establishing the respective procurement channels for the new products. To ensure good and safe refrigerant management including end-of-life treatment (EoL) of old refrigerants, several activities were planned and prepared: developing training material, installation of training centres and waste management centres, and training for trainers and AC technicians in Green ACs and EoL. These activities are to be jointly implemented with approved national training centres and national trainers. The training provided will give AC technicians access to the new technology and prepare them to handle the Green AC/HPs. Additional positive spillover effects to other sub-sectors are expected.

Step 4 aimed at developing an efficient and appropriate financing structure for the Pilot Implementation Phase. The envisaged financing structure is based on the funds provided by the International Climate Initiative, which will be used to close the price gap between conventional and Green AC/HPs in order to stimulate market uptake. As an Art. 6.2 piloting activity, carbon payments are granted for replacing (and adequately disposing of) existing equipment or for newly purchased equipment with Green ACs/HPs that exceed MEPS requirements. The German government will not use the theoretical Internationally Transferred Mitigation Outcomes (ITMO). Emission reductions generated during the Pilot Implementation Phase will be counted towards the unconditional NDC of the partner country. However, CooPSA also intends to prepare the way for the pilot to be transformed into an Art. 6 activity for the potential Implementation Phase, which will then generate tradable ITMOs. All lessons learnt will be fed

Figure 5: Work steps required for taking the cooling concept to the Pilot Implementation Phase



A staged photo of the ad hoc working group of CooPSA © giz Proklima

into the Art. 6 frameworks of the partner countries, who can use the pilot project to test their Carbon Market Frameworks. Figure 5 shows the work paradigm applied in the Project Preparation Phase.

Immediately after the preparation phase began, ad-hoc working groups (AWG) were set-up in each partner country to provide guidance to the consultant team on design decisions, to assess proposed implementation measures and to approve key decisions. The members consisted of a lead representative and an alternate from each key stakeholder agency in each of the countries. Regular virtual meetings and national and regional in-person workshops facilitate continuous, intensive exchange on experience between the project team and national stakeholders, and more importantly among the partner countries.

CooPSA is now preparing for the beginning of the Pilot Implementation Phase in 2024.

During the Pilot Implementation Phase, a financing instrument will be developed that builds on the experience gained during this phase and enables the large-scale rollout of the cooling programme by

- setting it up as a national Article 6.2 activity or a 6.4 programme of activities (if approved by the respective authorities in the countries);
- allowing the crowding in of additional funding sources, such as highly concessional loans from Development Finance Institutions;
- providing the opportunity to involve local debt capital markets.

Technical training leading to the creation of highly skilled (green skilled) and new green jobs will continue on a large scale.

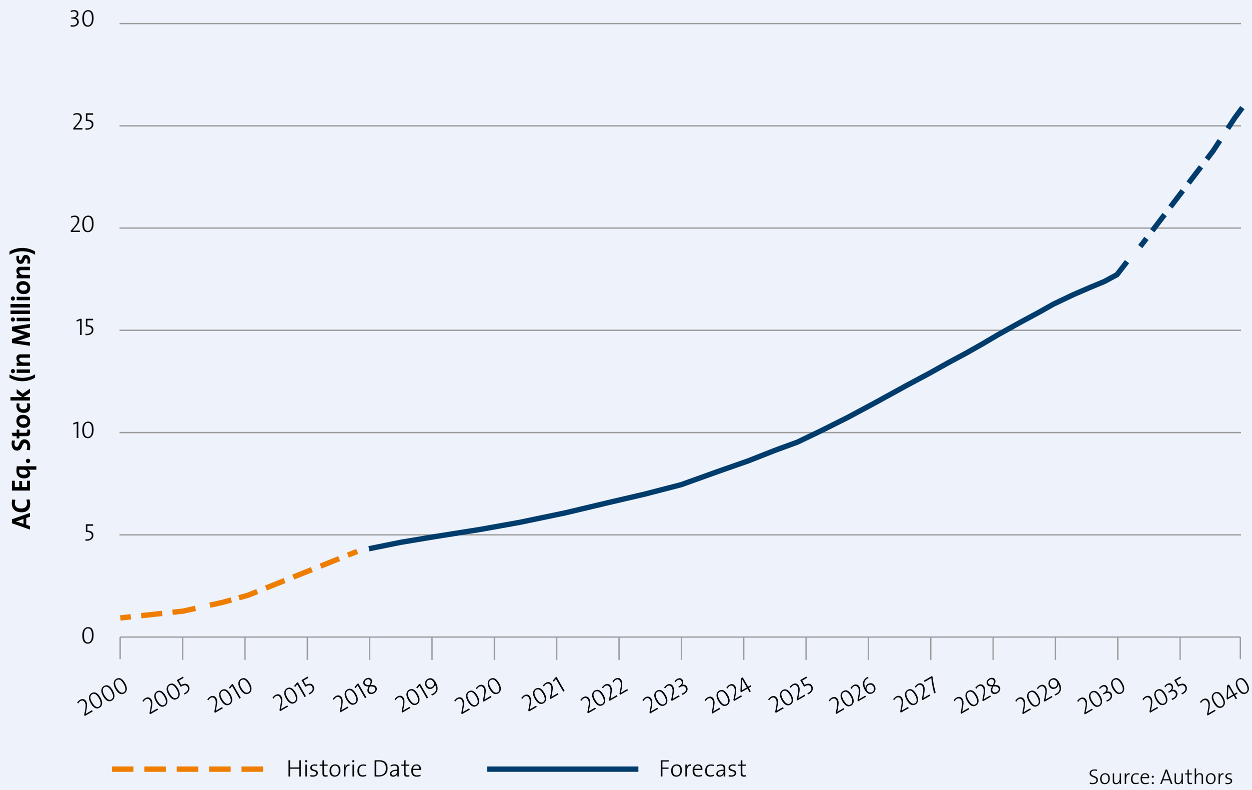
Modelling the impact on the SADC region

The Southern African Development Community (SADC) region is facing a significant need for cooling, which is projected to increase due to climate change. The average temperature increases in the SADC region are above global average projections and range from 3 to 5°C by 2100[3]. Due to the (increasing) need for cooling and the economic development of the SADC region, the amount of cooling devices is projected to increase from 5.39 million in 2020 to 17.68 million by 2030, see figure 6. This is well beyond the 1.5°C pathway. Cooling is a significant factor in this equation.

2.3 billion people from the lower middle income class are set to purchase the most affordable and possibly least efficient air conditioners. This could have a tremendous impact on global GHG emissions.

The table provides an estimation of potential GHG emission reductions (ER) from one air conditioner/heat pump unit over an assumed lifetime of 10 years in Namibia. The amounts vary depending on the cooling capacity of the device, which is given in British Thermal Units (BTU). The calculation comprises direct emission reductions (ER) through the use of a green refrigerant and energy efficiency gains from a highly efficient heat pump for both cooling and heating.

Figure 6: Development of single AC stock over time for the SADC region



Source: Authors

3 SADC Regional Indicative Strategic Development Plan

Table: Estimated GHG emission reduction (ER) potential for Green ACs/HPs installed in Namibia over the lifetime of the equipment

	Direct ERs (tCO_2e)	Indirect ERs tCO_2e)	Total ERs (tCO_2e)
9,000 BTU	1.12	2.30	3.42
12,000 BTU	1.69	8.54	10.23
18,000 BTU	2.37	14.70	17.07
24,000 BTU	3.05	16.30	19.35

Based on modelling carried out during project preparation[4], rolling out the cooling programme in the SADC region would approximately result in

- GHG emission reductions of 20.5 million tCO_2e by 2030[5],
- energy savings of 21,750 GWh by 2030 and 146,500 GWh by 2040, respectively,
- reducing the energy cost by EUR 9.375 billion for consumers,
- reducing indirect (energy) subsidies by EUR 6.9 billion for governments.

Outlook

The ultimate objective of CooPSA is to facilitate the large-scale deployment of Green ACs/HPs and sectoral transformation by developing and implementing national cooling programs. The corresponding activities would assist countries in reaching their energy sector-related targets for their NDCs and pave the way to assist them in setting long-term, ambitious targets for reducing GHG emissions from the RAC sector.

Overall, national cooling programs could contribute to various Sustainable Development Goals, thus providing additional co-benefits for the implementing countries.

It is high time that effective measures are implemented to counter the unavoidable increase in emissions in the cooling sector. The combination of the Paris Agreement and the Montreal Protocol (Kigali Amendment) within an integrated package of measures could offer a promising solution that can be implemented quickly.

4 The calculation does not yet include emissions from using the AC for heating purposes.
5 Using the lates available Grid Emission Factor of the Southern African Power Pool (SAPP)

Driving Change

COPA – using carbon markets to finance sustainable refrigerant management

by Malin Emmerich and Maria-Theresa Bruns, COPA Secretariat, GIZ Proklima

In almost every home, building, and vehicle worldwide, there is a type of fluorinated gas called hydrochlorofluorocarbon (HCFC) and/or a hydrofluorocarbon (HFC) used in cooling appliances and insulating foam. These gases, when leaked, harm the ozone layer, and contribute significantly to the ongoing anthropogenic climate change, with a potency thousands of times greater than carbon dioxide. The problem is exacerbated by the growing demand for cooling as a result of rising global temperatures, creating a vicious circle in which new appliances with more gases come onto the market.

Additionally, if outdated or end-of-life refrigerants, including foams, are not being managed in an environmentally sound manner, the accumulation of so-called ozone depleting substances (ODS) and HFC banks will continue to grow. Currently, each year, approximately 1.5 $GtCO_2eq$ is estimated to be released into the atmosphere due to improperly managed or disposed refrigerants. This corresponds to the annual greenhouse gas emissions of 441 coal-fired power plants.

Despite international treaties like the Montreal Protocol and the recent Kigali Amendment, which aims to phase down HFCs globally and replace them with more sustainable solutions globally, sustainable ODS and HFC bank management has historically lacked international attention.

In addition, financing of ODS/HFC bank management is generally challenging due to the sector's complexity and the different circumstances in the individual countries. The lack of awareness about the mitigation potential and corresponding financing opportunities has limited the support, leading to fragmented efforts implemented to date.

This is where COPA – **the Climate Ozone Protection Alliance** – finds its role. COPA was initiated by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) to put a spotlight on the need for ODS/HFC bank management. The COPA set-up and establishment is funded under the International Climate Initiative (IKI) and jointly implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, United Nations Industrial Development Organization (UNIDO) and United Nations Development Programme (UNDP). GIZ is hosting the COPA Secretariat as part of the GIZ Proklima Cluster, which has been promoting environmentally friendly and energy-efficient cooling technologies on behalf of the German government since 1995.

1 cp. Global roadmap on ODS bank management1). GIZ 2017, https://www.copalliance.org/imglib/downloads/2017_Global_roadmap_on_ODS_bank_management.pdf

COPA's member-centred approach

COPA operates as a member driven alliance, providing a platform for partner countries and members across private and public sectors to expand knowledge and exchange experience. Through thematic working groups and events alliance members actively contribute to the goals of the alliance.

COPA is open to all countries and entities, willing to support the global shift to sustainable refrigerant management and closing the loop to a circular economy in the cooling sector. By advancing holistic solutions to reduce ODS and HFC banks, COPA promotes a global shift to sustainable refrigerant management, while helping partner countries and members to access funding and support needed to enact mitigation measures.

