Baseline and monitoring methodologies for HFC mitigation action

MRV standardisation and streamlining as well as accounting of HFC mitigation – including energy efficiency improvement – under the Kigali Amendment and Paris Agreement

Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

On behalf of:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany

Imprint

Address
Global Programme Proklima
Dag-Hammarskjöld-Weg 1–5
65760 Eschborn, Germany
T +49 (0) 6196 79 – 4218
F +49 (0) 6196 79 – 804218

E proklima@giz.de
I www.giz.de/proklima; www.green-cooling-initiative.org

Programme:
GIZ Proklima / Green Cooling Initiative (GCI)

Responsible:
Philipp Denzinger (GIZ Proklima)

Authors:
Axel Michaelowa, Daniela Laßmann, Aglaja Espelage, Sven Feige, Lorena Moreno (Perspectives Climate Group)

Acknowledgment for Review & Input:
Sebastian Schnatz (German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
Philipp Denzinger, Nils Hansen, Ines Josten, Birgit Mayer, Philipp Munzinger, Julia Schabel (GIZ Proklima)

Design:
SCHUMACHER Brand + Interaction Design GmbH, Darmstadt

Photo credits cover:
© Shutterstock / Danila Shtantsov

On behalf of
The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
Division IG II 1 Fundamental Aspects of Chemical Safety,
Chemicals Legislation
Bonn, Germany

GIZ is responsible for the content of this publication.

Eschborn, 2021

Table of contents

List of tables II
List of figures II
List of abbreviations III
Units and Measurements III

1. INTRODUCTION 4

1.1 Background 5
1.2 Objectives 7

2. NATIONAL LEVEL REPORTING AND ACCOUNTING REQUIREMENTS FOR HFC AND HCFC MITIGATION UNDER THE PARIS AGREEMENT 8

2.1 Reporting under the ETF 10
2.2 Reporting and review under Article 6.2 guidance 16

3. NATIONAL LEVEL REPORTING REQUIREMENTS FOR HFC AND HCFC EMISSIONS UNDER THE KIGALI AMENDMENT 20

4. METHODOLOGIES AND APPROACHES FOR HFC BASELINE SETTING AT THE NATIONAL AND SECTORAL LEVEL 23

4.1 Differences in baseline setting in the context of the Kigali Amendment and the UNFCCC 24
4.2 Conversion of the KA baseline into the UNFCCC context 24

5. ARTICLE 6 REQUIREMENTS FOR CARBON CREDITING METHODOLOGIES 29

5.1 Article 6.2 guidance on methodologies 29
5.2 Rules for methodologies under the Article 6.4 mechanism 30

6. EXISTING BASELINE AND MONITORING METHODOLOGIES AND TOOLS FOR HFC REDUCTION AND RELATED ENERGY EFFICIENCY IMPROVEMENT 32

6.1 Identified principles and guardrails for Article 6 methodologies 33
6.2 Existing baseline and monitoring methodologies at the activity-level 33
6.3 Gap assessment of existing methodologies for activities 35

7. DEVELOPMENT OF ARTICLE 6 RAC MITIGATION METHODOLOGIES 38

7.1 Additionality determination 39
7.2 Baseline scenario determination 42
7.3 Emission reduction calculations 42

8. CONCLUSION AND RECOMMENDATIONS 47

References 50
Annex: Existing methodologies and tools for HFC reduction and related energy efficiency improvement 54

LIST OF FIGURES

Figure 1: NDC reporting and accounting under the Paris Agreement 9
Figure 2: Approach to calculate energy-related emissions of the RAC sector 13
Figure 3: Reporting requirements under the Article 6.2 guidance 19
Figure 4: Steps to translate KA HFC consumption baseline into an emissions baseline under the PA 25
Figure 5: Baseline setting approach for the RAC sector- the triple safety net for mobile AC 43
Figure 6: Baseline setting approach for the RAC sector- the triple safety net for industrial refrigeration 44

LIST OF TABLES

Table 1: Overview of IPCC 2006 Tiers and approaches relevant for HFCs 12
Table 2: Data needs related to energy consumption related emissions of the RAC sector 14
Table 3: Data requirements to transfer the KA consumption baseline into an emissions baseline 27
Table 4: Overview of existing baseline and monitoring methodologies in the RAC sector 34
Table 5: Gap analysis of existing carbon accounting methodologies with regard to technologies/activity types 36
Table 6: Summary of commercial and technical characteristics of different mitigation measures and technologies in the RAC sector 40
Table 7: Overview of emission sources included in emission reductions calculations 45
Table 8: Existing methodologies for HFC reduction and related energy efficiency improvement 54
Table 9: Existing tools for HFC reduction and related energy efficiency improvement 64

LIST OF TEXT BOXES

Text Box 1: NDC reporting and accounting under the Paris Agreement 11
Text Box 2: Reporting on Sustainable Development (SD) benefits 18
Text Box 3: Baseline setting under the CDM 30
Text Box 4: Monitoring of Sustainable Development (SD) benefits 34
Text Box 5: Policy instruments to reduce HFC and energy-related emissions in the RAC sector 41

LIST OF ABBREVIATIONS

A6.4ER	Article 6.4 Emission Reduction
A6.4M	Article 6.4 Mechanism
BAT	Best available technology
BAU	Business As Usual
BTE	Biennial Transparency Report
CAR	Climate Action Reserve
CCOP	Californian Compliance Offsets Program
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbon
CH_4	Methane
CMA	Conference of the Parties serving as meeting of the Parties to the Paris Agreement
COP	Conference of Parties to the UNFCCC
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CO_2	Carbon Dioxide
CSPF	Cooling seasonal performance factor
DOE	Designated Operational Entity
EB	Executive Board
ERF	Emission Reduction Fund
ETF	Enhanced Transparency Framework
ETS	Emissions Trading System
FES-CO_2	Spanish Carbon Fund
GEMS	Greenhouse and Energy Minimum Standards
GHG	Greenhouse Gas
GS	Gold Standard
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
IET	International Emissions Trading
IPCC	Intergovernmental Panel on Climate Change
ITMO	Internationally Transferred Mitigation Outcome
JCM	Joint Crediting Mechanism
JI	Joint Implementation
KA	Kigali Amendment
KP	Kyoto Protocol
LDC	Least Developed Country
LT-LEDS	Long Term Low Emissions Development Strategy
LULUCF	Land Use, Land-Use Change and Forestry
MEPS	Minimum Energy Performance Standard
MOP	Meeting of the Parties to the Montreal Protocol
MP	Montreal Protocol
MPG	Modalities, Procedures and Guidelines
MRV	Monitoring, Reporting and Verification
NABERS	National Australian Built Environment Rating System
NDC	Nationally Determined Contribution
NF_3	Nitrogen trifluoride
NIR	National Inventory Report
N_2O	Nitrous Oxide
ODP	Ozone Depleting Potential
ODS	Ozone Depleting Substance
PA	Paris Agreement
PoA	Programme of Activities
PUF	Poly urethane foam
PFCs	Perfluorocarbons
RAC	Refrigerators and Air Conditioners
RAC&F	Refrigerators and Air Conditioners & Foam
RMP	Rules, Modalities and Procedures
SB	Supervisory Body
SBL	Standardized baseline
SD	Sustainable Development
SDG	Sustainable Development Goal
SF_6	Sulphur hexafluoride
SIDS	Small Island Developing State
TACCC	Transparency, Accuracy, Completeness, Comparability, and Consistency
TER	Technical Expert Review
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary Carbon Market
VCS	Verified Carbon Standard

UNITS AND MEASUREMENTS

CO_2e	Carbon Dioxide Equivalent
MW	Megawatt
tCO_2e	Tonnes of Carbon Dioxide Equivalent
°C	Degrees Celsius

Executive Summary

The rapidly expanding cooling sector plays a pivotal role in the global effort to mitigate climate change. Making cooling more energy efficient and, at the same time, reducing emissions from highly climate damaging refrigerants, namely hydrofluorocarbons (HFCs), can reduce greenhouse gas (GHG) emissions by several billion tons of CO_2e in the next decades. The Kigali Amendment (KA) to the Montreal Protocol (MP) regulates the step-wise phase-down of Parties' HFC production and consumption. HFCs are also covered by the Paris Agreement (PA) under the United Nations Framework Convention on Climate Change (UNFCCC). In their updated nationally determined contributions (NDCs) for GHG mitigation, a growing number of governments specifies contributions of the cooling sector to achieve their climate targets. Market-based voluntary cooperation in the context of Article 6 (Art. 6) of the PA can serve as an important driving force to mobilise finance for GHG reduction activities in the cooling sector.

Activities realized in the context of international carbon markets through a baseline and credit mechanism need to apply stringent methodologies in order to determine the emission reductions achieved. These methodologies are crucial to guarantee environmental integrity of emissions credits issued. They need to test whether activities are additional, i.e. not already mobilized through national policy instruments in order to achieve unconditional NDC targets. Financial additionality, i.e. the fact that the activities would not have been carried out without the revenue from the carbon credits, must also be demonstrated. Baseline setting approaches must be conservative and result in crediting baselines situated below a business-as-usual (BAU) scenario. This can be achieved by performance benchmarks defined by Best Available Technology (BAT) or set at a high percentile of the performance distribution curve. A bold but effective approach would be to multiply the emissions intensity of a baseline technology by an 'ambition coefficient' whose value declines over time and becomes zero when net emissions of the host country should reach zero to be in line with the 1.5°C target of the PA.

At the minimum, baseline levels must be aligned with emission pathways derived from NDC targets. The reference scenario for cooling sector action under NDCs should be defined by the KA HFC phase-down path. However, different accounting approaches for HFC emissions under the UNFCCC/PA and the MP/KA regimes require a 'translation' of the HFC phase-down path from the KA to an NDC pathway. The KA regime is based on potential emissions, and assumes that any consumed substance will be fully emitted in the year of consumption, whereas the PA accounts for actual emissions which often will only occur years or decades after consumption when equipment is decommissioned. This makes it impossible to compare KA and PA targets directly. A robust stock model of cooling equipment, corresponding technical parameters and emission factors as well as modelling of future trends in the cooling sector is required for this translation.

A key element in defining the KA HFC phase-down path is the 'HCFC adder'[1]. According to the rules set in the MP/KA, countries can include a default value of 65% of their production and consumption of hydrocarbonfluorocarbons (HCFCs) – another ozone depleting substance the KA is phasing out – during a 2009–2010 baseline period to calculate the starting point of the HFC phase-down path. For some countries, especially those that already have reduced their HCFC consumption significantly, this leads to the HFC phase down path starting at a level that is substantially higher than BAU consumption of HFCs. If this level would now be translated into a PA baseline for Art. 6 activities the environmental integrity of these activities would be compromised due to the overestimate of the baseline emissions. It is therefore recommended to consider a 'PA aligned HCFC adder' for setting the NDC reference scenario which is based on current realistic HCFC consumption levels, instead of the full HCFC adder.

---

[1] The term is used for simplification, but is not an official term under the Montreal Protocol.

Moreover, many mitigation measures in the cooling sector do not solely address HFC-related emissions, but also aim at indirect emissions resulting from electricity consumption. These emissions need to be quantified and considered when establishing the crediting baseline(s) for an Art. 6 activity. Targets for mitigation of indirect emissions from the cooling sector thus need to be defined against a energy sector baseline. Double counting needs to be prevented.

There is a wide range of cooling sector-related baseline and monitoring methodologies in the context of different crediting mechanisms (e.g. the Clean Development Mechanism (CDM) or the Joint Crediting Mechanism (JCM)). These address both improving energy efficiency of cooling equipment as well as reduction of HFC emissions, but not all specific activity types that are principally available. The methodologies either apply a projected BAU approach or a default baseline scenario. None of the methodologies would meet the Art. 6 criteria for additionality determination and baseline setting and could be directly applied to an Art. 6 activity. Therefore, the development of an Art. 6 activity in the cooling sector requires a thorough upgrade of the existing methodologies.

© Shutterstock/P.Pengsopha

1. Introduction

1.1 Background

1.1.1 The refrigeration and air conditioning sector in the climate change context

According to the International Energy Agency (IEA), the global energy demand for space cooling reached nearly 8.5% of total final electricity consumption in 2019. Cooling is the fastest-growing end use technology in buildings, and energy needs for this purpose have more than tripled since 1990 (IEA, 2020). Moreover, as emerging and developing countries become wealthier, population grows, and more frequent and extreme heatwaves are expected to occur, cooling equipment market growth is accelerating, reaching 10% growth between 2018 and 2019. IEA (2020) expects the number of air conditioners installed to increase by another two-thirds by 2030. Efforts to boost the deployment of more sustainable cooling equipment, as well as improved building design and increased renewables integration are needed to cut cooling energy use and emissions and limit the power capacity additions required to meet peak electricity demand.

In parallel, the cooling sector has a huge greenhouse gas (GHG) mitigation potential through switching from highly climate damaging substances that are used as cooling agents in refrigeration and air conditioning devices to alternative solutions. Hydrofluorocarbons (HFCs) that are mainly utilized to replace ozone depleting substances (ODS) in cooling equipment, such as hydrochlorofluorocarbons (HCFCs), are characterized by a significant global warming potential (GWP). GWP values of HFCs in some cases exceed that of carbon dioxide (CO_2) by a thousandfold (IPCC 2013). The gradual reduction of HFCs is mandated by the Kigali Amendment (KA) to the Montreal Protocol of Substances that Deplete the Ozone Layer (MP). Purohit et al. (2020) developed pre-KA baseline scenarios assuming that the KA is not put into action. These scenarios which are based on socio- and macroeconomic factors as well as cooling degree days (CDD) show that between 2005 and 2050, HFC emissions are projected to increase by a factor of nine from 0.5 Gt CO_2e to almost 4.3 Gt CO_2e and reach almost 6.8 Gt CO_2e in 2100. According to the projections, and assuming full compliance with the KA commitments, global HFC emissions can be reduced by up to 87% between 2018 and 2100 (Purohit et al. 2020). Sovacool et al. (2021) estimate that the KA will mitigate around 61% of HFC emissions by 2050. They identify several loopholes in the KA, such as a relatively late and not complete phase-out of HFC consumption and exemptions for countries with high ambient temperatures. In addition, the KA does not address the emissions that occur from banks through the provision of finance for proper disposal and destruction, i.e. the problem that existing stocks of refrigerants in cooling equipment are released to the atmosphere when the equipment is not properly disposed of is not sufficiently addressed by the MP (Sovacool et al. 2021).

The technological feasibility of replacing ODS and HFC refrigerants by alternative solutions such as hydrocarbons, ammonia or carbon dioxide (CO_2) is already proven for many cooling technologies. A conversion of cooling equipment is accompanied by a change in the energy efficiency of the units due to different thermodynamic properties of refrigerants. In many cases, these changes are positive, i.e. lead to a higher energy efficiency. For example, the energy performance of split room air conditioners running with propane is estimated to be better than that of units using HCFC-22, resulting in a reduction of energy consumption of up to 11% (Rahman and Rahman 2012). This fact needs to be kept in mind for the development of mitigation measures, and more specifically for the design of activities that are foreseen for transfer of mitigation outcomes under the international market mechanisms of Article 6 of the Paris Agreement (PA).

Baselines in the context of market-based cooperation

International carbon markets can be an important driver for emission reductions. The most commonly used approach in international carbon markets is the baseline and credit approach, where activities generate emissions reductions compared to a baseline, or business-as-usual situation, and emission credits are issued accordingly. For example, the Clean Development Mechanism (CDM) under the Kyoto Protocol (KP) has been such a mechanism that incentivized over 8,000 projects in more than 100 developing countries, generating over 2 billion emission credits. In the context of such crediting mechanisms, credible while robust carbon accounting methodologies are crucial to ensure the environmental integrity of credits issued. To ensure this, it is critical that methodologies on the one hand ensure that GHG emission reduction calculations are based on high quality information (e.g., accurate data on past emissions, and emissions once the project is implemented) and on the other hand enable independent verification that the emission reductions generated by these activities are occurring. Therefore, methodologies under baseline-and-credit mechanisms for market-based cooperation are used for four different tasks:

1. Set the baseline against which mitigation outcomes are measured;
2. Define a (or refer to a separate) procedure for testing additionality of an activity, i.e. the activity itself is not happening under a business-as-usual scenario;
3. Define how emission reduction quantification is to be done and calculate activity emissions and leakage, and resulting emission reductions; and
4. Define monitoring, data management and reporting guidelines and requirements.

Current relevant baseline and credit mechanisms at the international level include the CDM, and the two main Voluntary Carbon Market (VCM) standards, namely the Gold Standard (GS) and Verified Carbon Standard (VCS). Overall, more than 300 methodologies have been approved under these mechanisms whose use varies widely. Only a few methodologies, e.g. for grid connected electricity or energy efficiency improvement of household appliances, have been used to a broad extent and applied for many projects, while the majority of methodologies is used only rarely. Many methodologies developed under the CDM are eligible also under the GS and the VCS. The continuation of the CDM is uncertain in the context of the PA, but its methodologies and activities are often a starting point for market-based cooperation under Article 6 of the PA. Such cooperation is to help countries reach the emission targets of their Nationally Determined Contributions (NDCs). In contrast to the market mechanisms under the KP, the new market mechanisms shall support the increase of mitigation ambition in the future and contribute to an overall mitigation in global emissions. Additionality and environmental integrity are key principles for Article 6 market mechanisms. This means that any emission reduction generated by an Article 6 activity must be additional to what is already being done or planned to be implemented and cannot lead to a higher overall level in emissions. While negotiations on Art. 6 rules are not concluded yet, the draft negotiation texts on the rules for carbon markets under the PA include a process for transitioning existing CDM activities and methodologies to the new Article 6.4 Mechanism (A6.4M) to be established under the Conference of the Parties serving as meeting of the Parties to the PA (CMA) by 2023. Under A6.4M, the Supervisory Body (SB) will approve baseline and monitoring methodologies for the A6.4M, as well as rules and procedures, which could be operational in 2023.

Parties can also pursue bi- or multilateral cooperative approaches, while following the Article 6.2 guidance. Here, different forms of market-based cooperation can be decided upon by Parties, but there are some guardrails for methodologies. Participating countries engaging in such approaches must ensure environmental integrity, apply robust accounting, including ensuring avoidance of double counting, and promote sustainable development (SD). This will be done with ‘guidance’ but international oversight will be limited to a technical expert review. Therefore, transparency of approaches used and the methodological underpinnings regarding the environmental integrity of the emission credits issued under Article 6, the so-called Internationally Transferred Mitigation Outcomes (ITMOs) is crucial to ensure the Article 6.2 guidance is respected.

Domestic baseline and credit mechanisms, such as those operated in Australia, China, Colombia, South Africa, Spain and the US often are based on methodologies used in international mechanisms and the related auditing procedures. Beyond these, carbon crediting standards are also recognized in compliance schemes in several countries. For instance, carbon credits of recognized standards can be used in Colombia and South Africa to comply with a carbon tax regulation. Some other countries such as Australia, the US and Spain have developed carbon crediting standards to account for, report, and verify GHG emission reductions associated with mitigation actions.

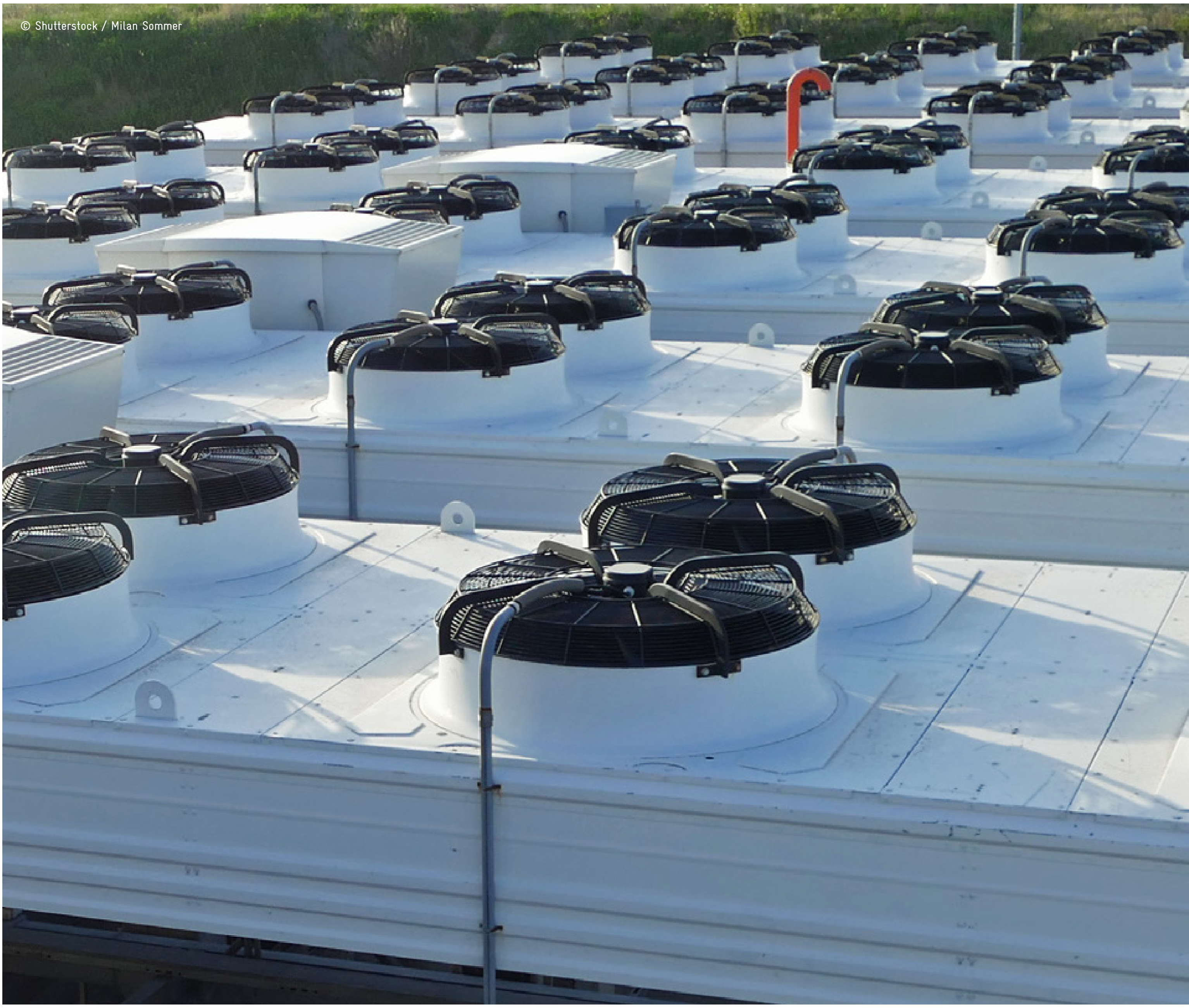
In the context of international market-based cooperation under the PA, existing methodologies must be adapted to the new context of the PA as some concepts and requirements did not exist at the moment of designing some of the international and domestic baseline and credit mechanisms (i.e., CDM, GS, VCS). Concretely, no methodology or tool is explicitly referring to NDC targets as the concept itself was introduced under the PA framework. Furthermore, the determination of the baseline scenario in existing methodologies is generally not aligned with the PA requirements since baselines of crediting mechanisms designed prior to the PA were not set to raise ambition with no requirement to go below BAU, such as considering best available technology (BAT) assessments in baseline-setting.

1.2 Objectives

The study aims at assessing how baseline and monitoring methodologies for the refrigeration and air conditioning (RAC) sector should look like for both refrigerant- and energy-related emissions to be mitigated in the context of Article 6 activities. In a first step, we analyse and outline the reporting and accounting framework in the context of both regimes, the PA and the KA, and put a specific focus on the implications for carbon market methodologies in the context of the RAC sector. By highlighting the differences in baseline setting between the UN Framework Convention on Climate Change (UNFCCC) context and the KA, we derive an approach how to ensure that KA phase-down paths are reflected in NDC reference scenarios.

In a second step, existing baseline and monitoring methodologies and tools for HFC reduction and related energy efficiency improvement in the context of existing baseline-and-credit mechanisms are assessed and gaps regarding the alignment with Article 6 requirements and principles, congruent with expected A6.4M rules identified. The gap assessment forms the basis for further considerations and recommendations for baseline and monitoring methodology development for RAC sector specific Article 6 activities. The possibility of standardization of certain parameters is discussed and potential approaches for baseline development at the sectoral as well as activity level are explained.

In a third step, a practical country example is used to illustrate the methodological considerations and to derive further recommendations for actors interested in developing HFC-mitigation activities compliant with Article 6 rules, as well as governments aiming at synergizing monitoring, reporting and verification (MRV) and accounting across the two regimes.



© Shutterstock / Milan Sommer

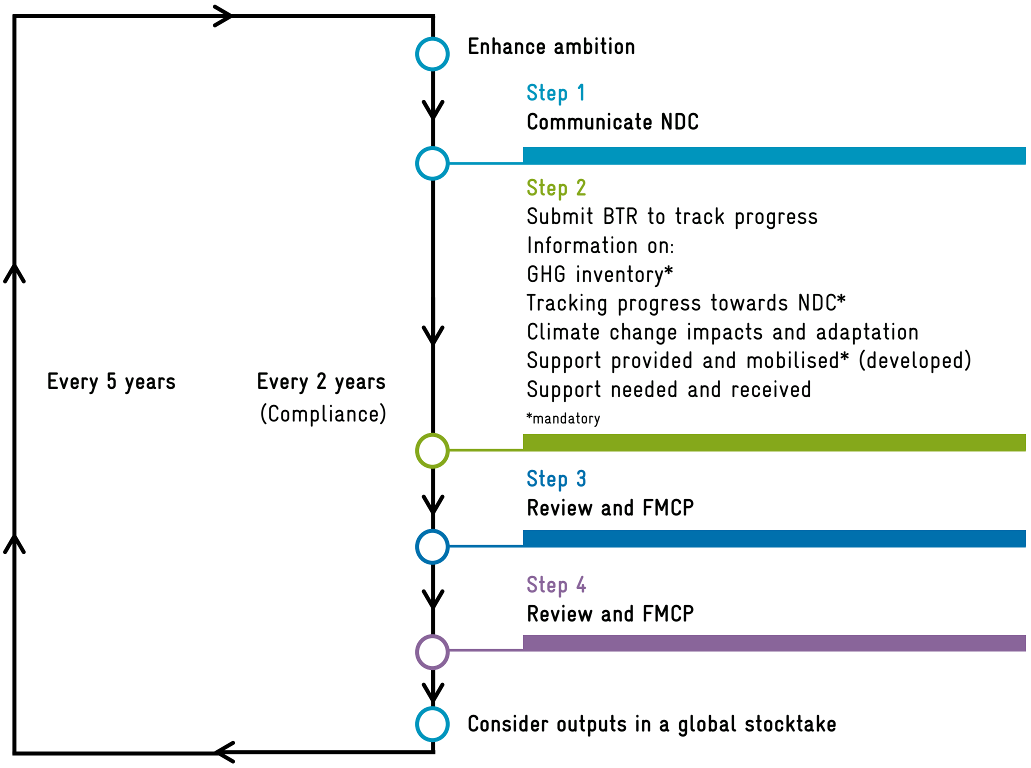
2. National level reporting and accounting requirements for HFC and HCFC mitigation under the Paris Agreement

As HFCs are both covered under the PA and the KA, similarities and differences of related reporting and accounting requirements under the climate regime need to be understood. This is relevant as carbon market methodologies are defined and conceptualized in the context of the PA regime and its requirements. In addition, this chapter discusses how contributions of HCFC emissions to global warming and related mitigation may be considered by Parties in the context of their NDCs, which can be formulated in a more flexible manner than this was the case under the KP and what implications that could have on RAC sector mitigation activities.

Under the PA, HFCs will be reported on and accounted for under the 'enhanced transparency framework' (ETF). The ETF is the backbone of the PA as it sets the guardrails and processes for accounting for NDCs and to ensure collectively that the international community is on track to meet its collective commitments. Reporting and accounting for progress made in NDC implementation and achievement is embedded in a cycle of action which aims to ratchet up ambition over time.

Transparency is also key to safeguard environmental integrity of cooperation under Article 6 of the PA and in the context of NDCs. Given the absence of a compliance mechanism under the PA, only in the context of a robust transparency framework, transparency can contribute to ambition raising, both on a general level and in the context of international market-based cooperation (Michaelowa et al. 2020c). But: If and how these pathways materialize depends on the "availability of comparable, complete and timely information" (Weikmans et al. 2020). The Article 6.2 guidance will establish reporting requirements for participating Parties and information submitted will be reviewed by a technical expert review (TER) process. In reporting, participating Parties demonstrate that they fulfil the participation requirements and respect the guidance in the design of mitigation outcomes and in avoiding double counting in transfer and use of mitigation outcomes. Through transparency, host countries can demonstrate that they respect the rules to build new partnerships and attract additional sources of climate finance. Transparency also allows buyer countries to make informed investment decisions regarding the quality of ITMOs they want to acquire.

Figure 1: NDC reporting and accounting under the Paris Agreement



Source: UNFCCC (2020), p. 14

Reporting and review under the Article 6.2 guidance will be closely linked to and embedded into the reporting and review process under the ETF. While reporting formats and tables are still to be endorsed by the CMA, the modalities, procedures, and guidelines (MPGs) of the ETF were adopted at COP24 in Katowice in decision 18/CMA.1. According to these MPGs, all Parties will need to report information through biennial transparency reports (BTRs) and national inventory reports (NIRs).

2.1 Reporting under the ETF

While the MPGs of the ETF were adopted in 2018, Parties are still negotiating the exact reporting formats and templates. Thereby, Parties need to find solutions to create reporting formats that promote comparability of information in the context of heterogeneous NDCs (Weikmans et al. 2020). Also, in NIRs, the in-built flexibility for developing countries brings challenges for common reporting formats.

By 31 December 2020, developed country Parties under the UNFCCC have submitted their final biennial reports under the KP. Developing country Parties will submit their final biennial updates by 2024. The latest by 31 December 2024 all parties will have provided their first biennial transparency reports under the Paris Agreement (UNFCCC 2020).