Find out more at https://www.copalliance.org/

© Climate and Ozone Protection Alliance (COPA)

COPA advances holistic solutions for lifecycle refrigerant management by combining financing, policy making, and expertise in recovery, reclamation, and destruction technologies with hands-on experience in the cooling sector. The Alliance increases knowledge, creates awareness, and contributes to securing sustainable financing solutions for a range of ODS and HFC banks management measures.

COPA goes Carbon Markets

Bringing together actors from different sectors to jointly work on holistic solutions needed to reduce ODS and HFC banks is an important part of COPA's work. In that spirit, COPA established a Working Group on Financing Mechanisms.

Several of COPA's members already have direct experiences from the voluntary carbon markets, e.g. with credits generated for destruction of ODS substances, while other members have participated in existing carbon markets such as the cap-and-trade Emission Trading Systems (ETS) in California or in the EU. This knowledge is shared through different COPA membership events, but also in more informal brainstorming sessions and exchanges in the Thematic Working Group for Financing Mechanisms, for example through peer-review of publications, or in Q&A with experts.

Additionally, COPA has organized several thematic webinars to shine light on the pivotal role of finance in driving change. In January 2024, COPA members delved deep into financing options under Article 6 of the Paris Agreement, facilitating international support for climate projects. Generally, there is a strong agreement in the Refrigeration and Air conditioning, heating, and ventilation (RACHV) sector on the importance of lifecycle refrigerant management, the disagreement is on how to best finance it. With this as a starting point, experts from the Yale Carbon Containment Lab introduced and assessed the financing options for lifecycle refrigerant management emerging from Article 6's three approaches – Article 6.2, Article 6.4, and Article 6.8. The session focused on how each approach is structured to mobilize international carbon finance to meet countries' Nationally Determined Contributions (NDCs), the challenges they face, and what role COPA could play in overcoming these obstacles.

The conclusions highlighted the lack of high-quality methodologies for conducting inventories and establishing accurate emission baselines for verifying and monitoring emission reductions as a major obstacles to the implementation of Article 6. However, COPA can assist in overcoming these obstacles, for example by providing guidance and training on appropriate and available methods. Challenges related to the financing and verification of mitigation activities for Greenhouse gases that are not part of the NDC reporting under UNFCCC (and thus outside the scope of Article 6) were also mentioned in the conclusion. Again, it was recognised that COPA may play a role in overcoming this hurdle by conducting research, raising awareness, and continuously publishing guidelines. View the recording of the webinar at https://www.copalliance.org/news-event/webinar-financing-refrigerant-management.

In May 2023, COPA hosted a webinar for National Ozone Officers with the aim to both spread the word on a new funding window by the Multilateral Fund (MLF) for the implementation of the Montreal Protocol for an inventory and action plan on banks of used or unwanted controlled substances, and to clarify the synergies between the MLF and COPA's work in this aspect. During the webinar, COPA's updated standard methodology for conducting ODS and HFC bank inventories was presented in detail, as it may support countries when applying for or implementing projects under the above-mentioned MLF funding window. The methodology may also facilitate establishing a baseline for entering carbon markets or designing targets in the NDCs.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Examples of COPA's activities

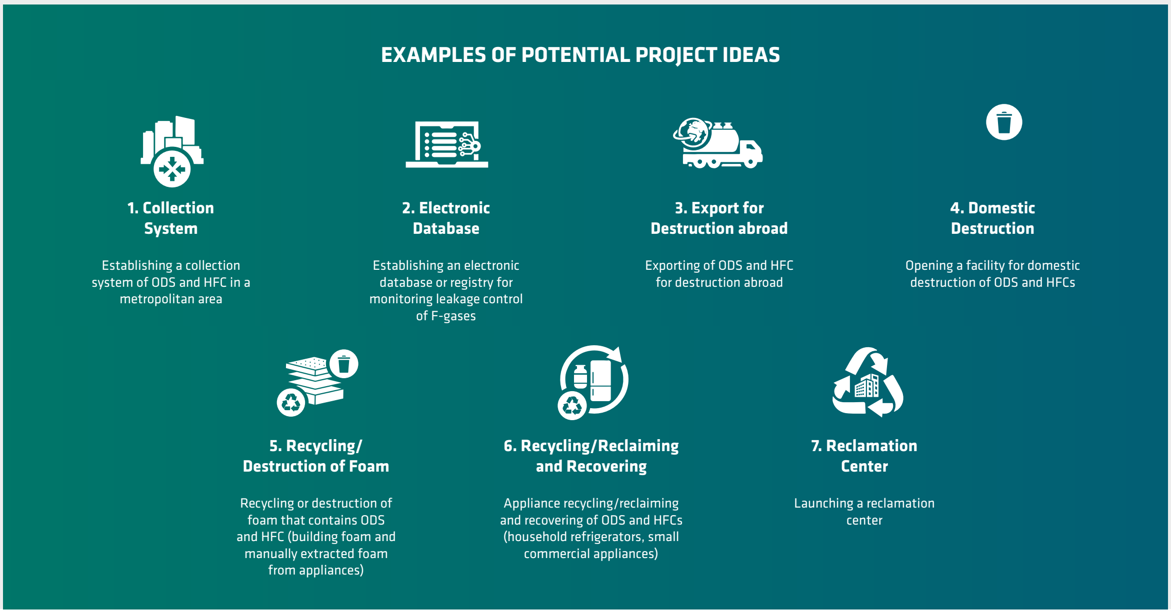
Example 1:
Let's cut refrigerant emissions – A Call for Ideas

In an open Call for Ideas, COPA encourages all its members to communicate and submit project ideas as a first step of a project preparation process that aims to introduce effective solutions for ODS and HFC banks management. In December 2023, an online workshop was held to present the Call for Ideas in more detail and promote a discussion about possible topics to further explore possible synergies between members. In a next step, the Steering Committee will evaluate the submitted proposals and in collaboration with the COPA Secretariat advance and advice the project ideas accordingly. Ideal would be not only to identify but secure sustainable financial solutions for these ideas.

If eligible and approved by the Steering Committee, COPA members can receive tailored support for their submitted project ideas. With the support of multi-disciplinary expertise, COPA works with its members to support them with developing their ideas into mature and ready-to-finance projects. In the process, the experts and member project team will assess and develop financial, technical, and regulatory aspects of the projects, dependent both on the identified need and the commitment contributed by the member(s) themselves.

In the context of project financing, the piloting of Article 6 instruments as well as the voluntary carbon market route are expected to play an important role for implementing COPA projects. Through continuous exchange and knowledge building sessions, and the support of the working groups, COPA will develop and implement project solutions with its members, contributing with real reduction of emissions from ODS and HFC banks toward the goals of the Paris Agreement.

Figure 1: Examples of potential project ideas. © COPA



Growing attention for a blind spot

The global awareness for the need to address lifecycle emissions in the refrigeration sector is steadily growing. Apart from the above-mentioned funding window from the MLF, there is an increased focus on reducing HFC bank mitigations in the ongoing implementation of the Kigali Amendment to the Montreal Protocol. Furthermore, the last Meeting of the Parties to the Montreal Protocol (MOP35) decided to dedicate a full day before its next annual meeting for a workshop on lifecycle emissions in October 2024.

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Notably, the momentum to tackle lifecycle refrigerant emissions is not limited to the Montreal Protocol and Kigali Amendment. At the 28th United Nations Climate Change Conference (COP28), the Global Cooling Pledge emerged as a landmark initiative, and more than 60 countries signed that they are committed to pursue the lifecycle management of HFCs banks.

This growing commitment at the international arena demonstrates the urgency and broad consensus to take action to reduce and limit the harmful emissions from both ODS and HFC banks. With its holistic approach and involvement of both private and public stakeholders as well as academic actors and representatives from civil society and financial institutions, COPA brings the relevant stakeholders together to develop the solutions needed to turn these commitments and plans into action.

Example 2:
Financial Model for assessing viability of carbon markets for financing EOL management of refrigerants

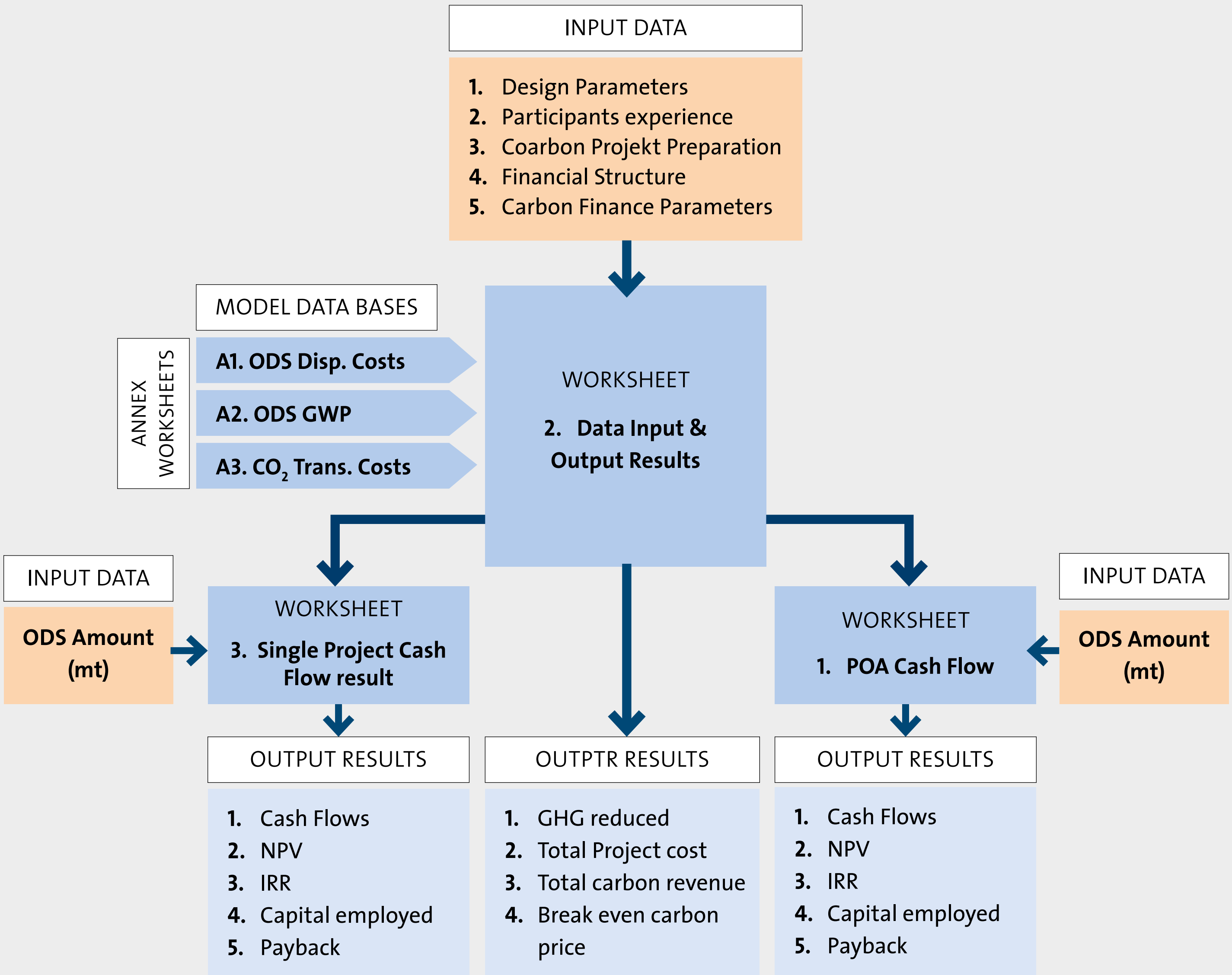
The report *"Using carbon markets to reduce emissions from end-of-life refrigerants and foam blowing agents"* commissioned by UNDP's Montreal Protocol and Chemicals and Waste Unit was published by COPA in May 2023. The study is focused on the assessment of the potential of using carbon markets for proper disposal of end-of-life (EOL) refrigerants and foam blowing agents with high global warming potential. The objective of the report is to assist National Ozone Officers in learning about existing management experiences, including applicable methodologies, to enable them to assess the financial feasibility of covering all stages of EOL (recovery, collection, storage, transportation, destruction) in their jurisdiction. The full report can be downloaded at https://www.copalliance.org /imglib/downloads/TWG%20FM/2023-03-30%20Report%20Carbon%20Financing%20Potential%20for%20ODS%20Destruction%20Projects.pdf

The tool works like a financial model in Excel by calculating a break-even price for entering the carbon market. As such, the excel-model may assist e.g. countries and developers in assessing the financial feasibility of projects under Article 6.2 for ITMOs but it can be adapted for voluntary markets, too. To learn more about the tool, go to https://www.copalliance.org/imglib/downloads/TWG%20FM/2023-03-30%20TWG%20FM%202%20presentation%20printversion.pdf.