2.1.1 National inventories and national inventory reports

Chapter 2 of the MPGs of the ETF defines the rules and processes for reporting on NIRs. Parties will have to compile their inventories based on the 2006 IPCC inventory guidelines and any subsequent version or refinement of these guidelines as agreed upon by the Parties to the PA[1].

The NIRs cover emissions and removals of direct GHGs from the 'Kyoto basket of gases': carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), HFCs, sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). In comparison to the MP, the following three points are important to note:

1. All emissions are reported in tCO_2 equivalent (tCO_2e) terms based on their GWP.
2. All CO_2e emissions are calculated using a 100-year time-horizon GWP as determined by the IPCC. It should be noted that HFCs are short-lived climate pollutants, so their GWP is higher on a 20-year time-horizon compared to a 100-year time-horizon.
3. HCFCs, although they do have GWPs, are not included in the national inventories. Therefore, also HCFCs in ODS banks are not covered in NIRs of Parties.
4. HFC emissions are covered relating to their manufacturing, emissions in production and consumption and emissions at the end-of-life of appliances. Thereby, the national inventories account for 'real' emissions at the time of their occurrence, in contrast to reporting under the Kigali Amendment on potential emissions (see chapter 3).

The emissions and removals are differentiated by five sectors: energy; industrial processes and product use; agriculture; land use, land-use change and forestry (LULUCF); and waste. Thereby, the RAC sector is covered in the NIR in the context of industrial processes and product use (IPPU) (HFC and HFC-blend refrigerant emissions) as well as the energy sector (emissions from energy consumptions from refrigeration, air-conditioning and cooling appliances).

Under the PA, several countries have included commitments to reduce emissions from cooling equipment by supporting the implementation of policies and programmes to avoid the use of less efficient equipment. However, the quantification and reporting of emissions stemming from electricity consumption of RAC equipment is not clearly defined nor separately included in the 2006 IPCC guidelines. The guidelines describe the methods and data necessary to estimate emissions from stationary combustion, and the categories in which these emissions should be reported (e.g. energy industries). The electricity generation category covers emissions from all fossil fuel use for electricity generation from main activity

---

[1] It should be noted that Annex I Parties to the UNFCCC (industrialized countries) will continue to be required to submit annual NIR, even in years where no BTR is due. Non-Annex I Parties are expected to submit the NIR in conjunction with the BTR.

Text box 1: Overview of the most common HFCs and HFC mixtures used in the RAC sector

HFC	Formula	Global Warming Potential (AR 5)	
		20 years	100 years
HFC-23	CHF_3	10,800	12,400
HFC-32	CH_2F_2	2,430	6,77
HFC-125	C_2HF_5	6,090	3,170
HFC-134a	CH_2FCF_3	3,710	1,300
HFC-143a	$C_2H_3F_3$	6,940	4,800
HFC-152a	$C_2H_4F_2$	506	138
HFC-404A	Mixture		3,922
HFC-407C	Mixture		1,774
HFC-410A	Mixture		2,088

Source: authors, based on GWP values given in IPCC (2013)

producers. Hence the sectoral share of GHG emissions from energy consumption in RAC appliances in the National Inventories is not calculated separately in national inventories.

Typically, emissions in the RAC sector are divided into one third of refrigerant-related emissions and two thirds of CO_2e emissions stemming from electricity consumption of the equipment. With regard to the share of refrigerant emissions, most emissions (about two thirds) occur during the operation of a cooling device (e.g., a household air conditioner) due to leakage and regular topping up of refrigerants. Approx. one third of the emissions originate from the release of the remaining refrigerant at the end of the life cycle of a RAC unit (assuming there is no proper recovery of the refrigerant) and only a marginal amount leaks into the atmosphere during the manufacturing process or first filling of the equipment (GIZ 2016).

The NIRs contain detailed descriptive and numerical information. The GHG emissions and removals are reported in tabular format, alongside implied emission factors and activity data. Good annual inventories should include transparent documentation and data to enable the reader to understand the underlying assumptions and calculations of the reported emission estimates. Parties will have to report on emissions from 1990 to two years prior of the reporting year (2020 and three years prior to the reporting year for developing countries) and project emissions 15 years ahead (no projection required for developing countries). Emissions are reported for the year in which they occurred and cover the lifecycle of technologies and appliances. In the RAC sector that relates to emissions in manufacturing and production of refrigerants and equipment, direct and indirect emissions in use of appliances, direct emissions in disposal of appliances and emissions of destruction of refrigerants.

In the context of HFC reporting under the UNFCCC, a scandal has been revealed in Italy. Italy, from some of its northern areas near the border with Switzerland, has repeatedly been emitting HFC-23 in excess of what is being officially declared in its inventory. Measurements at locations in Western Europe, i.e., in Jungfraujoch (Switzerland) and Mac Head (Ireland), showed that HFC-23 emissions of 144–216 t/yr for July 2008 – July 2010, i.e. 2.1– 3.2 Mt CO_2e, have been 60–140% higher than the official emissions figures stated in the national reports for the year 2009 (Keller et al. 2011, European Parliament 2017).

This scandal regarding Italy's HFC reporting under the UNFCCC is symptomatic for the "accounting gap" of HFC emissions and the fact that atmospheric measurement of various F-gas pollutants commonly identifies large and disturbing discrepancies between reported HFC emissions and actual HFC concentration found in the atmosphere, partly but not only due to significant illegal trade of banned F-gas substances (see Sovacool et al. 2021, p. 34). Market-based cooperation with credible standards that impose comprehensive MRV can play an important role in closing this data gap.

2.1.2 National HFC inventories of the RAC sector

The Intergovernmental Panel on Climate Change (IPCC) has been tasked by the UNFCCC to develop guidelines for national GHG inventories. It has published such guidelines in 1996 and again in 2006, with sector-specific updates in between and since then. Those guidelines provide a general framework for estimating emissions from HFCs. In contrast to the baseline setting and reporting of production and consumption under the MP/ KA (see chapter 3), the 2006 IPCC guidelines provide a set of methods for the determination of HFC emissions resulting from the refrigeration, air conditioning and foam (RACF) sector at different levels of aggregation. First of all, the guidelines differentiate between a Tier 1 and Tier 2 approach.

- **Tier 1** considers emissions at an aggregated level which means that those are estimated for the entire RACF sector and not broken down to the sub-sector, respectively equipment, level. This method is considered less complex than Tier 2; also, less data is required.
- **Tier 2** methods result in emission estimates at the sub-sector, respectively equipment, level and each individual refrigerant. For the calculation of emissions, it is necessary to determine the stock of equipment for each sub-sector, i.e., the appliances in operation in the country. Hence, this approach is more data-intensive and requires data at a disaggregated level which is sometimes difficult to obtain.

A Tier 3 method which applies data based on actual monitoring and measurement from point sources is not considered for the RACF sector, as it is technically very challenging and too complex to monitor individual point sources that are very divergent.

In addition, the IPCC guidelines discern between the emission factor and the mass-balance approach. For the **emission factor approach**, one applies either a country specific

Table 1 : Overview of KA HFC phase-down schedule

	Emission factor approach (a)	Mass-balance approach (b)
Tier 2 (emission estimation at a disaggregated level)	Data on chemical sales and usage pattern by sub-application [country-specific or globally/regionally derived] Emission factors by sub-application [country-specific or default]	Data on chemical sales by sub-application [country-specific or globally/regionally derived] Data on historic and current equipment sales adjusted for import/export by sub-application [country-specific or globally/regionally derived]
Tier 1 (emission estimation at an aggregated level)	Data on chemical sales by application [country-specific or globally/regionally derived] Emission factors by application [country specific or (composite) default]	Data on chemical sales by application [country-specific or globally/regionally derived] Data on historic and current equipment sales adjusted for import/export by application [country-specific or globally/regionally derived]

Source: IPCC 2006

or (composite[2]) default factor (Tier 1) to derive emissions from national HFC consumption data or, in the case of a Tier 2 approach, specific emission factors at the equipment level. The emission factors consider the different stages of a RAC appliance in its lifecycle and thus provide estimates for emission occurring during manufacturing, operation (in-use) and disposal (end-of-life) of equipment. The **mass-balance** approach takes into account measured consumption, i.e., sales, of each refrigerant and basically assumes that emissions equal the amount of substance that is used to re-fill refrigerant on a yearly basis, i.e., emissions due to leakage (or operation emissions). This approach might estimate emissions rather accurately in the case that equipment is topped-up annually and assuming a static market with a constant level of equipment stock. However, a more precise estimate would follow a Tier 2 emission factor approach (IPCC 2006). The following table provides an overview of the four different approaches described above.

2.1.3 Approaches for calculating energy-related emissions of the RAC sector

As the share of energy consumption attributable to the RAC sector cannot directly be derived from national inventories, there must be clarity on the sectoral emission reference scenario when determining energy-related mitigation targets for this sector. A robust approach to quantify emissions that covers all applicable sources of emissions relevant in the RAC sector and which avoids double counting of energy related emissions needs to be defined. In general, a two-step approach could be followed:

Table 2 describes the different options that could be applied and the data needs in order to establish a robust and conservative baseline which can be considered as reference scenario.

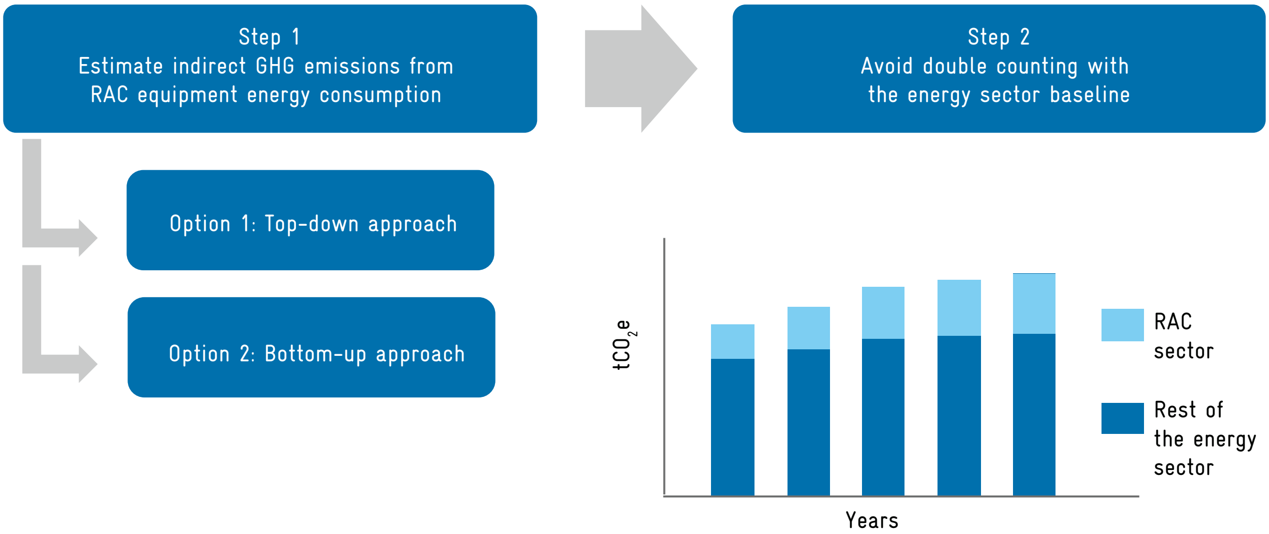
The RAC emission level can be calculated as follows.

$$BE_{EC,y} = EC_{BL,y} * EF_{grid,y} * \left(1 + TDL_y\right) + FC_{BL,y} * EF_{FF,y}$$

Where

$BE_{EC,y}$ = baseline emissions in year y (tCO_2e)
$EC_{BL,y}$ = baseline electricity consumed in year y (MWh)
$EF_{grid,y}$ = electricity grid emission factor for year y (tCO_2e/MWh)
TDL_y = average technical grid losses in year y (%)
$FC_{BL,y}$ = baseline fossil fuel consumed in year y (MWh) (including fossil fuel burned for electricity generation for captive use – proportional to the RAC equipment electricity consumption and for the operation of HFC destruction processes)
$EF_{FF,y}$ = average technical grid losses in year y (%)

Figure 2: Approach to calculate energy-related emissions of the RAC sector



Source: authors

---

[2] "Composite emission factors are determined by taking an average of the applicable [sub-application=e.g., unitary air conditioning] emission factors, weighted according to the activity in each sub-application." (IPCC 2006)

Table 2: Data needs related to energy consumption related emissions of the RAC sector

Option	Data required

Option 1: Top-down approach	• Countries define the share of total final electricity consumption per year that was used by RAC equipment and the emissions reported in the 'Energy – Fuel Combustion' category are adjusted to reflect this proportion in the following subcategories: 'Energy Industries – Electricity generation', 'Other sectors' – 'Commercial/Institutional', 'Residential' and 'Agriculture / Forestry / Fishing / Fish farms'. There are two possible options depending on the level of electrification in the country:
	  • Option a: High level of electrification: countries falling under this category would not need to adjust the 'Other sectors' subcategory as electricity will mainly be provided by public utility companies or its equivalent, only the 'Energy Industries – electricity generation' category is to be adjusted.
	  • Option b: Low level of electrification: countries falling under this category typically rely on operation of generators (e.g., diesel) in off-grid areas. When this is the case, emissions from autoproducers (which generate electricity wholly or partly for their own use, as an activity that supports their primary activity) are typically accounted in the 'Commercial/ Institutional' and/ or 'Residential' and/or 'Agriculture / Forestry / Fishing / Fish farms' subcategories. Therefore the share of total final electricity consumption per year that was used by RAC equipment would need to be differentiated between electricity consumed from the grid and from off-grid sources. Default values for this proportion could be developed on a regional basis (e.g., proportion of RAC equipment operated in areas with grid access). In this option, the emissions in the subcategories: 'Energy Industries – Electricity generation' and 'Other sectors- Commercial/Institutional', 'Residential' and/or 'Agriculture / Forestry / Fishing / Fish farms' are to be adjusted.
	• Countries define the share of total final electricity consumption per year that was used for the operation of HFC destruction processes
	• Countries define the share of fossil fuels consumed per year that was used for the operation of HFC destruction processes
	• It is recommended that countries document how the share of total electricity consumption by RAC equipment was estimated.

Option 2: Bottom-up approach	• Equipment stock: statistical data on existing installed RAC equipment at the appliance level (e.g., air conditioners, domestic and commercial refrigerators, transport refrigeration, etc.) and area of the country where the equipment is used/ source of electricity generation (on-grid or off-grid)
	• Sales of equipment: statistical data on sales of RAC equipment at the appliance level (e.g., air conditioners, domestic and commercial refrigerators, transport refrigeration, etc.) and area of the country where the equipment will be used/ source of electricity generation (on grid or off-grid)
	• Forecast of future equipment stock and equipment sales by area of the country where the equipment will be used/ source of electricity generation (on-grid or off-grid)
	• Technical parameters of BAU or baseline equipment:
	  • Typical annual energy consumption of equipment
	  or
	  • (Average) cooling capacity
	  • Energy efficiency parameters (Coefficient of performance (COP), Energy Efficiency Ratio (EER))
	  • Annual operating hours
	  and
	  • National grid emission factor (GEF)
	  • Grid transmission losses
	  • Off-grid electricity generation equipment performance (typically diesel generators)
	• Energy consumption per year (both electricity and fossil fuels) at the HFC destruction facilities
	and
	  • Fossil fuel emission factors differentiated by fuel including fossil fuels used for electricity generation in off-grid areas (typically diesel)

2.1.4 Biennial transparency reports

Chapter 3 of the MPGs sets the rules and processes for reporting within the BTRs on the information necessary to track progress made in implementing and achieving their NDCs. These MPGs require Parties to account for NDC implementation and achievement in a way that promotes environmental integrity, transparency, accuracy, completeness, comparability, and consistency (TACCC) and ensures the avoidance of double counting (UNFCCC 2018). Parties must track progress in NDC implementation via a "structured summary" in the BTR. In these structured summaries, Parties will have to provide information on their selected indicators to track NDC progress as well as participation in Article 6 cooperation and account for ITMO transfers.