The tool is available upon request via mail to contact@copalliance.org.

Kindly note that neither COPA nor UNDP are responsible for any damages, losses or other consequences resulting from the use of this tool. The information in this document does not constitute legal or other professional advice.

Figure 2: Flowchart of Tools for ODS Destruction Projects with Revenues from ITMO Transfer.



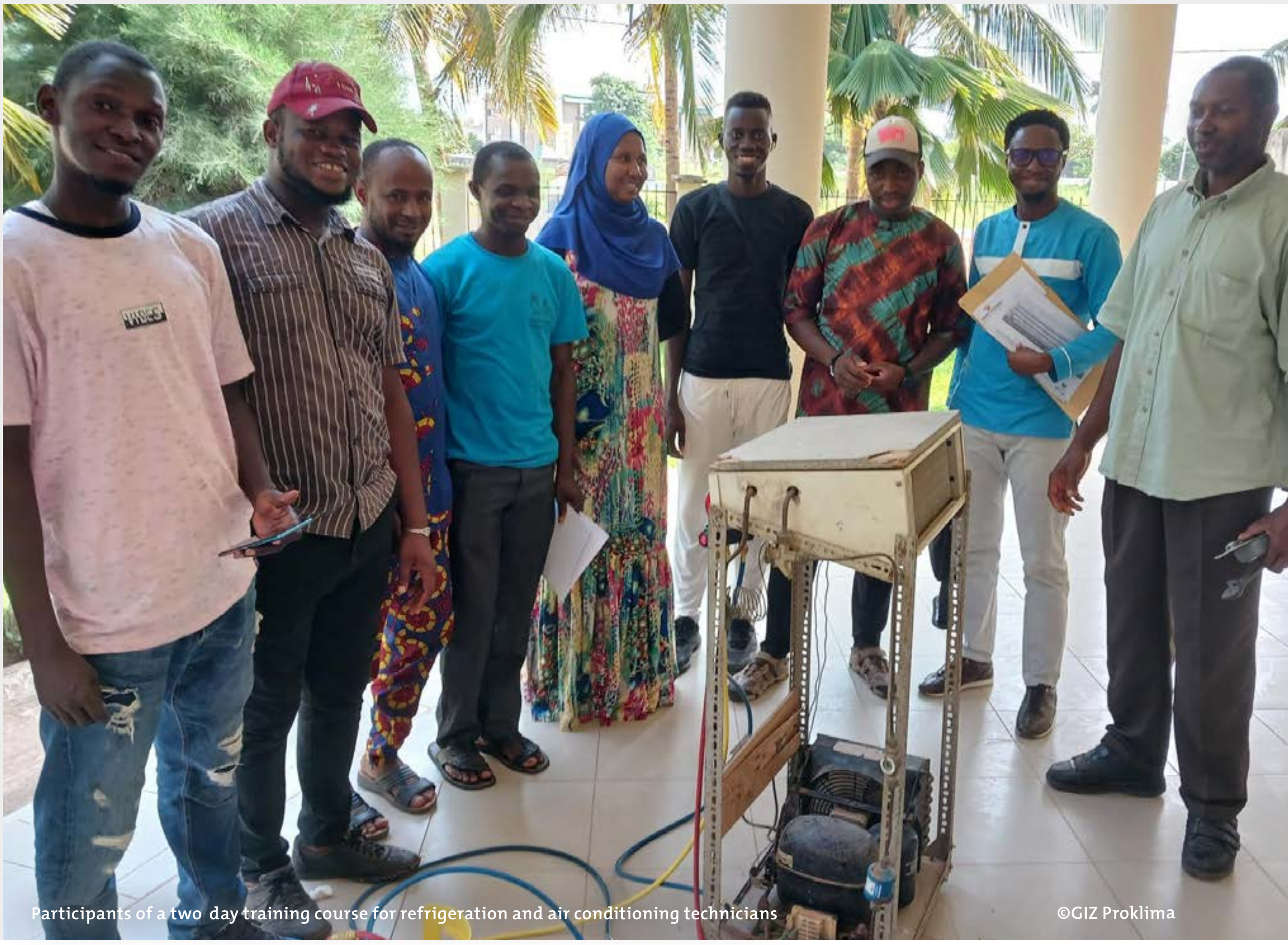
Source: © Juan C Mata Sandoval, UNDP

Example 3:
COPA trains technicians in The Gambia in refrigerant recovery

In The Gambia, a two-day training course for refrigeration and air conditioning technicians was organised by COPA. This initiative, which was conducted jointly by the National Environment Agency (NEA) and GIZ, aimed to improve technicians' skills in the responsible use of refrigerants, with a focus on the important aspect of refrigerant recovery.

The training covered fundamental aspects of refrigeration circuits, awareness of climate issues, and the essential steps for safe refrigerant recovery. Another emphasis was put on best practices, practical exercises, and insights into alternative eco-friendly refrigerants such as natural refrigerants. The training concluded with recommendations to continue and intensify similar programs, educate appliance owners on responsible practices, advocate for stricter environmental standards, and increase accessibility to recovery machines.

This initiative played a vital role in raising awareness among technicians regarding the environmental impact of refrigerants. Therefore, it sets the stage for continued collaboration reinforcing The Gambia's dedication to environmental preservation and reduced greenhouse gas emissions.



Participants of a two day training course for refrigeration and air conditioning technicians ©GIZ Proklima

Beyond the Obvious

The urgent problem of anthropogenic methane emissions

by Elias Spiekermann, German Federal Ministry for Economic Affairs and Climate Action, BMWK; Sarah Rieseberg, Advisor to BMWK

The role of CO_2 in global warming is well known. However, 30% of the today´s temperature increase has been driven by methane emissions. While many efforts have been made to combat CO_2 emissions globally, methane abatement approaches are still poorly developed. Today, the concentration of methane in the atmosphere is three times higher compared to the pre-industrial era, and methane emissions continue to rise. It is estimated that around 60% of methane emissions are caused by human activities. The remainder comes from natural sources. Three sectors are mainly responsible for the global anthropogenic methane emissions: The agriculture sector (e.g. livestock farming, especially ruminants, and wet-rice cultivation), the fossil fuel sector (e.g. methane from coal seams, associated gas in the oil production, leakages in gas value chains) and the waste sector (mainly biological components disposed on landfills).

The data on methane emissions is subject to a high degree of uncertainty. Overall, the rising methane concentration in the atmosphere can be well tracked, and methane molecules provide some information about their origin. However, anthropogenic and natural sources of methane emissions are diverse, often diffuse, and in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many cases very difficult to monitor. Methane emissions from inland waters such as wetlands face the highest degree of uncertainty, showing large variability over time (e.g. seasonal flooding). At the same time, it is difficult to track the complex chemical removal processes of methane in the atmosphere, the main sink of methane. These uncertainties are the reason why the high methane growth rates since 2007 have been difficult to explain. While some scientific studies conclude that these high growth rates are driven by anthropogenic sources, other studies see a stronger contributor in tropical wetlands. Scientists expect that higher temperatures, increased humidity, and changing precipitation patterns lead to increased microbial methane production in wetlands.

This process represents a potential positive climate feedback loop, bringing the world closer to climate tipping points. Another example of a positive feedback loop is the releasing of methane emissions through the thawing of permafrost. However, methane threats are not only sitting within ecosystems. Rising methane concentrations also affect the stratospheric and tropospheric chemistry, potentially slowing down methane removal processes. Compared to carbon dioxide, one additional methane molecule is much stronger contributing to global warming. At the same time, the lifetime is much shorter – methane is decomposed in the atmosphere in approximately 9-12 years. One of the results of the chemical decomposition processes is CO_2. Because of these properties, the contribution of methane to global warming is higher in the short term (over 20 years approx.

84 times; over 100 years approx. 28 times stronger than CO_2). The short lifespan also means that any reduction in methane emissions would pay off relatively quickly. It is estimated that reducing anthropogenic methane emissions by 45% (180 million tons a year) until 2030 would avoid nearly a 0.3°C global temperature increase.

Technologies and mitigation measures available today would be sufficient to tackle methane emissions in line with 1.5°C-pathways. For example, almost 70% of methane emissions in the fossil fuel sector could be mitigated with existing technologies, with around 40% being avoidable at negative or no net cost, based on energy prices in 2023. The annual net methane mitigation potential with net positive revenue from the waste, oil and gas sectors is estimated to account for more than 3 Gt-CO_2e. Moreover, the abatement costs across sectors are relatively low for almost all measures with less than 50 USD/t- CO_2e. In addition to technological mitigation options, phasing out of fossil fuels, reducing and separating waste, developing a circular economy, and a transitioning towards a sustainable agriculture with reduced meat and dairy consumption are key strategies for reducing anthropogenic methane emissions to a minimum.

Positive effects of methane emissions abatement are not only limited to climate change. Methane also contributes to the production of low-lying ozone which can have harmful effects on human health, crop yields and ecosystems. Reducing methane emissions would therefore also reduce premature deaths, decrease crop losses, and bring economic benefits.

"With better tracking, you can run but you can't hide"

At COP28, John Kerry, the former US Special Presidential Envoy for Climate, used strong words to urge the fossil fuel industry to finally address methane emissions of the sector. With around 120 million tons of methane emissions in 2023, the sector is responsible for around one third of the total anthropogenic methane emissions. For a long time, companies and other stakeholders in the sector have swept the problem under the rug. It is very likely that today the embedded methane emissions of a crude oil delivery to any country are unknown or at best a very rough (but often wrong) estimate. Methane emissions of companies, products and respective value chains as well as of many countries are hardly known and barely measured. However, the slogan "only what gets measured gets done" is also true for methane emissions.

Improved measurement technology – from cameras to satellites – and the introduction of sector specific Measurement, Monitoring, Reporting and Verification (MMRV) schemes allow for better data collection and transparency. While still in the early stages, the field is developing quickly. In March 2024, a new satellite from the Environmental Defense Fund and partners, MethaneSAT, was installed to explicitly measure methane emissions from oil and gas facilities around the world. Together with existing satellites and several upcoming missions until 2026, data availability will therefore improve significantly for all three sectors. Already today, the so-called Methane Alert and Response System of the International Methane Emission Observatory (IMEO) uses satellite data to detect large methane emissions events around the world and to notify respective governments. The significant improvements in the measurement of methane emissions are likely to become a game changer in the near future.

Methane emissions abatement – still in its infancy

Within the last three years, methane has risen to the top of the global climate agenda, driven primarily by the "Global Methane Pledge". Under the pledge, 156 countries have committed to collectively reducing global methane emissions by at least 30% by 2030 from 2020 levels across all three sectors. The pledge sparked international activities, discussions, financial commitments, and new research.

Despite rising activity levels, there are still no signs of a trend reversal in human-caused methane emissions. Markets clearly have failed to internalize the negative external effects in all three sectors, agriculture, fossil fuel, and waste. Also, governments of the relevant methane emitting countries have largely missed to address the issue effectively. Until 2023, globally only 13% of anthropogenic methane emissions have been covered by methane abatement policies – often with unclear effectiveness. Two promising examples of regulatory approaches are the proposed EU Methane Regulation for the energy sector, and the US approach to charge fees for excess methane emissions in the oil and gas sector. Missing coverage is also visible in the NDCs. While most countries address methane in their NDC targets, so far only a small number identifies measures to tackle methane.

There are several reasons for the lack of well-designed legal frameworks and enforcement mechanisms. As mentioned, missing data is among the main problems. High transparency of methane emissions would not only enable regulatory measures, but would also allow for informed investment and purchasing decisions and would support the understanding of climate-related risks of investments.

The complexity of methane sources and vested interests are additional reasons why methane has not been a policy focus. In the agricultural sector for example, common farming practices are highly sensitive topics that cannot be easily addressed by technological solutions. While technological fixes in the oil and gas industry are widely available and cost-effective, the economic importance and political connectedness of the sector makes it often "immune" to environmental regulation. In the coal sector, on the other hand, coal phase out is a major lever to reduce emissions, but this is connected to its own major political complexity.

In the waste sector, municipal stakeholders are predominantly responsible for waste management. However, they are often overburdened with public service obligations, reducing capacities for addressing climate change issues on a voluntary basis. In addition, national regulators dread regulatory approaches, since they are aware of the costs connected to waste separation, the difficulties in banning municipal landfills, or the lack of capacity on the ground. Lack-

ing capacities and knowledge of methane mitigation is also affecting the activity level of companies and financial institutions.

The underexplored policy opportunities are also one reason for why methane abatement is chronically underfinanced. Current annual finance flows (public and private) for methane abatement have to increase by almost four times until 2030 to around USD 48 billion and to around USD 119 billion by 2050 in order to deliver 1.5°C-aligned emission reductions. In addition to the finance gap, existing finance flows are not allocated efficiently across sectors and regions. Of around USD 13.7 billion that have been identified as methane abatement finance in 2021/2022, less than 1 % addresses the fossil fuel sector, missing out the highest abatement potential that could be achieved per dollar of investment. The lack of regulatory frameworks, reduction targets of companies, mitigation pathways of countries, and data leads to unclear investment opportunities and missing project pipelines for methane mitigation.

Future perspectives of market-based methane abatement

In the current mix of global methane abatement approaches, market-based instruments play a very limited role. Similarly, methane emissions are not part of the vast majority of carbon pricing mechanisms. For instance, only 2% of carbon credits from land-based projects between 1996 and 2021 addressed methane. Within the Clean Development Mechanism, a significant number of projects included methane (e.g. landfill, animal manure or waste water treatment methane recovery; methane capture in mining) with mixed results.

The Pilot Auction Facility for Methane and Climate Change Mitigation (PAF) – A possible blue print for future auctioning mechanisms

With the foreseeable end of the demand for certified emission reductions (CER), the further performance of CDM methane project activities was at risk. Shortages in financing flows towards the projects would have stopped methane abatement activities. Having anticipated the vulnerability of certain methane project activities, the World bank set up the Pilot Auctioning Facility (PAF) with financial support from Germany, Sweden, Switzerland and the US. The initiative was later opened up to credits under the Verified Carbon Standard and the Gold Standard.

The supply of credits came from already existing CDM activities, facing only operational and transaction costs. In three auctions for methane (2015, 2016, 2020), 49 million US-Dollar were allocated with a total mitigation potential of around 18,6 $MtCO_2$-eq. Auctioning-based certificate prices paid at that time made it possible to continue the projects' operation. The model is worthwhile to repeat in the future, especially under an upscaled programmatic or sectoral Article 6.4 crediting. However, this requires the willingness to accept the higher prices of certificates contributing to actual and new investments.

There are several arguments in favor of using an auctioning model under the Paris Agreement's ambition mechanisms, especially Article 6.4. The beauty of this concept is that it could be a global auction conducted in a standardized manner for all countries, provided that country-specific auctioning access would be allowed and all relevant parameters are comprehensively defined before its start. The parameters for countries could be determined, for example, by equalizing the standardized baseline for each country.

To find out more, go to https://www.pilotauctionfacility.org/

Reasons for the low coverage of methane in existing market-based approaches are manifold. Missing data, lack of awareness, non-existence of credible regulation approaches, and limited available finance contribute to the low number of emission trading schemes and crediting mechanisms covering methane. Also, determining an appropriate price as well as choosing the best time perspective and hence the warming potential of methane emissions are two examples of additional challenges.

For now, financial and technological attractiveness of CO_2 mitigation options has been higher compared to non-CO_2 GHG projects. Incorporating methane in existing carbon market approaches needs to be based on updated methodologies using ambitious baselines while enabling NDC progression over time and strengthening the development towards GHG-neutrality. Discount factors, for example, have to be aligned with net zero objectives. Overall, different sectors and different sources of methane emissions require different answers. This holds true for market and non-market policy instruments. In some cases, non-market instruments such as binding “Lead Detection And Repair” (LDAR) requirements are the appropriate policy tool. At the same time, regulatory approaches are often the basis for market solutions.

These obstacles make it quite difficult to develop market approaches for methane abatement. However, developing **compliance markets** allow at the same time to address some of these challenges. The most prominent example of a domestic compliance market is the inclusion of methane emissions of the maritime sector into the EU ETS from 2026 onwards. The prerequisite for the instrument is a robust and accurate MRV-system. It can be expected that the new regulation will trigger investments and push the adoption of mitigation technologies as well as their technological advancement in the sector. For now, methane emissions are not monitored with the same accuracy as carbon emissions, constituting a major obstacle for compliance markets. With future experiences in monitoring methane emissions in the maritime sector and the planned EU Methane Regulation imposing rigorous measurement and monitoring standards for the energy sector, new opportunities could be explored within the EU to put a price on methane emissions. One idea to introduce a methane price could be the integration of methane emissions into the EU ETS.

With rapidly advancing climate change, methane abatement approaches must ensure a high accuracy in reaching the necessary emission reductions. Compliance markets for methane abatement – especially with cap and trade systems – in combination with complementing policies could adequately address the social costs of methane emissions. In general, compliance markets typically have a broader sectoral coverage than Voluntary Carbon Markets and usually set clearer requirements for additionality. Due to the regulatory basis, compliance markets support long term planning, can reduce investment risks, and set the basis for market-driven investments. As always, carbon markets for methane abatement also need to be part of a broader coordinated policy mix, combining technical assistance for domestic policy development in the host country, the use of climate finance for the support of transformational processes and, whenever additionality is given, the use of the financing stream from international carbon markets.

Voluntary Carbon Markets (VCM) for methane abatement will face challenges in being as accurate as well-designed compliance markets. However, they also bear specific advantages and opportunities in terms of innovation, flexibility and incentives to act, especially in this early phase of abatement approaches. For instance, in regions where compliance markets are not likely to be implemented as well as for smaller and dispersed methane sources, voluntary approaches could incentivize methane abatement and complement regulatory approaches. Especially because of the mostly low abatement cost and existing business models for methane emission reductions, there are meaningful areas of application for voluntary markets.

At the same time, increasing transaction costs under the Paris Agreement and continued relatively low carbon prices might reduce possible financial payments and hence the economic viability for projects. In many cases, methane abatement approaches also require financial actions through companies responsible for the emissions. In these cases, additionality might be given and – depending on price levels for emission reduction certificates – international carbon markets can play a role.

Under the Verified Carbon Standard (VCS), around 100 dedicated methane projects are currently registered or in the pipeline. More standards, methodologies, and protocols have been developed by other crediting and offset programs. Currently, new approaches are established to address methane and other GHG-emissions from rice production through adjustments in the cultivation methods, and to reduce enteric methane emissions of ruminants by using feed additives. However, the chances of the VCM can only be realized if the ambition of projects is aligned with the Paris Agreement and double counting is avoided.

First linkages between such projects and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) are established. Thereby, CORSIA could speed up the development of the VCM and combine compliance and voluntary market approaches. Another example of possible future applications for carbon crediting mechanisms is the subsequent sealing of orphaned and abandoned oil and gas wells in the USA.

However, the well-known challenges of voluntary markets such as additionality, credible emission baselines, perverse incentives, or standardization issues also apply to methane abatement projects. Greenwashing under the Voluntary Carbon Market has been criticized broadly and concerns regarding potential underperforming of such projects are not unjustified. For landfill projects under the CDM, only 35% of the expected emission reductions have been realized. As other project types performed much better, one conclusion is that mitigation projects in the methane sector must be better prepared. In addition, recent activities by SBTi, ICVCM and VCMI may correct failures and contribute to the required Paris Alignment of international carbon markets.

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Light at the end of the tunnel – but unclear travel direction

In conclusion, the window of opportunity to significantly reduce anthropogenic methane emissions in line with a 1,5°C pathway is rapidly closing. National and international policy actions for addressing methane emissions are currently lagging behind, with carbon market approaches playing a limited role. However, well-designed carbon market approaches could be an important driver for methane abatement. The interest in market approaches for methane abatement is rising.

Due to the still underdeveloped policy landscape in many of the methane-relevant countries, the application of carbon markets is challenging. At the same time, well-designed and transparent voluntary markets could help to build up methane abatement ecosystems and support further regulatory steps. The limiting factor is the ability of voluntary approaches to internalize negative external effects of methane emitting activities at scale and speed. VCM methane abatement projects are often complex and time-consuming. Effective and rapid methane abatement requires a regulatory environment including ambitious and obligatory reduction targets for all sectors. Policy makers, therefore, need to take concrete actions and establish the regulatory environment for (market-driven) methane abatement.

The momentum around the Global Methane Pledge and other international initiatives have paved the way to free methane abatement from its shadowy existence. Improved data availability and transparency of methane emissions are likely to increase the pressure for companies and governments to act. The next round of NDCs is an important opportunity to present national reduction targets and respective policy instruments. NDCs could be designed as attractive and feasible investment plans to mobilize necessary finance for tackling methane emissions.

Towards sustainable fertilizers?

The role of carbon markets in the transition to more sustainable synthetic fertilizers

by Emilio Martin and Leliah Karbe, GIZ

Synthetic fertilizers have played a pivotal role in revolutionizing agriculture, boosting crop yields and ensuring food security worldwide, and will become even more essential for meeting the feeding demands of a growing global population. However, the indiscriminate use of synthetic fertilizers has engendered detrimental environmental impacts, including soil degradation, water pollution, and notably, substantial emissions of greenhouse gases during both manufacturing and application phases.