A national GHG inventory reported by a Party in its BTR should be complete and cover all anthropogenic sources and sinks in the country. While the GHG inventory will be reviewed, not all emissions and removals need to be considered in the Party's NDC accounting (UNFCCC 2020). Also NDC targets do not need to be expressed in GHG metrics that can be tracked through the NIR.

Parties can track NDC targets through different indicators, e.g., policy-related indicators (e.g., adoption of a carbon tax) or in other non-GHG outputs (e.g. increase of renewable energy capacity in Megawatts (MW)). Countries are free to determine their NDCs, they just need to communicate them transparently and enable tracking progress. In theory, Parties can include the mitigation of HCFC emissions and ODS-related indicators in their NDCs. However, Parties need to ensure adherence with TACCC principles, promote environmental integrity and avoid double counting. Once an emission source or sink is included in the NDC it must consistently be reported upon (UNFCCC 2020).

Under the ETF, the structured summary will also be used by Parties for information related to ITMOs and Article 6 cooperative approaches, as determined by paragraph 77d of decision 18/CMA.1 (UNFCCC 2018). Under this paragraph, Parties need to report their annual emission balance of sources and sinks covered by the NDC and apply adjustments to this emission balance for all ITMOs that were transferred to be used for another Party's NDC or that were authorized to be used for other purposes than domestic NDC achievement (e.g., a credit sold to an airline for compliance under the international air traffic Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)). If a mitigation outcome is transferred, the host country cannot account for the mitigation achieved and must add the corresponding emissions "back" to its national emission balance of sources and sinks. If a country uses an ITMO towards its NDC, it can lower its NDC emission balance. This is called a *corresponding adjustment* to the annual NDC emission balance.

The adjusted NDC emission balance is then compared to the achievement of a quantified NDC target (for participation in Article 6, countries must quantify the relevant NDC targets if they are not expressed in a GHG metric). In the context of aligning host countries' action under the MP and the PA, it should be noted that the adjusted emission balance plays *no role* in accounting under the MP. So even if the host country cannot account for exported mitigation outcomes towards its NDC (and must therefore ensure any mitigation goes beyond its national targets), reduced levels of HFC consumption can be accounted for as MP compliance.

However, as decision 18/CMA.1 was adopted in absence of an agreement on Article 6.2 guidance, paragraph 77d included some assumptions about Article 6 rules, in particular the way corresponding adjustments are made to emission balances, also assuming that ITMOs are only denominated in CO_2e and extended to international mitigation purposes. This generated some controversy in Article 6 negotiations. As the paragraph does require 'consistency with Article 6 guidance' in reporting information, some Parties (e.g., China, Saudi Arabia, and the African Group of Negotiators) insist that the paragraph has no validity on its own but can only be operationalized once Article 6 is agreed. Other Parties (e.g. US, Switzerland, and the European Union) adhere to the statement that the paragraph is part of a binding decision and therefore valid also in the absence of an agreed Article 6 rulebook – laying the foundations needed to go ahead with bilateral market-based cooperation. At COP26, Parties will have to ensure congruence when finalizing the Article 6.2 guidance and reporting formats for the structured summary (Michaelowa et al. 2020c).

2.1.5 Flexibility provisions

As mentioned above, reporting requirements do not apply to all countries in the same way. Least developed countries (LDCs) and small island developing states (SIDS) can submit these reports 'at their discretion' which is usually related to the possibility to receive international support, while developing countries in general can invoke 'flexibility' for certain provisions. The need for flexibility can be related to the scope, frequency, and level of detail of reporting as well as to the scope of the review, where such flexibility is granted at a provision level (Michaelowa et al. 2020c). This includes, for example, in the context of the NIR the flexibility to identify key categories or to report at least 3 gases (CO_2, CH_4 and N_2O, whereby HFCs is not required to be covered), instead of the mandatory requirement to report on the basket of 7 gases.

This need for flexibility will be self-determined by developing country Parties and cannot be judged or overruled by anyone. Still, this principle marks a deviation from the strict division of responsibilities and obligations along the lines of developed and developing countries as known from the KP.

However, this flexibility may infringe on Parties' abilities to cooperate in international market mechanisms which will require robust accounting in a timely manner. On the other hand, market-based cooperation can increase participating Parties' capabilities in reporting and accounting and thereby reduce the need to apply flexibility.

2.2 Reporting and review under Article 6.2 guidance

As per the current status of negotiations the Article 6.2 guidance is likely to require reporting from participating Parties through an initial report, annual quantitative information, and regular reports. Where practical, the initial report can be provided in conjunction with the country's next due BTR, but the latest at the time of first authorization of transfer in a cooperative approach. Afterwards, regular information is to be included into the BTRs (Michaelowa et al. 2020c).

In their initial reports, participating Parties must provide the information necessary to ensure robust accounting. This relates to:

- the ITMO metrics and method for corresponding adjustments (for multi-year/single year NDCs) that will be applied throughout the NDC implementation period;
- quantified mitigation information in its NDC in tCO_2e, including sectors, GHGs, time periods, reference levels and target levels (or, if this is not possible for a Party, a methodology for the quantification of the NDC in tCO_2e). It is expected that this quantified information is congruent with the quantified information on sources and sinks that countries report in their NIR, even if that link is not (yet) made explicit in any rules. However, if countries may choose to include HCFC-related mitigation action in their NDC, they could add CO_2e emissions to their emission balance against which they will account for NDC achievement (and perform adjustments to in case of transfers of mitigation outcomes);
- for NDCs or targets using non-GHG metrics, the quantification of the NDC (or a portion of the NDC) in the relevant metric for ITMO transfers.

This information is necessary to ensure that corresponding adjustments are undertaken against the emission balance of gases and sinks covered by the NDC and to ensure there is consistency in the quantification and generation of ITMOs and accounting for them in the context of NDC emission balances. This is the central safeguard to avoid double counting of an ITMO, authorized to be used by others (other NDCs, CORSIA, voluntary purposes, etc.) with the NDC of the host country, which would lead to an overall increase in emissions.

In addition, Parties will provide a description of the cooperative approaches in which they participate, including the expected mitigation and the participating Parties, in their initial report.

From this moment onwards and annually, Parties must provide annual quantitative information which allows for transparent tracking of ITMO transfers through unique identifiers which at least identify the originating participating Party, the vintage of the underlying mitigation, activity type and buyer country. This could be done through serial numbers as known from the KP. In an electronic format, Parties must submit information to an Article 6 database on ITMO authorization, first transfer, transfer, acquisition, holdings, cancellation, use towards NDCs, etc., while also providing the underlying unique identifiers. It must be noted that Parties must have their own, or have access to an existing, registry which allows them to track this information, and which holds all the necessary accounts for any project participants and ITMO transactions (Michaelowa et al. 2020c)

Biennially, Parties are then required to provide regular, both quantitative and qualitative information in the context of their BTRs. The regular information is differentiated into three categories:

1. Reporting on a Party's participation in cooperative approaches: This includes:

    a. proof of fulfilling the participation requirements (e.g., having submitted the latest NIR, having a national registry)
    a. updates necessary to information provided in the initial report
    b. Information on authorizations on first transfer, including for other international mitigation purposes (e.g., CORSIA) and other purposes (e.g., VCM); information on corresponding adjustments undertaken and avoidance of increase in emissions in and between NDC implementation periods as well as avoidance of double counting.

2. Reporting on how each cooperative approach meets the requirements of the Article 6.2 guidance. This includes reporting on environmental integrity of the mitigation activity and mitigation outcomes as discussed in chapter 4.1. This also includes information on how the international cooperation promotes sustainable development in the host country (text box 2)
3. Reporting of annual quantitative information on ITMOs authorized, transferred and use; on the emission balance of sources and sinks covered by the NDC and undertaken corresponding adjustments to these annual emission balances (see above).

To perform a corresponding adjustment, a Party:

- Applies an addition to the quantified annual balance of sources and sinks covered by its NDC for the year in which an ITMO was authorized and first transferred (host country).
- Applies a subtraction to the quantified annual balance of sources and sinks covered by its NDC in the year and acquired ITMO is used towards an NDC (buyer country).

It should be noted that corresponding adjustments by host and buyer country do not have to take place in the same year. Also, if an ITMO is used under CORSIA or on the VCM or in other contexts, there will only be a corresponding adjustment undertaken by the host country.

When reporting on NDC achievement, Parties will have to demonstrate that they account based on an emission balance which is adjusted for transfers and use of ITMOs. Accounting for ITMO transfers will be different for countries with a single-year or a multi-year target. If a Party has a single-year NDC target, it can define an accounting trajectory that translates the single-year target in annual indicative emission levels to which the adjusted emission balance is compared. Alternatively, the country can account for NDC achievement in the single-target year through applying the average amount of ITMOs transferred or use throughout the NDC implementation period to the emission balance of the accounting year. Accounting for multi-year targets can be done directly against the annual emission balances.

In any case, host countries should ensure that their NDC emission balance covers the sources and sinks where Article 6 market-based mitigation action is undertaken. In case the emissions and sinks are not included in that balance; the host country is disproportionally impacted by the corresponding adjustment. This may result in difficulties for the host country to achieve its NDC target, even if it is otherwise on track of meeting its commitments. For mitigation of ODS with GWP that means that their emissions, converted in tCO_2e, should be included in this balance, if the host country plans to generate ITMOs for their reduction.

Only then a corresponding adjustment does not increase opportunity costs for the host country (as long as the activity is additional to host country mitigation commitments, see below).

It should be noted that the Article 6.2 draft text provides reporting flexibility for LDCs and SIDS where the requirements relate to NDCs and other special circumstances that still need to be defined.

The Article 6 TER will review the consistency of information submitted in the initial report, the annual information and the regular information and forward their reports to the TER under the ETF (Michaelowa et al. 2020c).

Text box 2: Reporting on Sustainable Development (SD) benefits

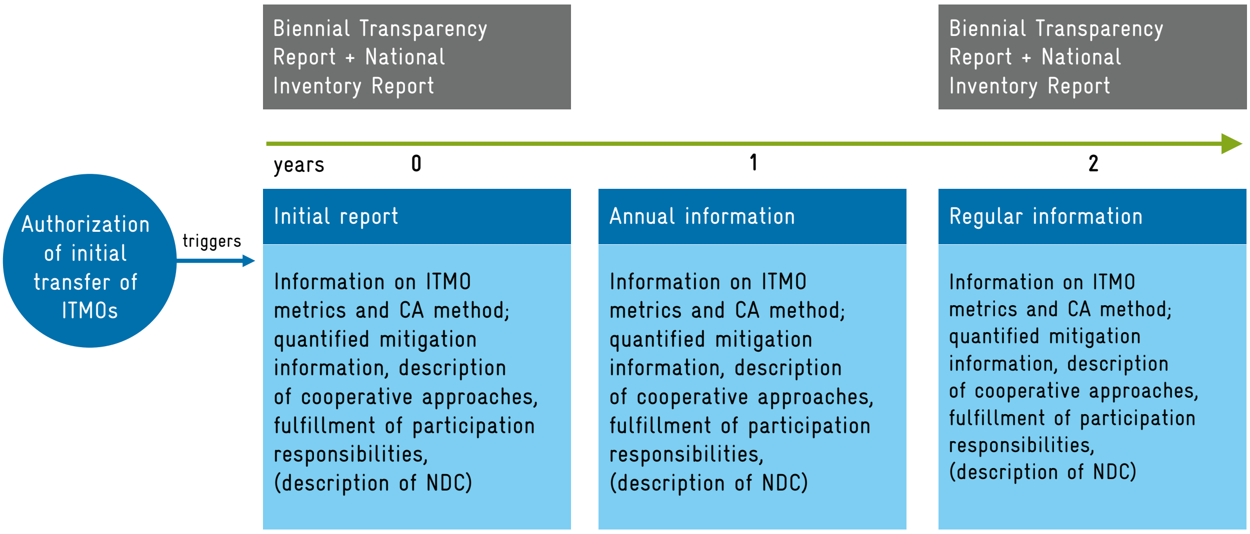
In the context of the contribution to SD, paragraph 22(g) asks Parties to report on how the cooperative approaches in which they participate are consistent with the SD objectives of the host Party. As Parties are only required to report on how the cooperative approach contributes to the SD objectives of the host Party, for each cooperative approach, this information would only need to be reported by the host Party, and could then be referenced by the other participating Party. Whereas a contribution to SD is one of the core objectives of cooperation under Article 6 (Article 6.1) the requirement to report on SD under Article 6.2 is relatively soft. First because paragraph 22(g) does not specify the type of information that Parties should provide to create a sufficient level of transparency on how the cooperative approach supports SD in the host country. Secondly because the requirement is only related to the SD prerogatives of the host Party. There is, for example, no link to Sustainable Development Goal (SDG) reporting or agreed elements of what Parties consider 'SD' (Michaelowa et al. 2020c).

Relevance of sustainable cooling in the context of Sustainable Development Goals (SDGs):

- **SDG 1** – No poverty: RAC sector transformation towards green and sustainable cooling technologies involves the creation and formalization of jobs (e.g., through training and certification of technicians).
- **SDG 2** – Zero hunger: Reliable and sustainable cold chains improve food quality and security and thereby contribute to the improvement of nutrition.
- **SDG 3** – Good health and well-being: Well functioning cold chains are essential in the health sector in order to preserve medicines and vaccines.
- **SDG 4** – Quality education: Training and qualification of technicians is a crucial element for a sustainable RAC sector transformation.
- **SDG 7** – Affordable and clean energy: Many cooling devices using HFC alternatives tend to have better energy performance and thus offer energy savings.
- **SDG 8** – Decent work and economic growth: The transformation towards green cooling allows for sustainable economic growth by creating and formalizing jobs in the RAC sector. In addition, the application of green cooling technologies, e.g. in the agricultural sector, provides additional income especially to low-income groups.
- **SDG 9** – Innovation and infrastructure: Developing countries benefit from the transformation of the RAC sector by building technological capacity.
- **SDG 12** – Responsible consumption: Natural refrigerants have no ODP, negligible GWP and do not form persistent substances in the atmosphere.
- **SDG 13** – Climate Action: The use of low-GWP (ideally natural) refrigerants and energy-efficient equipment reduces the negative impacts of the sector on the climate while meeting the growing demand for cooling applications.

(Sovacool et al. 2021; GIZ 2016)

Figure 3: Reporting requirements under the Article 6.2 guidance



Source: authors, based on Michaelowa et al. (2020c), p. 33


© Shutterstock / Milan Sommer

3. National level reporting requirements for HFC and HCFC emissions under the Kigali Amendment

After discussing reporting and accounting for HFC and HCFC emissions under the PA, this chapter turns to related requirements and obligations under the MP and its KA.