After urea, nitrate-based fertilizers are among the most extensively produced synthetic fertilizers. This category encompasses compounds such as ammonium nitrate (AN), calcium ammonium nitrate (CAN) and urea ammonium nitrate (UAN). These have in common the utilization of ammonia and nitric acid as main raw materials in their manufacturing processes.

Consequently, carbon dioxide (CO_2) stemming from ammonia production sourced from fossil fuels, and nitrous oxide (N_2O) emissions, generated as a by-product during nitric acid production, constitute the primary contributors to the carbon footprint associated with the production of nitrate fertilizers. Although other sources of emissions, including those related to energy consumption in transportation and additional manufacturing processes exist, their impact on the overall carbon footprint is comparatively small.

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In the manufacturing process of ammonium nitrate, for example, the predominant nitrate-based fertilizer[1], approximately 50% of the aggregated emissions stem from the release of N_2O emissions as a by-product during the production of nitric acid. N_2O has a global warming potential (GWP) of 273 relative to CO_2, according to the Intergovernmental Panel on Climate Change (IPCC) and stated in its Sixth Assessment Report (AR6). 80% of the global nitric acid production is used in the manufacturing process of nitrate fertilizers. It is estimated that the global nitric acid sector has an average annual emission of above 120 Mt CO_2e[2]. These emissions represent a significant portion of the total greenhouse gas contribution associated with the fertilizer industry.

Carbon markets' early contribution to sustainable synthetic fertilizers

Carbon markets have once played a pivotal role in incentivizing the reduction of N_2O emissions and advancing sustainable practices within the fertilizer production sector during the Clean Development Mechanism (CDM). From 2000 until 2012, a total of 97 CDM projects[3] aiming at reducing N_2O emissions in nitric acid plants were registered across several countries, including China, Chile, Egypt, Uzbekistan and South Africa, among others. These projects collectively issued 100 million carbon credits over their operational lifespan. Carbon markets also notably contributed to the technological develop-

1 Ammonium nitrate is directly used as a fertilizer or utilized as raw material for the manufacturing of other nitrate-based fertilizers and NPK compounds

2 The Nitric Acid Climate Action Group (nitricacidaction.org)

3 According to the CDM/JI Pipeline Database from UNEP Risøe. Only N_2O emission reduction projects at nitric acid plants using Methodologies AM0028, AM0034 and ACM0019 were counted.

ment of N_2O abatement solutions and to the expansion of the market, resulting in an increase of the number of technology providers.

Regrettably, the collapse of the CDM market led to a dearth of financial incentives, and with it, the dismantling of numerous already installed abatement technologies and stalling of several other abatement projects. The absence of incentives or regulatory mechanisms has hindered the further exploitation of N_2O emission reductions in the nitric acid sector, considered as “low-hanging fruits” in terms of abatement opportunities, because they are easy and cost-effective to implement within the production facilities. And the same situation can be observed across numerous industrialized countries, as underscored by research[4] published by Öko-Institut in 2023, focusing on N_2O emissions in such contexts.

The Nitric Acid Climate Action Group (NACAG) – Current status of the Initiative

In order to reverse this negative trend, the German Federal Government officially launched the Nitric Acid Climate Action Group (NACAG) Initiative at COP 15 in Paris. The initiative, implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Affairs and Climate Action (BMWK), is designed to globally reduce N_2O emissions originating from the nitric acid production sector. NACAG provides technical and financial support to governments and plant operators in eligible developing and emerging countries.

Financial support is deployed on the condition that partner countries commit to designing and implementing appropriate policies to ensure permanent and sustainable reduction of N_2O

4 Mitigation potentials for emissions of nitrous oxide from chemical industry (oeko.de)

emissions emitted during nitric acid production. Presently, 10 countries including Tunisia, Zimbabwe, Georgia, Argentina, Mexico, Peru, Colombia, Uzbekistan, Thailand[5] and Jordan have already pledged their adherence to this commitment.

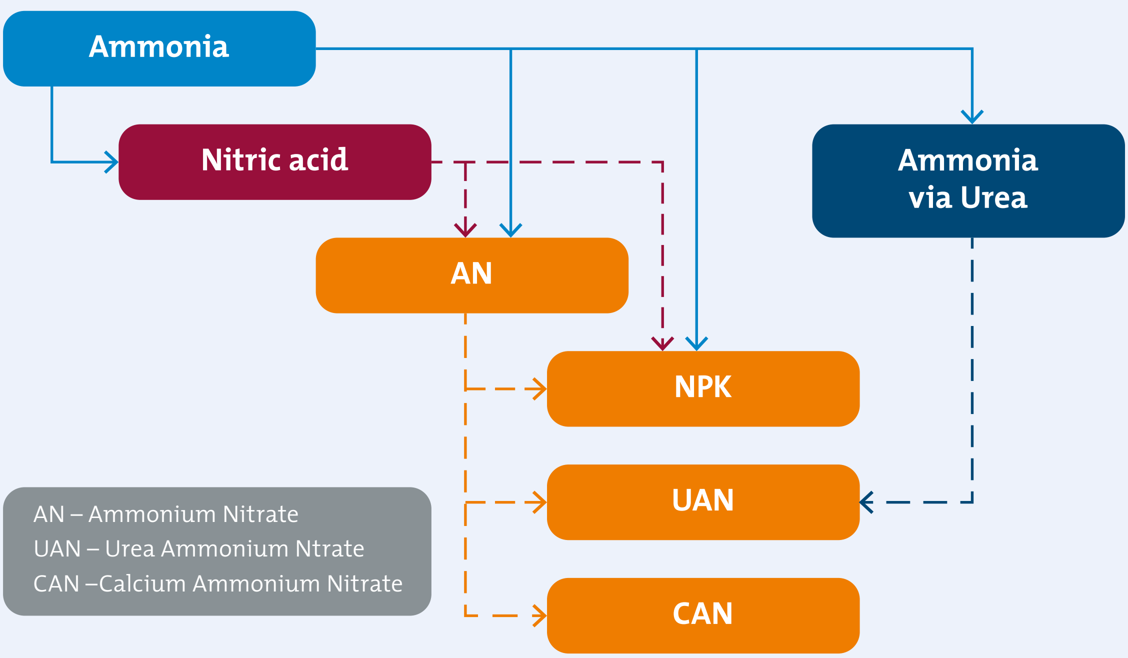
As a consequence, GIZ has already signed 9 grant agreements covering the comprehensive funding of monitoring and abatement technology with eligible plant operators. Initial contracts for monitoring technology procurement have been finalized, with several tenders for the acquisition and installation of abatement technology currently underway[6]. It is projected that successful implementation of all envisaged grant agreements under the NACAG initiative could lead to the avoidance of up to 10 Mt CO_2e annually by 2030. Another notable achievement of NACAG is the incorporation or impending inclusion of the nitric acid production sector in the Nationally Determined Contributions (NDCs) of many aforementioned countries, alongside corresponding emission reduction targets.

CO_2 emissions from the production of ammonia, the other side of the coin

Reducing N_2O emissions is an important step in reducing the carbon footprint of nitrogen-based fertilizers. But looking at the entire supply chain, it becomes evident that addressing the emissions linked to the production of fossil-fuel based ammonia as main constituent of nitrogen fertilizers is equally crucial in order to achieve the goal of limiting global warming to 1.5°C by the end of this century. Globally speaking, ammonia production, a significant portion of which is allocated to fertilizer production (approximately 80%), accounts for approximately 1.8% of global CO_2e emissions.

Today, ammonia is predominantly produced by steam reforming using natural gas as the most common feedstock. This process contributes

Figure 1: Simplified production chain of the main nitrate fertilizers and NPK compounds



5 In Thailand, NACAG finances the reduction of N_2O emissions stemming from caprolactam production sector.
6 Tenders – The Nitric Acid Climate Action Group (nitricacidaction.org

more than 45% of the carbon footprint of nitrate fertilizers. According to own estimates, mitigating emissions in the production of ammonia and nitric acid could achieve a combined reduction of 85% of GHG emissions related to the manufacturing process of nitrate fertilizers.

Table 1 below shows the global average carbon footprint of the production of nitrate fertilizers and NPK[7] compounds, as well as the impact of ammonia and nitric acid consumption on final product carbon footprint. The annual production of nitrate-based fertilizers is estimated as 72 Mt. Considering annual production values for each fertilizer type and the respective emission factors calculated from the ammonia and nitric acid carbon footprint contributions, total annual GHG emissions amount to 268 Mt CO_2e. 50% of these emissions are accounted as CO_2 emissions during ammonia production[8] and 38% to N_2O emissions during nitric acid production. The remaining 12% is due to energy consumption, the use of other raw materials, and undesired reactions during the production process.

Table 1: Carbon footprint mitigation potential of nitrate-based fertilizers.

		Ammonia	NA	AN	CAN	UAN	NPK
N content	%	82	22	35	26	32	15
Ammonia used (kg/kg)		1	0.38	0.21	0.16	0.29	0.13
Nitric acid (NA) used (kg/kg)		0	1	0.79	0.59	0.35	0.21
Carbon footprint (kg CO_2-eq/kg product)	BAU w/o mitigation	3.47	3.13	3.31	2.47	2.33	1.37
	After mitigation in NH_3 and NA production	0	0.21	0.28	0.22	0.27	0.32
Carbon footprint due to ammonia production (CO_2 emissions)				47%	47%	60%	48%
Carbon footprint due to nitric acid production (N_2O emissions)				50%	49%	32%	32%
Others				3%	4%	8%	20%

7 NPK fertilizer is a compound containing three primary nutrients nitrogen (N), phosphorus (P), and potassium (K). Although not considered as nitrate-based fertilizer, a substantial portion of its carbon footprint is attributed to its main precursor, AN, used as main source for N

8 All CO_2 emissions generated during the production of ammonia from fossil fuels are accounted for, regardless of whether these are subsequently used in the production of urea, as they will be re-emitted during land application.

Roughly speaking, 55% of GHG reductions in the manufacturing process of nitrate and NPK fertilizers could be achieved by switching from fossil fuel based ammonia to green ammonia and 45% by reducing N_2O in nitric acid production. Green ammonia is produced using green hydrogen as feedstock. Green hydrogen is obtained from the electrolysis of water, with the electricity used in this process being free of carbon emissions. This method is one of the most mature methods of hydrogen production using a clean energy source. It has high product purity and is technically feasible on both small and large scales.

However, higher production costs are the biggest hurdle on the path to shift fossil-fuel based ammonia to green ammonia, currently making this process not competitive. Green ammonia production can cost 4-6 times[9] more than fossil fuel-based ammonia. Unlike for N_2O abatement technologies, with abatement costs ranging from 1-3 €/ton of CO_2e, abatement costs related to green ammonia production can be as high as 175-300€/ton of CO_2e[10]. These higher production costs of ammonia have a significative effect in the final price of fertilizers, as in order to produce 1 ton of AN fertilizer, around 500 kg of ammonia are utilized.

The role of carbon finance

Access to carbon markets could play a pivotal role in catalyzing the necessary financial incentives to enhance the bankability of projects focused on producing sustainable nitrate-based fertilizers derived from green ammonia. Consequently, such access can foster the development and implementation of sustainable practices within the fertilizer industry, contributing to overall environmental conservation efforts.