The MP mandates parties to reduce production and consumption levels of ODS as well as HFCs in a step-wise manner. Article 3 and Article 5 of the MP further determine specific rules regarding the baselines against which countries have to cut their production and consumption levels. Thereby,

- production is specified as the quantity of substances produced, minus the amount destroyed and the amount entirely used as feedstock in the manufacture of other chemicals (MP Article 1, para 5);
- consumption is defined as production of substances plus imports, subtracted by exports (MP Article 1, para 6).

In contrast to the calculation of controlled levels of ODS, which is based on the ozone depleting potential (ODP) of substances and expressed in ODP tonnes, the calculated levels of HFCs are derived by multiplying the amount of the specific HFC with its corresponding GWP (MP Article 3, para 2). Consequently, HFC production and consumption levels are determined in CO_2 equivalent.

According to the rules established in Article 5 (MP Article 5, para 8 qua), developing countries will calculate their allowed production and consumption of HFC (i.e., the KA baseline) in CO_2e considering the following two components:

1. the average annual quantity of HFCs consumed and produced during a 3-year baseline period

   a. for Article 5, Group 1 Parties[3]: 2020 – 2022;
   b. for Article 5, Group 2 Parties[4]: 2024 – 2026;

2. 65% of its baseline production and consumption of HCFCs which is obtained from the average HCFC production and consumption levels in the years 2009 and 2010 (MP Article 5, para 8 qua). In this report, we use the term 'HCFC adder' for this default value.

Therefore, and as set out by Article 7 of the MP, countries are obliged to report statistical data on quantities of ODS and HFCs produced and consumed on a yearly basis – the first expressed in ODP tonnes and the second calculated in t CO_2e (MP Article 7, para 2 and 3).

The **information to be provided annually** by the Parties to the Secretariat include:

- Statistical data on its annual production (as defined in paragraph 5 of Article 1) of each of the controlled substances listed in Annexes A, B, C, E (ODS including **HCFCs**) and F (**HFCs**) and, separately, for each substance,

  - Amounts used for feedstock
  - Amounts destroyed by technologies approved by the Parties
  - Imports from and exports to Parties and Non-Parties respectively

According to the reporting guidelines of the Ozone Secretariat, which is the administrative office for the MP, Parties are requested to report the production and consumption of bulk controlled substances **in tonnes**, without multiplying the relevant ODP or GWP values. The Ozone Secretariat then calculates the CO_2 equivalent. Data needs to be provided separately for each individual controlled substance listed in the forms (UNEP 2018). 'Controlled substance' means a substance in Annex A, Annex B, Annex C, Annex E or Annex F to the Protocol, whether existing alone or in a mixture **(see Annex F lists HFCs)** (UNEP 2018). Separate data forms are provided for imports, exports, production, destruction, trade with non-parties and emissions of controlled substances. The **baseline data reporting** under Article 7 has to be reported once for HFCs (Ozone Secretariat 2020).

---

[3] Article 5 countries, Group 1: "Any Party that is a developing country and whose annual calculated level of consumption of the controlled substances in Annex A [Chlorofluorocarbons (CFCs) and halons] is less than 0.3 kilograms per capita on the date of the entry into force of the Protocol" (UN 1989)

[4] Article 5 countries, Group 2: Bahrain, India, Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, UAE (UNEP Ozone Secretariat 2020b)

It should be noticed that the same forms are used for baseline- and annual reporting. Further information that needs to be reported by the Parties include:

- A list of the reclamation facilities and their capacities available in their countries (to be reported annually)
- New ozone-depleting substances reported by the Parties (reported when new substances emerge)
- Strategies on environmentally sound management of banks of ozone-depleting substances (reported once, but updated as required)
- Reporting on consumption and production under the exemption for high-ambient-temperature parties (Ozone Secretariat 2020).

However, the experience with this reporting system has been mixed as illustrated by different scandals. For example, between 2013 and 2018 companies in Eastern China emitted significant quantities of CFCs. Only after discovery of these emissions in 2019 and heavy criticism by the international community against China these emissions stopped, as shown by recent monitoring (Montzka et al. 2021). Similar incidents have been made public for HFCs under UNFCCC reporting, as outlined in chapter 2.


© Shutterstock / Olga Kashubin

4. Methodologies and approaches for HFC baseline setting at the national and sectoral level

Based on the reporting and accounting requirements under the climate and ozone regime discussed above, this chapter discusses how accounting for KA commitments can be integrated in UNFCCC and PA accounting for mitigation. Here, we would like to explain the differences in baseline setting, accounting for emissions and expression of commitments under both regimes carefully. Building on the differences identified, we develop an approach to translate a KA baseline and compliance pathway into a baseline scenario that can be accounted for under the UNFCCC.

4.1 Differences in baseline setting in the context of the Kigali Amendment and the UNFCCC

Comparing the approaches to determine HFC emissions provided by the 2006 IPCC guidelines and the rules established by the MP, respectively KA, a substantial difference becomes evident: whereas the KA operates its compliance mechanism on the basis of *potential* emissions (i.e., assuming any consumed substance will be emitted in some point in time), the UNFCCC and PA framework accounts for *actual emissions*. This means that the methods used to determine or estimate emissions in the UNFCCC context factor in the actual time when emissions occur and consider a time gap between consumption of HFC refrigerant and the actual emissions. Actual emissions can be different for different types of equipment. For instance, some cooling devices, such as air conditioners or large cooling equipment in supermarkets, need to be frequently serviced and re-filled with refrigerant (operation emissions). Other appliances, such as household refrigerators, are usually not maintained during operation and, in case they are not properly disposed, main leakage of refrigerants and consequently emissions are most likely to happen at the end of the lifecycle. Therefore, emission levels for baseline setting or reporting of emissions respectively consumption under both regimes cannot directly be compared and need to be 'translated'.

For the design of Article 6 activities and, more specifically the development of crediting baselines in the context of such activities, this is a crucial aspect which needs to be addressed first before being able to set up any robust and conservative crediting baseline.

Therefore, KA commitments to phase down HFC production and consumption should be reflected in the RAC sector emission reference scenario of countries' NDC (NDC reference scenario) in order to safeguard environmental integrity. Michaelowa et al. (*forthcoming*) assess the different approaches for baseline setting under the KA and PA, including the effects of the HCFC 'adder' in the KA baseline, and discuss their implications on NDC reference scenarios and Article 6 baselines. They conclude that in the context of developing countries, the HCFC adder is a problematic factor as it can lead to overestimated KA HFC consumption baselines (and consequently emissions baselines). One of the main reasons for this overestimate is the assumption that countries would reduce HCFC production and consumption only to the level required by the original HCFC phase-out schedule as mandated by the MP. However, the assessment of the current state of HCFC consumption reduction of various countries revealed that many countries achieved an accelerated phase-out, some even to almost zero. As a consequence, these countries might get a massively overestimated KA baseline, if they apply the full 65% HCFC adder.

To guarantee environmental integrity and additionality, NDCs and hence Article 6 crediting baselines should be based at the minimum on a realistic HFC BAU path. It is therefore recommended that countries do not consider the full HCFC adder to set the NDC reference scenario but only apply a realistic percentage of the adder that is consistent with BAU. This enables the translation of the KA baseline into NDC and Article 6 baselines. In this study, we will refer to this as **'PA aligned HCFC adder'**.

The next section outlines the different steps required to derive a (NDC) RAC emissions baseline from the KA consumption baseline.

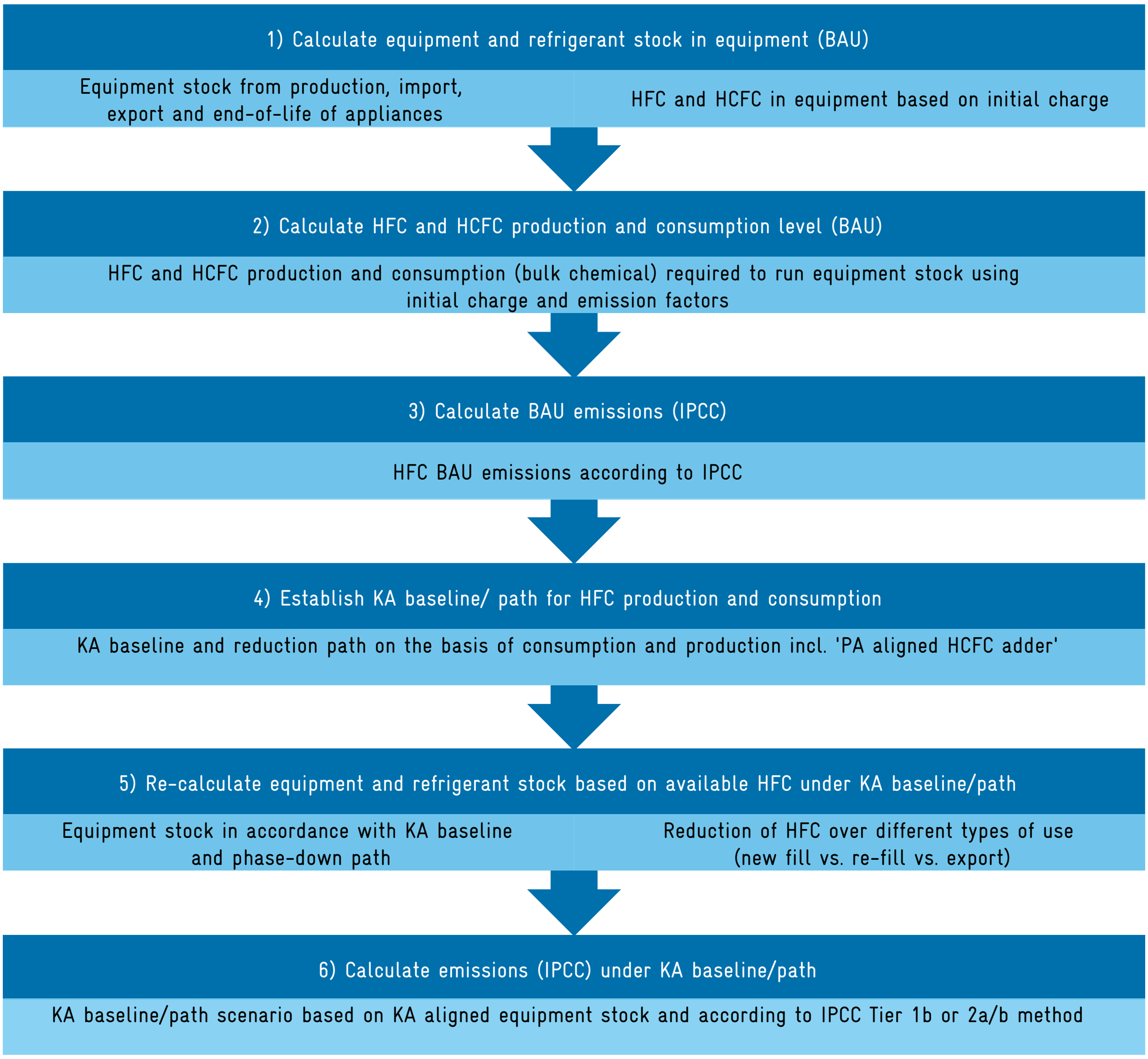
4.2 Conversion of the KA baseline into the UNFCCC context

As delineated in the previous section and by Michaelowa et al. (2021), there is a need to translate the KA HFC production and consumption baselines into an emissions baseline before integrating it into as the reference scenario in countries' NDC and use it as starting point for developing crediting baselines under Article 6. The following approach describes the different steps that need to be applied in order to establish a robust and conservative baseline which can be considered as NDC reference scenario prior to actual baseline setting under Art. 6. The calculation and estimations follow the methods recommended by the IPCC 2006 Guidelines, as described in the previous section.

The underlying basis for the translation of the baseline is ideally a comprehensive inventory of a country's RAC sector, which contains data at the disaggregated level for the different appliances and technologies.

As a first step to derive actual emissions under BAU (1), the equipment and refrigerant stock needs to be calculated and projected based on statistical data on

Figure 4: Steps to translate KA HFC consumption baseline into an emissions baseline under the PA



(Sovacool et al. 2021; GIZ 2016)

production, import, export and lifetime of RAC appliances. Technical parameters, i.e., charge size and leakage during manufacturing respectively first filling of the equipment, are then used to determine the quantity of HFC and HCFC refrigerants in the (projected) equipment stock. If such parameters cannot be specified for the national context, it is recommended to use conservative default values. The IPCC 2006 Guidelines provide estimates for emission factors, charge size and equipment lifetime for different sub-sectors and applications. Recent studies can also provide data at the global, regional or national level. Sovacool et al. (2021), for instance, report leakage rates for different appliances.

In a second step (2), the bulk of chemicals which is required to run and frequently service (re-fill) the equipment under BAU is calculated assuming that production of refrigerants is driven by the demand for the same. This requires data (national data or default values, e.g., from the IPCC 2006 Guidelines) on average operation emissions at the disaggregated level, i.e., for the different types of equipment (e.g., split air conditioners, air conditioning chillers, domestic and commercial refrigerators, etc.). As available, historical data on production and consumption of refrigerants can be taken also from reporting obligations under the MP/KA.

Actual BAU emission levels can now be derived using a Tier 1b or 2a/b approach according to IPCC 2006 Guidelines (see Table 1) (3).

Once the production and consumption level of refrigerants based on the stock of equipment and refrigerants has been determined, the KA baseline and phase-down can be calculated (as explained in section 2.1) on the basis of average HFC production and the consumption in the 3-years period and including the HCFC component (4). As already delineated in the previous section, it is recommended to apply a HCFC adder that is aligned with realistic HCFC consumption levels based on current data and projected consumption, instead of using the full HCFC adder derived from the baseline period set under the KA. The percentage of the HCFC adder, i.e., the ‘PA aligned HCFC adder’ should therefore be deduced from the stock model (equipment and refrigerant) developed under step 1.

Based on the determination of the KA baseline one could re-calculate the equipment and refrigeration stock based on the permitted HFC consumption according to the HFC phase-down path (5). Countries would be of course free to decide their pathway and their focus on one or the other application and corresponding measures. This requires profound modelling, taking into account market growth rates, technological developments and other national circumstances such as availability of certain appliances and refrigerants. For now, we here assume that HFC consumption reduction rates are aligned across different activity types, i.e., production/ new fill of equipment versus re-fill during servicing in the absence of country specific considerations.

In a final step (6), the actual emissions baseline under the KA HFC reduction path is derived by making use of IPCC Tier 1 or 2 methods and taking into account KA aligned equipment stock.

The following table 3 summarizes the data requirements for the individual steps.

The EU uses a similar model called AnaFgas (Analysis of Fluorinated greenhouse gases in EU-27) to project demand and emission scenarios for F-gases in different sectors and sub-sectors for the EU Member States in the framework of the EU F-gas Regulation ((EU) No 517/2014). The latter controls emissions from F-gases including HFCs by limiting and phasing-out the amount of F-gases sold in the EU, banning the use of most harmful F-gases and addressing servicing and recovery of the gases at the disposal stage. The AnaFgas model is based on a bottom-up stock model that takes into account annual changes in equipment stock, refrigerant distribution and charge sizes of the equipment as well as leakage during operation and disposal of appliances. Additional drivers such as population and GDP growth, technological changes and future trends in substitution patterns and expected changes in use patterns are used to derive model scenarios until 2050. Recently, the EU Commission decided to review the EU F-gas Regulation by the end of 2021 in order to align the HFC reduction targets and measures with the EU’s commitments under the KA, as well as the new EU climate objectives which foresee to cut GHG emissions by at least 55% by 2030 and achieve climate neutrality by 2050 (Öko-Institut 2021).