In addition, there is a growing demand for abatement projects developed for carbon markets to generate co-benefits that go beyond the mere GHG reduction effect. Initiatives related to sustainable fertilizer production have the potential to offer a broader array of such benefits. These may include improvements in air and water quality, socioeconomic development, creation of green jobs, and improved food security, while enhancing host countries' independence from traditional fertilizer and/or fossil fuel imports, reduced supply chain vulnerabilities, adoption of more environmentally friendly agricultural practices, poverty alleviation, or enhanced resilience to climate change impacts. This aspect of project design holds significant importance in enhancing the appeal of emission reduction projects, particularly within the context of voluntary carbon markets, as stakeholders increasingly seek initiatives that deliver additional positive outcomes across various domains, reflecting a growing recognition of the interconnectedness between environmental sustainability, social welfare, and economic development.

9 According to IRENA, production costs for new green ammonia plants are in the range of $ 720 – 1,400 per ton which is about six times higher than the traditional ammonia (natural gas-based ammonia and coal-based ammonia), which is in the range of USD 110-340 per ton.

10 Abatement costs calculated as the difference between production costs of green and fossil-fuel based ammonia divided by the EF for ammonia considered as 3.47 ton CO_2e/ton NH3. Lower abatement costs can be achieved when retrofitting fossil-fuel based ammonia production facilities

However, while carbon markets hold the promise for incentivizing the production of sustainable fertilizers, several challenges need to be addressed to ensure effective implementation. Among others, these include the development of robust, conservative and credible methodologies, which align to the Paris Agreement, ensure the accurate quantification of the emission reductions achieved by projects, and emphasize the importance of transparency, environmental integrity, and the contribution to the Sustainable Development Goals.

For more than 15 years, dedicated methodologies for renewable energy and N_2O reduction projects in nitric acid plants have been successfully developed and used under the CDM and other international standards. It is conceivable that such methodologies are used as blueprint in the development of tailor-made methodologies applicable to the production of sustainable fertilizers. However, in the Paris era, new requirements that go beyond past mechanisms have been agreed under Article 6.4. New rules adopted emphasize on the fact that methodologies "shall encourage ambition over time"[11]. This directly affects the setting of baselines. Baseline setting shall be done in a way that ensures the continuous adjustment of the baseline, leading to progressive reduction of the crediting levels. This can be achieved, for example, by referring to best available technologies (BAT), by considering ambitious benchmarks or by making use of historical emission series conservatively adjusted.

Methodologies shall also refer to how the additionality of projects shall be demonstrated and consider not only applicable legislation, even if not enforced yet, but also relevant national policies[12]. Also, they shall be aligned with the NDC

11 Rules, Modalities and Procedures (RMP) for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement, para 33.

12 Rules, Modalities and Procedures (RMP) for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement, para 38.

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of the host country. As NDCs should show progression in ambition, each new NDC shall reflect the highest ambition possible, leading to the introduction of new policies that help to achieve the more ambitious reduction targets defined. As a result, projects that are at some point considered additional, may become non-additional over time with the introduction of new policies. This is fundamental for ensuring the contribution to a net reduction of global emissions.

Conclusion

The utilization of carbon markets holds promising potential in fostering the rapid transformation of the nitrate-based fertilizer sector. These markets offer a win-win solution harmonizing economic incentives with environmental objectives. They also create a structured framework conductive to ensuring accountability and adherence to emissions reduction targets. By participating in carbon markets, fertilizer producers can underscore their commitment to environmental stewardship and concurrently safeguarding their competitive standing in the marketplace. Vice versa, incentivizing emissions reductions and promoting the production of sustainable fertilizers, carbon markets serve as a potent mechanism for significantly mitigating the inherent impact on climate of synthetic fertilizer production, all the while strengthening agricultural livelihoods. However, methodologies applied in the realm of carbon markets must evolve in order to consider methodological innovations that ensure environmental integrity, promote ambition over time and truly sustainable development, prevent environmental and social harms of projects and align with the long-term goals of the Paris Agreement.

Policy crediting under Article 6

How to make it work in practice

by Axel Michaelowa, Juliana Keßler and Oleg Pluzhnikov, Perspectives

As climate change accelerates and its drastic impacts are visible around the world, we are far away from an emissions pathway that is in line with the "well below 2°C" target of the Paris Agreement. This has been confirmed through strong language in the Global Stocktake decision of COP28 in Dubai. Article 6 with its three components is a critical part of the toolbox to bring us closer to this pathway, as clearly stated by the COP28 decision on Article 6.8 promoting actions that support the implementation of NDCs of host countries and contribute to achieving the long-term temperature goal of the Paris Agreement.

If international carbon markets under Article 6 want to contribute to closing the ambition gap, we need to become innovative and go beyond mitigation projects and programmes. While these are useful to identify "lighthouse activities" that then can be replicated, experience with the Clean Development Mechanism (CDM) under the Kyoto Protocol has shown that absolute emissions still increased instead of declining, even in countries with thousands of CDM projects.

To harness the full potential of international carbon markets, we therefore need to go beyond projects and programmes while aligning with the long-term goal of the Paris Agreement. We need to be able to issue emission reductions or removals generated by the implementation of policy instruments as internationally transferred mitigation outcomes (ITMOs) under Article 6 of the Paris Agreement. Efficiency standards or carbon taxes have been able to induce structural changes, as shown by the Nordic countries. Policy instruments can address barriers encountered by individual activities by making carbon market incentives more easily accessible. For example, by providing a subsidy for mitigation, the policymaker can provide access to upfront finance, overcoming a common barrier, and ensure a predictable revenue stream to individual activities.

The policy crediting challenge

Despite discussions about policy crediting that go back over a decade (see Okubo et al. 2011), there are only limited experiences with such approaches. Many are skeptical about policy crediting due to the challenge of attributing mitigation to the implementation of the policy instrument.

Characteristics of policy instruments determine whether crediting is possible (Okubo et al. 2011). Information instruments like labels or subsidies for research and development score badly as only the volume of funding generated by the policy is known, but not its output in terms of emissions. They are not suitable for crediting as opposed to those that generate quantifiable emissions impacts. We identify three main categories of policy instruments to be creditable:

- **Mandates,** which involve the deployment of low-carbon technologies or behaviours, the use of specific technology, or the exclusion of carbon-intensive technologies or behaviours.

- **Financial incentives** that aim to encourage the deployment of low-carbon technologies or behaviour by providing financial benefits. Financial incentives can include subsidies, tax benefits, or carbon pricing mechanisms like emission trading schemes (ETS) and carbon taxes.

- **Removal of prohibitions or prohibitive barriers to mitigation activities,** aimed at correcting past governance shortcomings. These may include legislative changes that allow the implementation of technologies that mitigate GHG emissions or enable practices that support the transition to low-emission pathways. Examples include the enabling of renewable electricity feed in through regulations that force the incumbent electricity monopolist to open its grid for transmission or the change of building standards to allow the use of cement blended with slag or fly ash.

In line with the concept of avoidance of emissions lock-in, policies that lead to a lengthening of the operation of technologies that use fossil fuels and generate related emissions are not suitable for crediting under Article 6 of the Paris Agreement.

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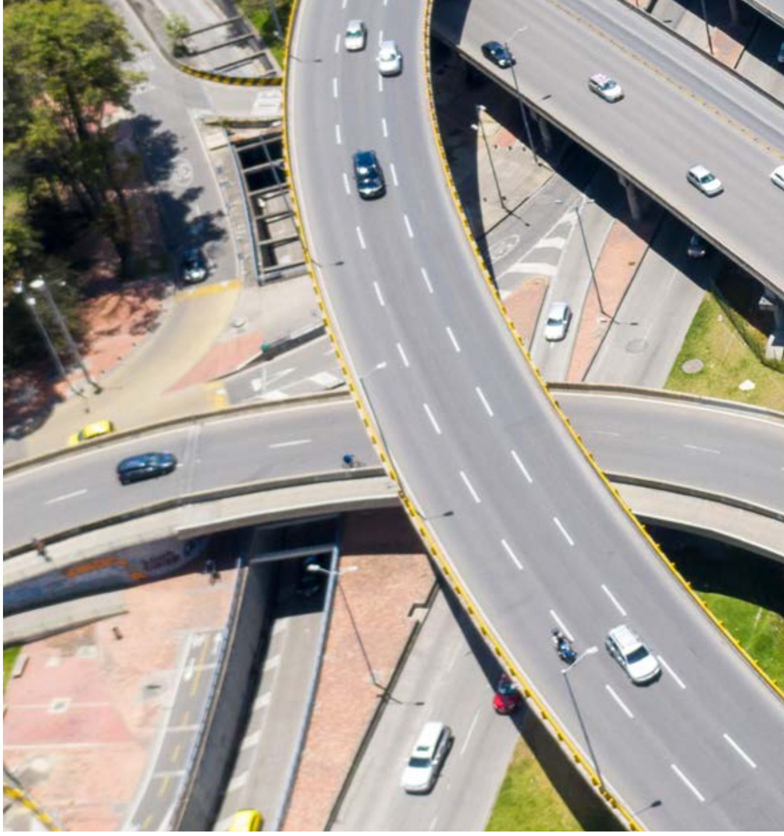


Determining the additionality of policy instruments

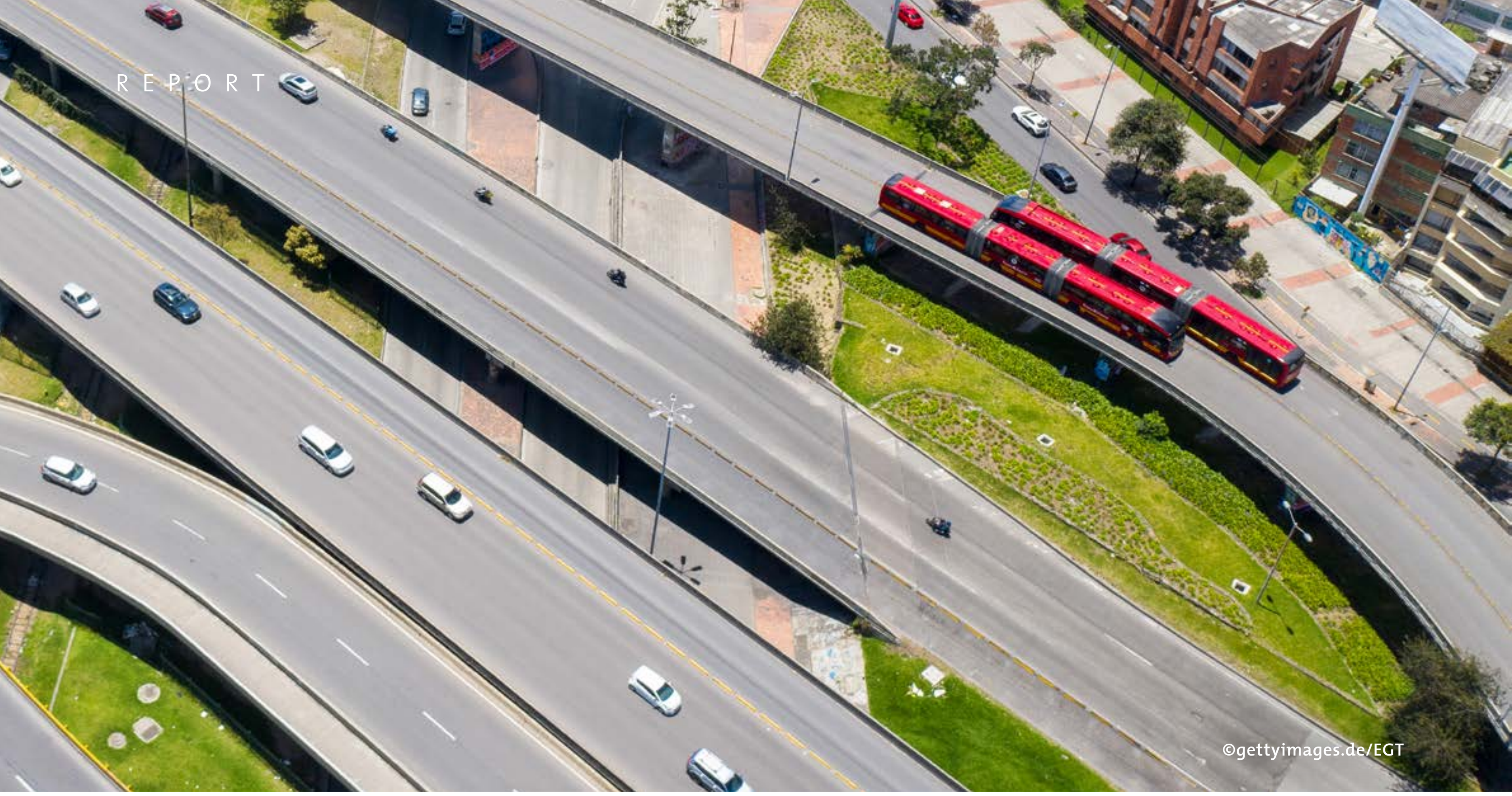
Additionality is a crucial concept for international carbon markets. Under Article 6.4 of the Paris Agreement, it must be demonstrated that activities generating ITMOs are mobilised by the revenues from the ITMO sales. Moreover, all relevant national policies need to be taken into account (UNFCCC 2021). Thus, policies necessary to achieve the unconditional NDC target do not satisfy the additionality criterion.

Fuessler et al. (2014) argue that the development of objective criteria for demonstrating the additionality of policy instruments is impossible. Do we thus have to give up on policy crediting? We think this is not the case.

In theory, a policy instrument cannot be additional if its benefits exceed the costs (Michaelowa 2013, Wooders et al. 2016). Fully considering the health benefits from reduced local air pollution, this could be the case for many mitigation policy instruments. The challenge is that benefits accrue to different actors than the costs, and co-benefits are usually much less tangible and more distributed than the costs. Moreover, there are many barriers that prevent the implementation of policies whose benefits exceed costs. These barriers are linked to the political economy of introducing policies, specifically the influence of emitter interest groups, as well as the difficulties in quantifying non-monetary policy benefits.

Perverse incentives to remain unambitious – a reason to eschew policy crediting?

Even the best additionality testing cannot address the inherent risk that carbon crediting opportunities may disincentivise governments for introducing more ambitious policies as part of increasingly ambitious (unconditional) NDCs. This is a systemic problem of the bottom up Paris Agreement regime which international carbon market regulations cannot resolve. It exists in all carbon markets, also on the domestic level. It is thus not a question of policy crediting.



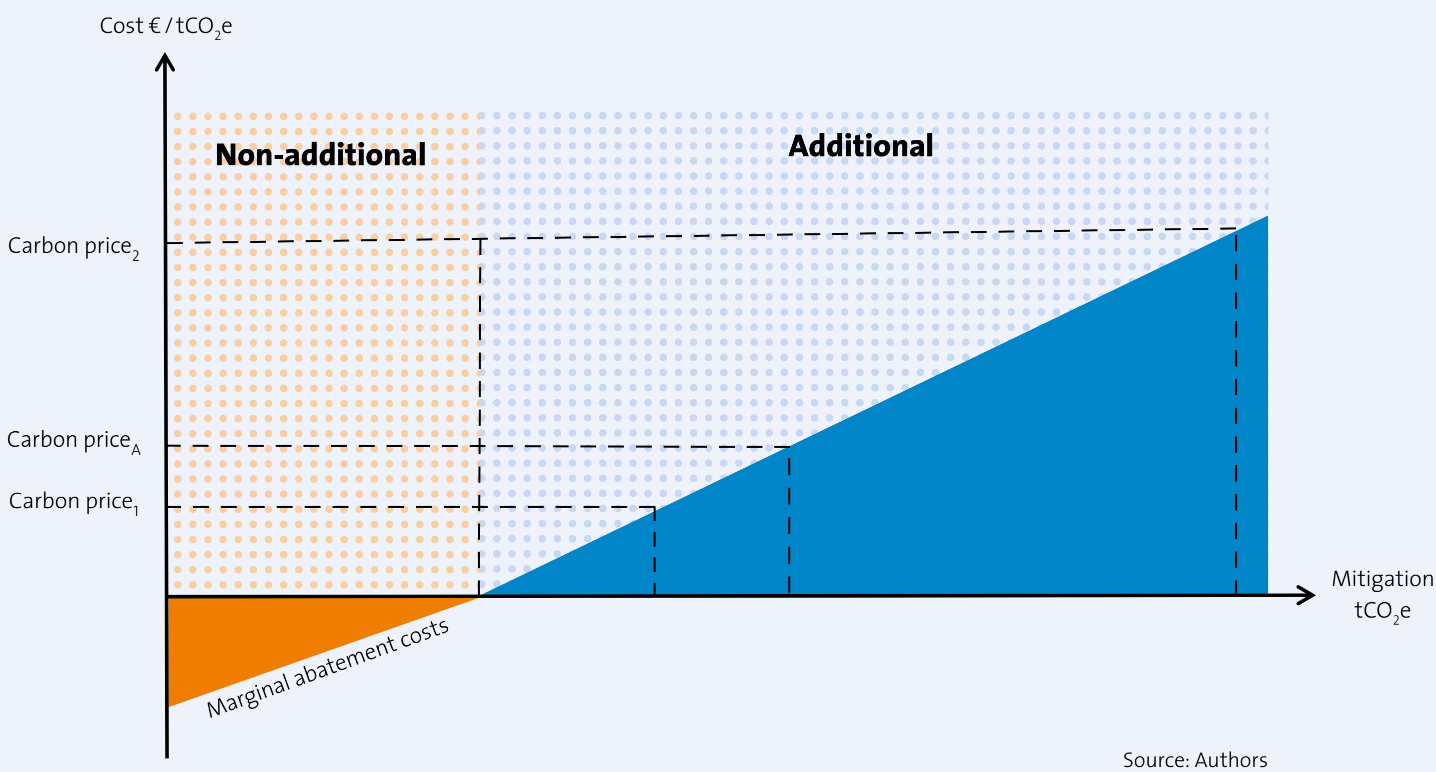
Different ways to determine additionality for policy instruments have been proposed to date. Some want to determine additionality indirectly through the process of setting the baseline while others see the necessity of a separate additionality test. Belonging to the former, the World Bank's Transformative Carbon Asset Facility (TCAF) defines additionality as the difference between the TCAF baseline and the actual emissions (TCAF 2022). Michaelowa et al. (2019) argue for the latter given that the policy baseline does not automatically capture the additionality of the policy instrument. Therefore, the policy instrument's additionality should ideally be determined through specific additionality tests to show that it actually mobilises mitigation, i.e. the mitigation activities have positive costs.

In a first step, it would have to be shown that a policy instrument goes beyond existing and scheduled policies to ensure that existing policy instruments are not rebranded or repackaged. This should also encompass the "substitution" of policies, for instance, when replacing a carbon tax with an emission trading scheme (ETS).

A second step should check whether the policy leads to mitigation with positive costs, or whether a lot of commercially attractive activities "pretend" to be triggered by the policy. Policies triggering activities which do not generate any benefits for the implementing entities clearly are additional. For activities that can generate revenues, the situation is more complex, and one needs to look at the characteristics of mitigation costs (Michaelowa 2013).

Let us assume that we have some activities that are profitable, i.e. they have negative marginal abatement costs (MAC), whereas with increasing mitigation volume MAC become positive and rise further. As Figure 1 below shows, at a very low carbon price (carbon price1), the volume of profitable activities is larger than that of costly ones. The policy is not additional. A stronger carbon pricing policy generates carbon price2. Here, the share of costly activities is much larger than that of profitable ones – the policy is additional. At carbon price level carbon priceA, the volume of mitigation from additional and non-additional activities is equal and the policy becomes additional.

Figure 1: Carbon pricing policies and their additionality



Source: Authors

For regulations such as technology and performance standards, pay-back period thresholds can be used to determine additionality. If the payback period for investment in the technology is higher than the industry standard, the policy instrument will be additional. Payback period thresholds will be shorter for countries with high perceived investment risks. Michaelowa et al. (2019) propose payback period thresholds at 4-5 years.

Additionality therefore only needs to be determined both at the policy instrument and activity level in case of policies removing restrictions for low-carbon technologies with widely differing characteristics regarding generation of non-carbon credit-related revenues. Let us apply the example of a policy that requires an incumbent electricity monopolist to allow grid access for independent renewable electricity providers. The activities at the sites with the best renewable energy resources would be attractive even without the revenues from emission credit sales, and thus not be additional. But at sites with medium-quality resources, they would not become attractive without the credit revenue.

Additionality will need to be reassessed at the end of the crediting period to prevent that a policy instrument that has become non-additional is still credited. The length of the policy crediting period should be consistent with the NDC implementation timeframe.

Baseline setting and quantification of mitigation outcomes

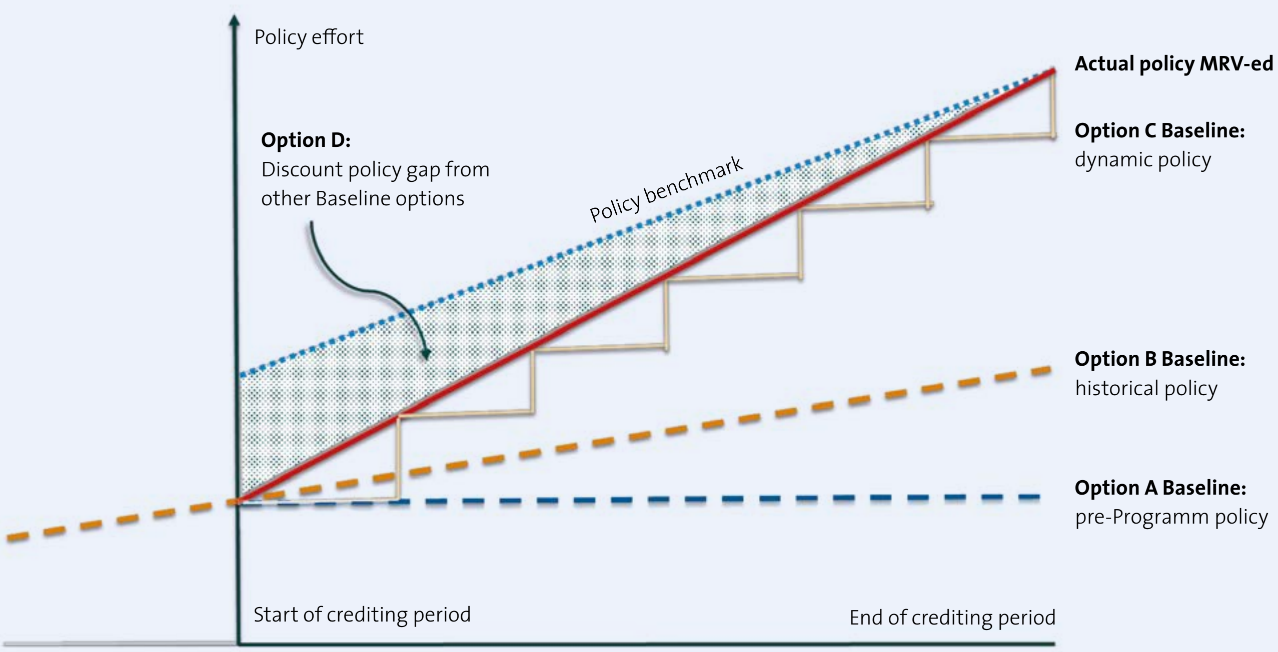
The baseline scenario needs to ensure that baseline emissions are not overestimated. According to the requirements under Article 6.2 and 6.4, baselines need to be set in a conservative manner, below business-as-usual (BAU). Article 6.4 specifies further baseline-related requirements including that methodologies shall encourage ambition over time, align with the NDC, the long-term low GHG emission development strategy (LT-LEDS) of the host Party and the long-term temperature goal of the Paris Agreement.