Table 3: Data requirements to transfer the KA consumption baseline into an emissions baseline

Step	Data required
1) Calculate equipment and refrigerant stock in equipment	Statistical data on production, import and export of equipment at the appliance level (e.g., air conditioners, domestic and commercial refrigerators, transport refrigeration, etc.) Distribution of different refrigerants (HFC and HCFC) at the appliance level (share of equipment using e.g., HFC-410a, HCFC-22, etc.) Technical parameters: Lifetime of equipment (Average) initial charge of refrigerant per equipment type (kg)
2) Calculate HFC and HCFC production and consumption level	Technical parameters: Manufacturing emissions (%) per equipment type Operation emissions (%) per equipment type
3) Calculate BAU emissions (IPCC) and	HFC and HCFC production and consumption estimates (from step 2) Technical parameters: • Manufacturing emissions (%) per equipment type • Operation emissions (%) per equipment type • Disposal emissions (%) per equipment type
4) Establish KA baseline/path	
5) Updates equipment and refrigerant stock based on available HFC under KA baseline/path	
6) Calculate emissions (IPCC) under KA baseline/path	

Source: authors

© Shutterstock / Julneighbour

5. Article 6 requirements for carbon crediting methodologies

Baselines in market-based cooperation under Article 6 will be informed by NDC pathways and -for the RAC sector- ideally also KA compliance (see approach developed in chapter 4.2). Nevertheless, there are additional requirements the CMA will introduce for the generation of ITMOs to ensure market-based cooperation is not impacted by any environmental integrity loopholes in NDCs.

Rules on methodological approaches to set crediting baselines and determine the additionality under the A6.4M are among the most contentious in ongoing negotiations (Sharma et al. 2020). This is a challenge for activity developers interested in pursuing mitigation activities in cooperative approaches or registering their mitigation activities under the A6.4M. Rules on methodologies for Article 6.4 activities will also impact the revisions necessary to methodologies in CDM activities that want to 'transition' to the A6.4M (Michaelowa et al. 2020a). As positions of Parties are well known, assuming the most stringent options on the table are adopted ensures a high degree of confidence that methodologies developed will comply with Article 6 rules.

5.1 Article 6.2 guidance on methodologies

In cooperative approaches under Article 6 Parties have large degrees of freedom on how to design market-based cooperation which, besides baseline and credit approaches, can include linking of Emission Trading Systems (ETS) to generate ITMOs. As per the status of negotiations, ITMOs are mitigation outcomes for either emission reductions or removals created from 2021 onwards, and must be real, verified, and additional (UNFCCC 2019a-c, Michaelowa et al. 2020b). In the context of baseline-and-credit approaches pursued under Article 6.2, it is crucial to establish methodologies that test additionality, set the crediting baseline, calculate mitigation achieved against the baseline and determine on how to monitor, report, and verify mitigation outcomes (Michaelowa et al. 2020a).

If Parties engage in cooperative approaches, they must report on how they are respecting the guidance in an initial report, in the context of biennial transparency reports (BTR) and through annual quantitative information (section 7 provides further information). Regarding methodologies, Parties must report that they (UNFCCC 2019a-c, Michaelowa et al. 2020c):

1. **Ensure that their participation in cooperative approaches does not lead to a net increase in global emissions but contributes to mitigation and the implementation of the host Parties' NDC.**
   To comply with this requirement, methodologies are key. Cooperating Parties should require proof of regulatory, financial and target additionality of a mitigation activity. In addition, they should oversee that crediting baselines are robust, conservative and lead to crediting of mitigation relative to a 'below BAU' and NDC-related emissions pathway. Not ensuring additionality or lenient crediting baselines would lead to an overall increase in emissions, if the resulting ITMOs are used to *offset* emissions caused by other entities/ in other jurisdictions. Contributions to the host Parties' NDC implementation can be ensured through various means. They can range from 'overly conservative' baselines, the host country retaining a share of the mitigation outcomes achieved or a share of the funding earmarked for new mitigation activities. This is separate from ensuring an 'overall mitigation of global emissions' through cancelling a share of mitigation outcomes generated which cannot be claimed by any participant but is an international 'GHG tax' to move beyond offsetting.

2. **Established robust and transparent governance processes.**
   In the context of Article 6.2 cooperation processes need to be in place that ensure oversight on the design of the activity at the approval stage and oversight on the transfer of mitigation outcomes through an authorization process. Developing clear criteria for methodologies is an important part of this oversight function which in Article 6.2 both the host country and the acquiring government (or non-governmental entity) need to ensure. In addition, participating governments must have processes and resources to comply with the reporting and accounting obligations under the ETF.

3. **Ensure the quality of the mitigation outcomes through stringent reference levels, conservative baselines, and below BAU emission projections. These reference levels, baselines, and projections must consider all existing policies and address potential leakage.**

This reporting requirement directly refers to methodologies used for quantifying mitigation outcomes and requires these methodologies to be conservative and 'stringent' as well as below a 'business-as-usual' emission projection. This means, that the reference scenario must factor in existing policies (ruling out a continuation of the E+/E- rule applied in the CDM which stated that newly introduced mitigation policies were not to be covered by the baseline, see text box below). Further, it must already indicate an assumed deviation from a continuation of current trends, meaning enhanced mitigation action over the course of the timeframe for which emission levels are projected. In the context of emission reduction activities that enhance efficiency of resource use (e.g., energy, raw material, water), carbon crediting methodologies should consider potential rebound effects of lower prices influencing higher purchasing behaviour and more intensive product use. Rebound effects can also be more indirect through shifted consumer or producer behaviour.

4. **Minimise the risk of non-permanence of mitigation and address in full any reversal of emission removals if they occur.**

   This principle relates to GHG removal activities and, in particular, activities with high risks of non-permanence (e.g., afforestation, reforestation, and sustainable forest management).

5.2 Rules for methodologies under the Article 6.4 mechanism

Under the A6.4M, the SB will approve methodologies that can be applied to credit Article 6.4 emission reductions (A6.4ERs). The host Party will also have to approve activities and authorize transfers of A6.4ERs to be used by other Parties for NDC compliance or for other purposes. In that context, the host Party will have to approve whether a proposed mitigation activity promotes SD and contributes to NDC implementation. Both impacts can be assessed and considered in Article 6 carbon market methodologies.

The draft rules of the A6.4M already include some guardrails for methodologies in general, eligible baseline setting approaches and requirements for additionality. However, these rules for methodologies are still highly contested. While very technical, they are key to determine

Text box 3: Baseline setting under the CDM

The Marrakech Accords of 2001, which completed negotiations on how to meet the GHG emission reduction targets of the KP, also determined eligible baseline setting approaches in the CDM. CDM baselines try to define, as robustly as possible, what would happen under a 'business as usual (BAU)' scenario in developing countries, which had no mitigation commitments under the KP. This could be done according to three general approaches, based on:

1. existing actual or historical emissions;
2. emissions from a technology that represents an economically attractive course of action, taking into account barriers for investment;
3. average emissions of similar project activities undertaken in the previous 5 years, in similar circumstances and whose performance is among the top-20% of their category.

In practice, often a mix of these approaches was applied in CDM methodologies. In addition, as host countries in the CDM had no international climate policy commitments to fulfil, considering mitigation policies in crediting baselines could have led to a perverse incentive for host countries not to adopt these policies. Therefore, the CDM Executive Board (EB) adopted the so-called E+/E- rule on the consideration of policies in baseline setting: Policies that provide a comparative advantage to more emission-intensive technologies (E+) were only considered if their adoption predated the adoption of the KP in 1997. Policies that provide a comparative advantage to less emission-intensive technologies (E-) were only considered if adopted prior to the adoption of the Marrakech Accords in 2001.

(Sovacool et al. 2021; GIZ 2016)

what type of mitigation activity will be pursued and promoted under the mechanism. Rules adopted by the Parties will also determine to what extent A6.4M methodologies will differ from CDM methodologies (see text box 3).

5.2.1 General principles

In UNFCCC negotiations, Parties are discussing general principles for Article 6 methodologies. Most Parties support the principles of transparency and conservativeness, as well as consistency with IPCC guidance when calculating emission reductions and consideration of uncertainty and leakage. While the consideration of relevant national policies is acceptable to most Parties, requiring a consistency with NDCs, long-term low GHG emission development strategies and PA long-term targets is still disputed. The same refers to the principle of requiring methodologies to ‘encourage an increase over time’. The most contested methodological principles are also the most difficult to operationalize, where limited international experience exists (Michaelowa et al. 2021).

5.2.2 Additionality

In current negotiations, Parties agreed that additionality rules will deviate from CDM rules and demand that activities are only additional if they are not mandated by national policies and laws (so-called regulatory additionality). Parties did not agree (yet) whether activities must also exceed mitigation from policies and measures associated with the NDC of the host Party (Michaelowa et al. 2020a).

5.2.3 Baseline setting approaches

In negotiations a wide range of different baseline setting were discussed and whether a default approach, a menu of different approaches or a default approach to baseline setting with alternatives as necessary shall be adopted. Most Parties agree that baselines must be ‘below BAU’. They prefer baseline setting approaches based on BAT assessment, performance benchmarks, or other benchmarks. Parties recognise the need to consider ‘national, regional, or local, social, economic, environmental, and technological circumstances’ (Michaelowa et al. 2021).

© Shutterstock / Xuanhuongho

6. Existing baseline and monitoring methodologies and tools for HFC reduction and related energy efficiency improvement

Following the description of expected future requirements of methodologies, this chapter now takes stock of existing carbon crediting methodologies that apply to activities in the RAC sector and both to energy-related emissions and mitigation actions as well as HFC-related emissions and mitigation actions. The existing approaches and methodologies are described and then assessed with regard to existing gaps (e.g., activity types where no methodology exists yet) and with regard to their alignment with the identified Article 6 requirements for methodologies.

6.1 Identified principles and guardrails for Article 6 methodologies

Based on the assessment of the status of negotiations, the following guardrails for methodology development under Article 6 can be developed. They aim at a high standard of integrity to increase the likelihood of being consistent with the eventually adopted rules:

First, activities must pass an **additionality** check, which shows that they would not have happened without the carbon credit revenue, based on a commercial business-as-usual scenario and technology cost and availability, current and expected regulatory context as well as expected measures to be implemented to achieve (unconditional) NDC targets.

Second, **baselines** must be robust and conservative and result in below-BAU mitigation outcomes. Where possible, baselines shall be set based on:

1. A stringent performance or other technology or activity related benchmark. This could be a benchmark based on an assessment of BAT in the specific context. Or, as proposed in negotiations a benchmark set, at least at the average emission level of the best performing comparable activities. Thus, providing similar outputs and services within a defined scope and boundary in the past three years and where the host Party may determine a more ambitious level at its discretion.
2. Where benchmarking is not possible, it must be credibly justified that the baseline setting approach results in below BAU emissions, considers the relevant context and fulfils the methodological principles of conservativeness and stringency. Here, an 'ambition coefficient' could be applied to projected emissions based on CDM methodologies which ensures a decrease in baseline emission levels consistent with reaching net-zero emissions at a point in time consistent with reaching the Paris Agreement long term temperature target. The year by which a country is expected to reach net zero would be different for countries at different levels of economic development or with different 'starting conditions' (e.g., have a great forestry coverage and therefore be able to reach net-zero emissions faster than other countries) (Michaelowa and Michaelowa 2021).

Third, baselines must consider the **impact of an activity on the NDC implementation of the host country** and associated opportunity costs for corresponding adjustments of the host country. This means, if the activity falls under the scope of the NDC and is necessary to achieve the NDC target, it must mobilize mitigation which is above and beyond what is needed for NDC achievement. How this can be operationalized depends on the type of NDC target of the host country and there is limited international experience with this requirement.

6.2 Existing baseline and monitoring methodologies at the activity-level

In the context of crediting mechanisms, a wide variety of methodologies and tools have been defined for both mitigation activities improving energy efficiency of RAC equipment as well as activities that promote the avoidance of HFC emissions. Under these methodologies, depending on the scope of the mitigation activity, project developers should include baseline and project emissions from electricity and fossil fuels consumption, together with emissions associated with the avoidance/destruction of use of high GWP refrigerants. Methodologies also include the requirements for monitoring and reporting (e.g., monitoring frequency, calibration requirements of measurement equipment, data collection and management practices, etc.). Existing mechanisms that have defined methodologies in the RAC sector include the CDM, the Australian Emission Reduction Fund (ERF), the Joint Crediting Mechanism (JCM), the Californian Compliance Offsets Program (CCOP), the Climate Action Reserve (CAR) and the Spanish Carbon Fund (FES-CO_2). An overview of the methodologies identified can be found

Table 4: Overview of existing baseline and monitoring methodologies in the RAC sector

Mechanism	Number of methodologies	Scope
CDM	10 methodologies and 3 tools	Fugitive emissions from production and consumption of HFCs and energy efficiency
JCM	8 methodologies	Energy efficiency
ERF	4 methodologies	Energy efficiency
CCOP	1 methodology	Destruction of eligible ODS
FES-CO_2	1 methodology	Substitution of HFCs

Source: authors

Text box 4: Monitoring of Sustainable Development (SD) benefits

In addition to the direct climate benefits from HFC mitigation, mitigation action in the RAC sector can positively contribute to SD by:

- Promoting a more efficient use of energy by introducing energy efficiency technologies.
- Strengthening resilience to climate change impacts in cities and in the food industry.
- Building more sustainable societies by improving human living spaces.
- Transition to a sustainable economic growth by creating jobs in the sector.

Existing mechanisms such as the CDM and the GS have developed some tools to report on the expected environmental, social and economic co-benefits of their project activities. Nonetheless, a holistic approach to determining anticipated or achieved results across adaptation, mitigation and SD will be extremely beneficial. Especially in the RAC sector where there is a strong synergy between adaptation and mitigation impacts.

The CDM developed an online platform that enables CDM project developers to highlight the additional value that projects can offer beyond emission reductions, however, monitoring and reporting of SD contributions is not required under the CDM. SD tends to play a bigger role in VCMs where buyers typically seek to not only offset their GHG emissions in the most cost-effective way, but also find value in activities that consider overall societal and environmental benefits. For example, the GS requires that certified activities actively embed SD principles throughout the entire project cycle and that all activities include reporting of SD performance as part of their annual Monitoring Report (Michaelowa et al. 2020a). In order to induce transformational change, Parties cooperating through the A6.4M or an Article 6.2 activities could put a stronger emphasis on promoting SD by requiring activities to monitor and report identified SD contributions.

(Sovacool et al. 2021; GIZ 2016)

in the following table. More information on each methodology including activity types covered, baseline setting approach, MRV approach and key parameters can be found in Annex 1.

Under Article 6 of the Paris Agreement, Parties must strive to promote sustainable development in the host country, beyond increased efforts in mitigation action. Here, monitoring methodologies for GHG emissions may be complemented by tools and approaches to monitor both negative and positive sustainable development impacts as well as quantify and verify positive contributions (see text box 4). In the following, we focus on mitigation methodologies for the RAC sector as SD tools and methodologies are of cross-cutting nature and can be applied in a wide range of sectors.

6.3 Gap assessment of existing methodologies for activities

Existing methodologies are applicable only to a set of activities that comply with the eligibility criteria defined in the methodology. Eligibility criteria include for example: (i) the type of activity (i.e, substitution of HFCs, recovery/ destruction of HFCs, energy efficiency improvement, etc.); (ii) the size of the activity in terms of potential GHG emission reduction, (iii) the ODS refrigerants and ODS blowing agents covered; and (iv) types of RAC equipment. Furthermore, methodologies define the baseline setting approach, typical approaches include: (a) a projected BAU emissions approach; (b) a technology-specific benchmark; and (c) default baseline scenario. Depending on the type of activity, the estimation of emission reduction could include emissions from energy consumption (including fossil fuels and electricity) and emissions from manufacturing, usage, and disposal of the refrigerant. As the objective of methodologies to be applied under Article 6 is to ensure the environmental integrity of credits issued, existing methodologies need to be further aligned to ensure full coverage of activity types, technologies and GHG emissions and to fulfillment of all requirements under Article 6.

6.3.1 Gaps regarding technologies/activity types

GHG emissions from the RAC sector have the particularity to come from two very different sources. The first indirect one, is related to the energy needs to operate RAC equipment. The second direct one, are the HFC emissions throughout the life cycle of RAC equipment, from the manufacturing till the disposal of the equipment. Hence, mitigation efforts and accounting methodologies in the RAC sector should target and cover all applicable sources of emissions. Moreover, given the variety of type of activities and technologies that could contribute to mitigate emissions in the sector, methodologies should cover the relevant potential project activities and technologies in the sector. Table 5 below shows the gap analysis of existing methodologies with regard to technologies and activity types.

6.3.2 With regard to Article 6 alignment

Most methodologies were developed prior to the adoption of the PA and negotiations on principles and rules for additionality, baseline, and monitoring methodologies in carbon markets under Article 6 of the PA. If existing methodologies were to be applied in the context of Article 6 cooperation, they would need to be adapted. Building on the identified principles and guardrails for Article 6 methodologies (see chapter 4.3), we identify gaps and revision needs to strengthen Article 6 alignment. For some methodologies, revision needs may be more extensive than for others.

CDM methodologies refer to additionality tools that have significantly developed over time. Initially, additionality determination included regulatory, investment, barrier, and common practice tests. However, barrier tests proved to be easily gamed and common practice tests were often non conclusive. Therefore, the investment analysis was refined considerably and became the generally applied approach to additionality testing (Michaelowa 2009). While financial additionality can be tested with CDM tools, regulatory additionality cannot be determined (due to the E+/E- rule) and NDC target additionality is not considered, as the CDM was established by the KP. The CCOP and the CAR requires proof of additionality to regulation and a common practice test, however, financial and target additionality are not considered. Under the JCM, additionality determination is substituted by eligibility criteria for each of the methodologies, like a positive list of projects deemed automatically additional. In Article 6 cooperation, it must be proven that the eligibility criteria for positive list are aligned with financial, regulatory and target additionality. For the FES-CO_2, regulatory additionality must be proven, but financial additionality is not considered. The CAR mostly relies on standardized baselines (Michaelowa et al. 2019). No existing standard is likely to meet the additionality requirements of Article 6 cooperation.

Methodologies will also need alignment with the requirement for Article 6 baselines to be robust, result in below BAU mitigation outcomes and contribute to NDCs of the host countries. Most CDM methodologies are not aligned with this criterion, because they mostly try to depict a BAU emissions pathway as realistically as possible, due to the non-existence of mitigation commitments of developing countries under the KP. Benchmarks are used in some existing methodologies for the RACF sector; however, they are usually not determined based on a 'BAT assessment' and their stringency would need to be revisited on a case-by-case assessment.

Table 5: Gap analysis of existing carbon accounting methodologies with regard to technologies/ activity types

Criterion	Appropriateness / Coverage	Gaps
Technology disaggregation, and coverage of technologies	Type of activities covered by existing methodologies could be grouped in the following categories: • Capture of HFC released during production processes. • Recovery/destruction of HFC used in RAC equipment. • Switching high GWP refrigerants agents with low GWP/non-GWP refrigerants agents. • Replacement of existing equipment by more energy efficient one. • Avoiding use of less efficient equipment . • Equipment upgrade/modification to reduce energy consumption. • Improvement of the energy performance of buildings Typical equipment covered include: • Refrigerators • Air conditioners • Chillers • Foam blowing agents	Project activities that replace ODS as solvents and aerosols are not covered by existing methodologies, however this type of activities is not relevant in the RAC sector.
GHG emission-coverage	GHG emission reduction covered by existing methodologies: • GHG emission reduction from electricity consumption decrease due to energy efficiency improvement of RAC equipment. • GHG emission reduction from fossil fuel consumption decrease due to energy efficiency improvement of RAC equipment. • GHG emission during manufacturing (HFC refrigerant emitted to the atmosphere during initial charging of the refrigeration cabinets in the manufacturing site) • GHG emission during usage and servicing of the HFC • GHG emission during disposal of RAC equipment • GHG emissions from the use of fossil fuels and grid-delivered electricity at the HFC destruction facility	Existing methodologies do not cover emissions from ODS banks (HCFCs).
Coverage of both HFC-mitigation and energy-efficiency related impacts	Methodologies applicable to energy efficiency project activities in the RAC sector that consider mitigation impacts from both the recovery/destruction of HFC refrigerants and the reduction in energy consumption are: • AM0060: Power saving through replacement by energy efficient chillers • AM0120: Energy-efficient refrigerators and air-conditioners • AMS-III.X. Energy efficiency and HFC-134a recovery in residential refrigerators	Most energy efficiency methodologies do not include emissions associated with the loss of refrigerant. Methodologies outside the CDM do not include both emissions sources in the approach. Some methodologies under the JCM require that project developers prepare a plan for not releasing refrigerant used for the project equipment.

However, regulations are considered in rules for baseline setting in different methodologies. For instance, CAR methodologies require emission reductions to exceed what would have occurred because of compliance with international, federal, state, or local regulations.

No existing methodology is considering the achievement of (unconditional) NDC targets. Here, new approaches must be developed. Considering NDC targets in baselines, however, cannot safeguard NDC achievement if the host country does not implement measures needed to achieve their NDCs. In addition, host countries may require additional safeguards when engaging in international carbon markets. This could be an in-kind or monetary taxation of transfers: either the host country retaining a share of mitigation outcomes for compliance with their NDC targets, or the host country retaining a share of the ITMO revenue to finance additional mitigation activities. This approach of 'sharing' achieved mitigation outcomes between the host and the buyer country is already operationalized in the JCM and bilateral cooperation of Japan with partner countries. Conservative baselines also ensure that JCM activities contribute to net emission reductions in the host country (Michaelowa et al. 2021).

© Shutterstock / Andrii Zhezhera

7. Development of Article 6 RAC mitigation methodologies

The gap assessment has shown the need to develop, based on existing methodological approaches to date, new baseline and monitoring methodologies for the RAC sector and for activities in the RAC sector, if they are to be implemented in international market-based cooperation under the PA. Currently, and as described above, no existing methodologies can be readily applied to an Article 6 activity in a robust manner while satisfiying all requirements of the expected Article 6 rulebook.
In this chapter, we discuss the guardrails for setting crediting baselines at a sectoral level or for projects and programmes for mitigation action in the RAC sector. The operationalization of these guardrails will be discussed in the context of a case study in the Colombian RAC sector [chapter 8].

7.1 Additionality determination

As discussed above, additionality determination under Article 6 of the Paris Agreement must consider three different criteria: Financial additionality, regulatory additionality and target additionality. Additionality determination- while based on the same criteria- is different for crediting at a sectoral level or for specific project and programmatic activities as the reference scenario is different.

7.1.1 Financial additionality

First, **would the activity have happened anyway considering its investment needs, barriers to investment and the availability of (commercial) funding?**
In the context of activities, this aspect of additionality can be determined with the CDM additionality tool, which focuses on an investment test (**criterion 1**).
Table 6 illustrates that for most HFC uses and cooling appliances there is a more or less established market with commercially viable solutions. For many applications the switch to natural refrigerants is associated with energy efficiency gains. However, this needs to be assessed against the specific national background of countries as some technologies show differing characteristics with regard to different ambient air temperatures. In addition, commercial availability of technologies might also be dependent on the established supply chains and the socio economic context of a country. Therefore, in the context of project activities or programmes additionality must be assessed on a case-by-case basis and considering BAT in a given country context.

At the sectoral level, commercially viable investments in (best available) technologies in the RAC sector must be considered in the sectoral emission reference scenario for the crediting period if additionality not tested for each activity.

7.1.2 Regulatory additionality

Mitigation outcomes generated either sector-wide or in the context of projects or programmes should **not be mandated by existing policies.**

At the level of project or programmatic activities, there should be a check whether the activity (e.g., use of a specific technology) will be mandated by policies in the short-term future (i.e., during the initial crediting period). This "regulatory" additionality is not required under the CDM but in some domestic crediting mechanisms. It requires a complete and consistent mapping of policies with clear direct financial or regulatory impact on the activity (e.g., ban on certain technologies or substances (e.g., high-GWP refrigerants), energy efficiency standards, a carbon tax, fiscal incentives to shift to low-GWP technologies) (see Text box 5). If a policy is not considered to have an impact or the policy is not enforced, this must be robustly explained and documented (**criterion 2**).

For sector-level crediting, robustly estimated impacts of different RAC-sector policies on the observed emission levels must be calculated into the sectoral emission reference scenario against which additionality is determined.

7.1.3 Target additionality

The third dimension of additionality relates to whether **the implementation of the activity is necessary to achieve the unconditional NDC target of the host country and if so,** to what extent? (**criterion 3**)

For sector-level crediting, the emission reference scenario against which additionality is determined must be either below or at the level of a sectoral emissions pathway in line with either a multi-year (NDC target indicates an emission trajectory) or single-year NDC target (target is only expressed for the end of the NDC implementation

Table 6: Summary of commercial and technical characteristics of different mitigation measures and technologies in the RAC sector

	Technology/ measure	Commercial availability	Energy efficiency	Cost	Main barriers
HFC uses and processes	Natural refrigerant solutions for **domestic, commercial and industrial refrigeration** (hydrocarbons, ammonia, CO_2)	🟩	• Commercial refrigerators with low GWP refrigerants can be 15–30% more efficient (e.g. CO_2 and propane) • Ammonia shows good energy efficiency characteristics for large commercial and industrial systems		• **Safety concerns**: hydrocarbons are highly flammable, ammonia is toxic, CO_2 requires high discharge pressures • **Lack of regulatory framework** such as safety standards that regulate and enable the use of low GWP refrigerants • Safety standards restricting the use of hydrocarbons, e.g. for systems with larger charge sizes • **Lack of skilled RAC technicians** • **Cost and energy efficiency** considerations with using HFC alternatives in condensing units and larger air conditioning systems has limited applicability to certain regions and applications • For **transport refrigeration reduced efficiency** in high ambient temperatures and limited component supply currently limit market penetration • For large **CO_2 AC systems** low critical temperature of carbon dioxide may not be a good option in warmer climates due to **reduced efficiency and higher cost**
	Hydrocarbon refrigerants for **domestic and commercial air conditioners and AC chillers**	🟩	• Chillers using ammonia or propane have better energy efficiency than HFC systems • Energy efficiency of propane split ACs is comparable to HFC systems	USD 10–40/ tCO_2 (for unitary AC units)	
	CO_2 **mobile air conditioning and transport refrigeration**	🟨	In high ambient temperatures CO_2 -based transport refrigeration has reduced energy efficiency		
HFC disposal and banks	Recovery and reuse of HFC refrigerants	🟩		USD 15–35/ tCO_2	**Economic viability**: Only 8.8 Gt of emissions in banks (out of 21.2 Gt) are classified as easy to recover or economically viable
	Application of **circular economy principles**	🟨			
HFC destruction	**Thermal destruction** technologies, such as HFC incinerators, plasma abatement technology	🟩		Investment costs of up to USD 5 million.	No revenue
	Fully integrated recovery and destruction systems; hybrid renewable energy destruction facilities	🟧			

🟩 commercially available (as of 2020)

🟨 emerging soon with working prototypes (as of 2020)

🟧 experimental and likely only after 2025

Source: authors based on Sovacool et al. (2021); Azar et al. (2018); Usinger et al. (2018); Seidel et al. (2016)

Text box 5: Policy instruments to reduce HFC and energy-related emissions in the RAC sector

Policy instruments in the RAC sector driving abatement of HCFCs and HFCs may be:

- Fiscal policy instruments:
  - Levies or taxes on the production or use of (high) GWP refrigerants
  - VAT exemptions for low GWP refrigerants
- Regulatory instruments:
  - Active plans to ban or gradually reduce HFCs, e.g. by introducing a quota systems
  - Mandatory refrigerant leakage tests to be conducted by consumers or sellers (e.g. for car air conditioning)
  - Extended producer responsibilitiy schemes which require the producer to take back appliances at their end of life
  - Labeling, e.g. adoption of eco-labels to create awareness and better inform consumers
  - Training and certification of RAC technicians with regard to installation and maintenance of RAC equipment with low GWP/natural refrigerants and proper disposal of end-of-life equipment (Sovacool et al. 2021; GIZ 2016)..

Improvement of energy efficiency of cooling equipment can be promoted by the following policy instruments:

- Minimum Energy Performance Standards (MEPS) that set the floor and are raised over time according to a defined timeline
- Labels which indicate the energy (and ideally environmental) performance of appliances; can be coupled with procurement programmes (e.g. Green Public Procurement)
- Compliance testing helps to ensure that only efficient appliances enter the market
- Import standards to avoid products entering the market that are below national standards (K-CEP 2019)

Country example: Progressive HFC regulations in the Republic of Seychelles

In February 2021, the Republic of Seychellles endorsed a staggered levy system which is tied to the GWP values of substances with a 10% levy on refrigerants with GWP › 3000 (Environment Protection (Environmental Levies) (Amendment) Regulations (2021), S.I. 9 of 2021). This is accompanied by a VAT exemption for refrigerants with GWP ‹100 and related equipment (Value Added Tax (Amendment of First Schedule) Regulations (2021), S.I. 6 of 2021). In addition, the Seychelles introduced a certification scheme for all practicing refrigeration technicians, both local and foreign (Licenses (Miscellaneous Services) (Amendment) Regulations (2021), S.I. 7 of 2021).

(Sovacool et al. 2021; GIZ 2016)

period), provided the target is actually binding, i.e. below BAU. Here, a differentiation between the unconditional and the conditional part of the NDC needs to be made. The latter is explicitly linked to receiving international support and thus should not be considered in additionality determination.