A pragmatic approach could be to apply time-tested project-specific baseline methodology approaches to parameters affected by the policy, e.g. electricity production or consumption.

Modelling has been proposed but comes with numerous challenges including whether to choose a bottom-up (engineering) or a top-down (computable general equilibrium) approach (Wooders et al. 2016). In the case of TCAF, the baseline is determined through a comparison of the target emissions trajectory (informed by the unconditional NDC targets) with the BAU emissions trajectory determined by economic modelling and selecting the lower one of both (TCAF 2022). This approach is only conservative if the unconditional NDC is ambitious, and the economic modelling based on conservative assumptions.

While an approach for modelling the baseline for energy subsidy removal in Morocco was published (World Bank 2018), TCAF did not implement this in Morocco in practice. In this context, TCAF discussed four specific baseline approaches (WB 2018, p. 48) and argued to choose the most conservative of those (see Figure 2):

Figure 2: TCAF baseline options for policy crediting



Source: World Bank (2018), p. 48

- **Option A.** Set baseline at the level of policy effort observed prior to the introduction of the new policy;
- **Option B.** Set baseline based on the historical policy effort during a period preceding policy introduction
- **Option C.** Baseline as incremental policy improvement year over year;
- **Option D** was conceptually different to the other three ones proposing a discount for emission credit volumes proportional to the shortfall compared to a policy benchmark, here set as a full cost-recovery electricity tariff.

When starting its Designing Article 6 Policy Approaches (DAPA) approach, the Global Green Growth Institute (GGGI) also built on economic modelling to generate policy crediting baselines (GGGI 2021).

Concrete examples for policy crediting

Concrete applications of policy crediting are slowly starting to emerge.

The TCAF, a trust fund administered by the World Bank (WB), has been working on policy crediting approaches since 2017. It was the first serious initiative in this field. In October 2023, the facility announced the implementation of the first policy crediting approach in Uzbekistan, see box.

Policy crediting approach in Uzbekistan (World Bank)

Uzbekistan has traditionally provided high subsidies for electricity and gas, which discourages energy efficiency and conservation efforts. In 2020, these subsidies reached 6.6% of GDP and prices for electricity and gas covered only 70% and 50%, respectively, of the actual costs. The WB agreed with Uzbekistan to provide USD 46.25 million for the Innovative Carbon Resource Application for Energy Transition Project (iCRAFT), which will be used both to cushion the impact of the increase in energy prices foreseen until 2026 for the lowest income users as well as to finance an awareness campaign of the necessity and advantages of cost-covering tariffs (Climate Cent Foundation 2023). The WB estimates emissions reduction from subsidy removal at 60 million tCO_2 over the project's lifetime (WB 2023). Of this, around 2 million tCO_2 are attributed to the TCAF intervention (Climate Cent Foundation 2023), which means that the ITMO price reaches USD 23.1.

The Global Green Growth Institute, an intergovernmental organisation, is supporting pilot policy approaches under Article 6. The Designing Article 6 Policy Approaches programme is financed by the Norwegian Ministry of Climate and Environment with the aim to enable Indonesia, Morocco, Senegal and Vietnam to identify and design a viable policy approach (GGGI 2021).

In June 2023, GGGI and Gold Standard jointly announced that that they are collaborating on a programme for the certification and crediting of mitigation outcomes from policy approaches (GGGI 2023). The aim is to publish specific requirements for policy crediting, so that these can be applied in 2024. In January 2024, Gold Standard launched the public consultation on its draft policy requirements and procedures for the certification of policy outcomes, including a tool for determining the additionality of a policy (see Gold Standard 2024).

Recommendations

The potential of large-scale mitigation outcomes inducing transformational change is a key reason to consider policy crediting under Article 6 of the Paris Agreement. However, the implementation of credible policy crediting approaches faces many challenges. We recommend the following:

- As always in baseline and credit systems, additionality determination is crucial to safeguard environmental integrity. It seems to be possible to apply policy-level additionality determination for mandatory regulation as well as carbon pricing, at least if project characteristics are not too diverse with regard to non-carbon revenue. The use of default parameter thresholds like minimum carbon prices or payback periods could be a "Gordian Knot" approach to the additionality conundrum. In the case of policies aimed at removing past obstacles to mitigation action, an activity level additionality test seems to be warranted to prevent widespread creation of credits by highly attractive activities.

- There is no universally convincing approach to set policy crediting baselines through economic and energy modelling, despite highly reputed institutions spending many years and a lot of resources on this. A pragmatic approach may be to apply emissions factors from activity-specific baseline methodologies to the parameters influenced by the policy, e.g. the "combined margin" to kWh generated by policies addressing electricity production or consumption. Policy crediting baselines need to be frequently updated in line with NDC periods and apply downward adjustment factors that become more stringent over time (see Michaelowa 2021b).

- Important eligibility criteria for policy instruments to be creditable under Article 6 of the Paris Agreement include their avoidance of emissions lock-in (alignment with Paris Agreement's long-term temperature goal) and their alignment with the host country's NDC in terms of going beyond its (unconditional) NDC targets. Policies that just contribute to the unconditional NDC or lead to continued use of fossil fuel infrastructures should thus not be eligible for crediting.

- A robust MRV framework is decisive for the credibility of any policy crediting approach. It needs to be clear that the policy is actually operational and not just "theoretically on the books". This needs to be reflected in collection of the relevant parameters, e.g. energy efficiency of a significant sample of buildings in the case of a building energy efficiency standard. Independent third-party verification of the policy implementation is a must; ITMO buyers need to refrain from buying from countries where such verification is absent.

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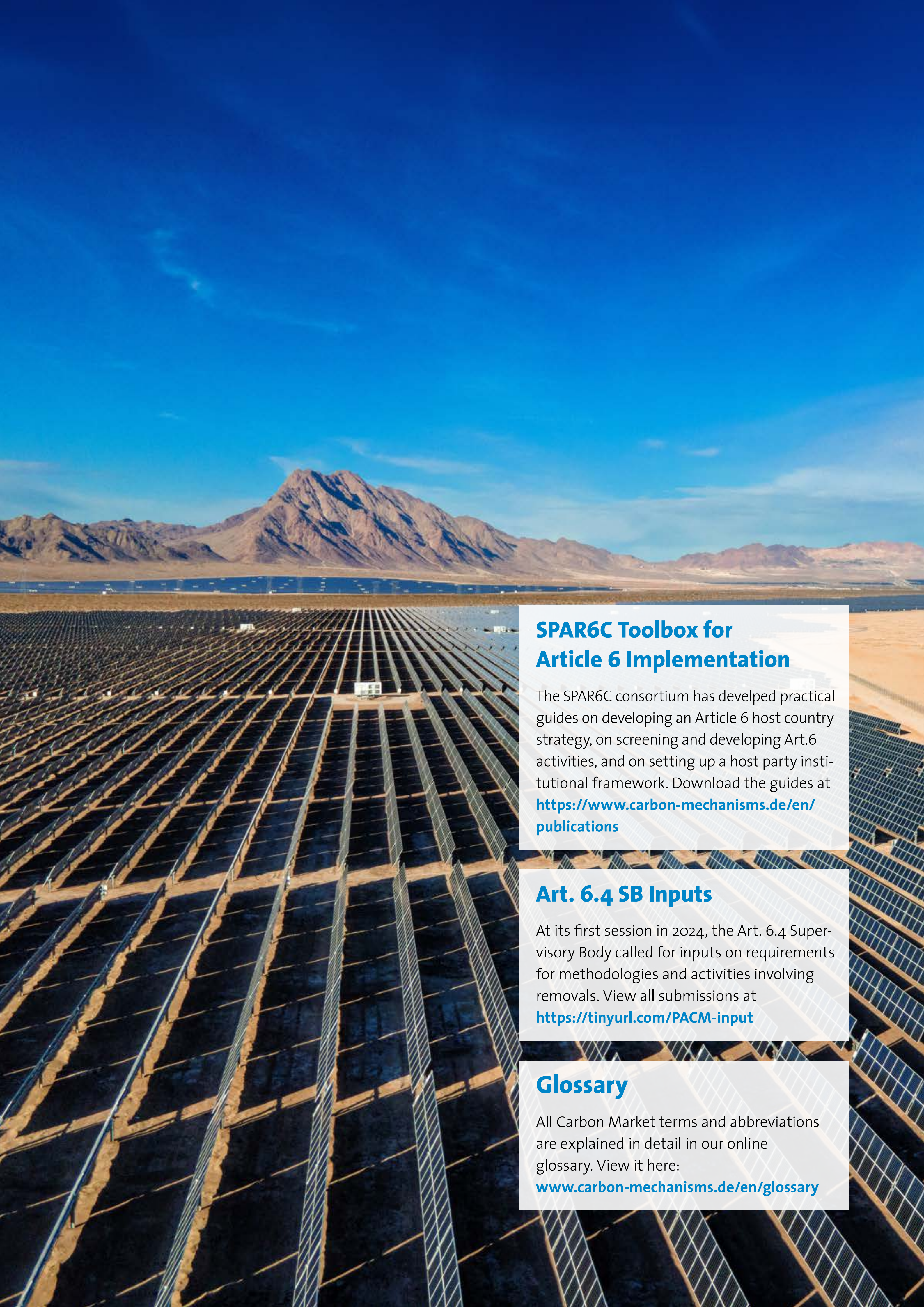

SPAR6C Toolbox for Article 6 Implementation

The SPAR6C consortium has develped practical guides on developing an Article 6 host country strategy, on screening and developing Art.6 activities, and on setting up a host party institutional framework. Download the guides at **https://www.carbon-mechanisms.de/en/publications**

Art. 6.4 SB Inputs

At its first session in 2024, the Art. 6.4 Supervisory Body called for inputs on requirements for methodologies and activities involving removals. View all submissions at **https://tinyurl.com/PACM-input**

Glossary

All Carbon Market terms and abbreviations are explained in detail in our online glossary. View it here: **www.carbon-mechanisms.de/en/glossary**