Target additionality can be tricky to determine for project level and programmatic crediting. The best approach depends on the specific type of quantitative or qualitative unconditional targets a country has set and on the underlying assumptions, projections and plans of the host country that were used to set these targets. NDC targets are either set in a bottom-up or top-down manner:

If the NDC target is set in a bottom-up manner, the host country took stock of its mitigation activities and policies in course of implementation and planned, projects their impact on emission levels and then sets NDC targets accordingly. Here, additionality of a project or programme to the NDC target can be proven, if the activity is not part of the measures foreseen under NDC implementation, is not commercially viable (see criterion 1) nor indirectly or directly tackled by policies which are introduced to achieve NDC targets (see criterion 2).

If an NDC target is set in a top-down manner, based on modelled emission levels at sector and/or national level, and not linked to specific activities at the sub-sectoral level, NDC additionality is more difficult to prove for project or programmes. One option is to "allocate" responsibility for the achievement of a sectoral NDC target to different installations or actors at the sub-sectoral level. This may not be feasible in a heterogenous sector with different actors involved. Another option is to derive a performance benchmark (e.g., CO_2 intensity benchmark) that is consistent with the level of ambition of the unconditional NDC target. For instance, if an unconditional NDC target defines an absolute reduction of CO_2e emissions in the RAC sector by x%, the performance benchmark shall be set x% lower compared to the average performance benchmark in the sector, adjusted for changes of appliance production levels. The benchmark would thus become more stringent if production increases. If the target is defined in terms on intensity, the benchmark can be directly derived from the % reduction in intensity.

Some host countries are developing positive lists for technologies they deem additional in the context of their NDC implementation. These positive lists can be applied for additionality determination for projects and programmes if the technology in question also satisfies criterion (1) and (2) above and the positive list is regularly updated in a reasonable time frame (e.g. every 3 years).

7.2 Baseline scenario determination

Sectoral and project activity crediting baselines will have to be aligned with PA principles and ensure an activity contributes to lowering emission levels in the host country (so moving beyond a zero-sum game) and raises ambition in the long term. As discussed above, the following baseline-setting approaches are currently considered in the negotiations: A stringent performance benchmark, a BAT-derived technology benchmark and projected emissions if the projection includes the consideration of raising ambition in mitigation beyond "business as usual". All three baseline setting approaches in theory can be applied for most RAC-sector activities that tackle direct production emissions, in-use emissions, and end-of-life emissions of HFCs and indirect emissions related to energy consumption. Baselines should clearly differentiate between those two emission sources and the most appropriate approach will have to be determined on a case-by-case level.

Regardless of the baseline setting approach chosen, the baseline scenario must be:

1. below an emission level of comparable, commercially viable activities and technologies, i.e., a credible BAU pathway.
2. below an emission level incentivized or mandated by existing and planned policies and regulations. For RAC sector activities targeting HFC consumption, this translates into the requirement to go beyond an "NDC-translated" KA emissions pathway.
3. below an emission level required to ensure achievement of domestic unconditional NDC targets.

We focus on activity-specific baseline setting, considering the challenges existing in defining robust baselines on the sectoral level (see discussion in Wooders et al. 2016).

All three emission levels should be calculated, where not already available, and then compared. The lowest of these three levels should determine the actual baseline scenario. This ensures that neither an overestimate of the KA baseline due to the HCFC adder nor an NDC target above BAU can lead to generation of credits not representing real emission reduction. Thus, this triple safety net ensures the environmental integrity of the mitigation outcomes generated.

In the following, we compare baseline setting for two sub-sectoral activity types in the same ficitious country. In the context of mobile air-conditioning, the emission levels associated with meeting the unconditional NDC target[5] is more stringent than emission levels associated with KA

---

[5] For this example we now assume that the RAC sector NDC target is broken down at subsectoral level in proportion to their percentage of overall RAC sector emission and not based on mitigation potentials and costs, which would be a more "sophisticated" but also transaction cost intensive exercise.

compliance and significantly more stringent than emission levels associated with commercially viable technologies or activities. This means, a strict carbon price signal will be required to secure achievement of the unconditional NDC target and drive mitigation beyond this level. Crediting mitigation in Article 6 cooperation would be done against a baseline that reflects the achievement of the unconditional NDC target. All mitigation mobilized below “BAU” accrues to the host country for KA and NDC compliance (Figure 5).

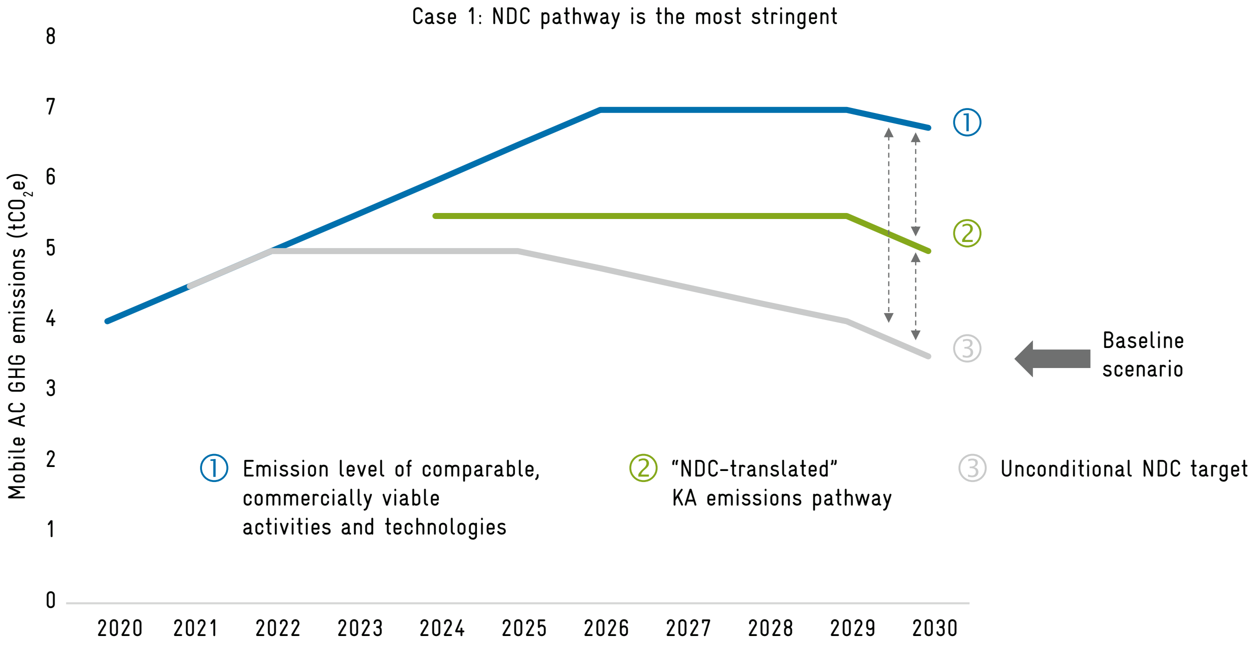
In the same country, and the same emission levels associated with KA compliance and achievement of the RAC-sector unconditional NDC target, the baseline would look differently for industrial refrigeration activities. Here, and in contrast to mobile air-conditioning, there are commercially viable activities which would result in lower emission levels than “necessary” for KA compliance and NDC achievement (assuming a simplistic allocation of NDC target “responsibility” to the different sub-sectors). Therefore, performance benchmark associated with available technologies is the most appropriate crediting baseline for an activity in this sub-sector. The industrial refrigeration activities would automatically raise additional mitigation to the NDC of the host country for crediting activities that are below a credible business-as-usual scenario (Figure 6).

As the political and economic context of the sector constantly evolves, the parameters of the baseline equation as well as the appropriateness of the baseline setting approach need to be revisited at five year intervals in line with NDC periods until the end of the crediting period. Under the A6.4M, Parties are currently considering crediting periods of either five years, renewable twice or ten years nonrenewable.

While not likely to be prescribed in the Article 6 rulebook, carbon market actors are increasingly considering applying “dynamic” baselines to align baseline setting with the Paris Agreement context of ratcheting up of ambition every five years. There are two different types of “dynamic” baselines:

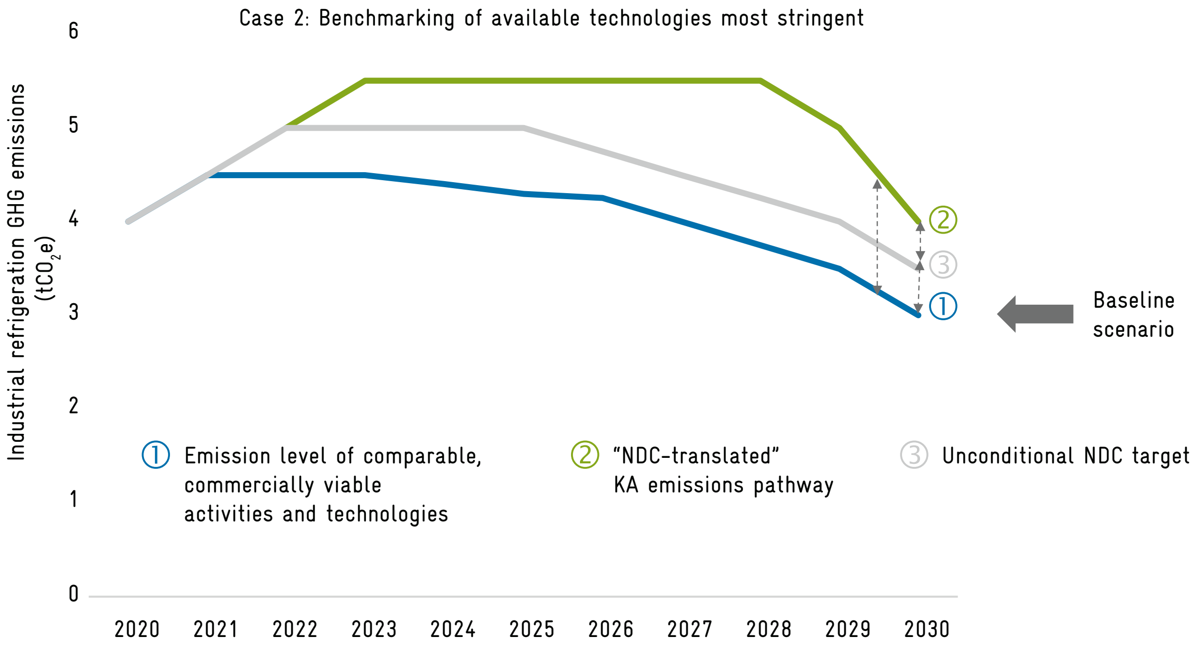
1. Baselines where key parameters are estimated ex-ante but where credits are then issued for ex-post calculations of these parameters, based on data collected and validated. This ensures the baseline accurately reflects what happened (instead of providing a likely projection).

Figure 5: Baseline setting approach for the RAC sector- the triple safety net for mobile AC



Source: authors

Figure 6: Baseline setting approach for the RAC sector- the triple safety net for industrial refrigeration



Source: authors

However, it also creates significant uncertainties for activity developers on the amount of mitigation outcomes they will generate (and sell) and the price they will need per unit to be financially viable.

2. Baselines that become more stringent over time through default coefficients applied to key parameters. These coefficients can also be used to ensure the baseline levels decrease in alignment with the national or sectoral NDC- or long-term decarbonization pathway of a given country.

Both approaches ensure that the crediting baseline is conservative, and that the activity contributes to the achievement of the Parties' NDC, prevents "overselling" of the host country, and ensures alignment of the activities with the achievement of long-term targets. Different actors may favor different approaches. A governmental actor may favor approach (1) as it can ensure the mitigation outcomes generated are "real" and not needed to ensure NDC achievement. Therefore, this approach will be relevant for a bilateral cooperation, where the buyer country government is willing to pay a certain overall price – maybe even blending climate finance and carbon finance- to implement the mitigation activity and may accept certain deviations in final transactions of ITMOs. A private sector activity developer would favour approach (2) as there is higher certainty on the share of ITMOs that can be generated and the unit price necessary to finance the activity. Therefore, this approach may be more appealing for project or programme level activities, where carbon credits may be sold on the international carbon market and should be eligible in different contexts (NDC compliance use, voluntary offsetting, offsetting in ETS, CORSIA).

To reduce transaction costs for crediting baseline determinantion, key parameters can be standardized at the sectoral or national level. Standardized parameters need to be approved by the host country and validated by an auditor but can then be applied across a range of similar activities. This could relate to benchmarks for HFC emissions in different appliances (e.g., average annual quantity of refrigerant leaked for each type of equipment, average emission factors for end-of-life emissions, etc.), energy efficiency standards in a sub-sector (e.g., baseline electricity consumption for each volume class of refrigerators, Energy Efficiency Index, (Seasonal) Energy Efficiency Ratio (SEER) of air conditioners, etc.).

7.3 Emission reduction calculations

Emission reduction in the RAC sector mainly come from the replacement and/or recovery and destruction of HFCs that would have otherwise been emitted to the atmosphere and from the energy efficiency improvement of the equipment that results in less fossil fuels burned for electricity generation.

Generally, emission reduction is estimated as:

$ER_y = BE_y - AE_y - LE_y$

Where

ER_y = Emission reductions in year y (tCO_2e/year)
BE_y = Crediting baseline (tCO_2e/year)
AE_y = Activity emissions (tCO_2e/year)
LE_y = Leakage emission in year y (tCO_2e/year)

Emission sources considered include, as per a conservative life-cycle based approach:

Depending on the activity context, some sources of emissions may not be relevant, for instance emissions from the destruction processes of HFC may not be applicable for activities in countries that do not have the facilities to do so. A justification of the inclusion or exclusion of the emission sources should be well documented.

In general, the baseline emissions could then be specified as:

$$BE_y = (MA_y + OP_y + DE_y + ID_y) \times GWP_{BL} + DP_y + (EC_y \times EF_{elec} \times (1+ TDL_y)) + \Sigma FC_{i,y} \times EF_{FF,i}$$

Where:

MA_y = HFC emissions from the manufacturing of RAC equipment replaced by the equipment used in the activity (*t refrigerant /year)

OP_y = HFC emissions from the operation of RAC equipment replaced by the equipment used in the activity (t refrigerant/year)

DE_y = HFC emission from the disposal emissions of RAC equipment replaced by the equipment used in the activity (t refrigerant/year)

ID_y = Emissions of HFC from incomplete destruction of HFC in equipment replaced by the equipment used in the activity (t refrigerant/year)

GWP_{BL} = Global Warming Potential of the refrigerant used in equipment replaced by the equipment used in the activity (tCO_2e/t refrigerant)

Table 7: Overview of emission sources included in emission reductions calculations

HFC related emissions	Energy-related emissions
• HFC emissions from the manufacturing of RAC equipment replaced by the equipment used in the activity • HFC emissions from the operation of RAC equipment replaced by the equipment used in the activity • HFC emission from the disposal emissions of RAC equipment replaced by the equipment used in the activity • Emissions of HFC from incomplete destruction of HFC in equipment replaced by the equipment used in the activity • Emissions from the destruction process of the HFC in equipment replaced by the equipment used in the activity	• Emissions from electricity consumption of RAC equipment replaced by the equipment used in the activity • Emission from electricity consumption and fossil fuel consumption for the operation of HFC destruction processes addressing equipment replaced by the equipment used in the activity

Source: authors

DP_y = Emissions from the destruction process of the HFC in equipment replaced by the equipment used in the activity (tCO_2e/year)

EC_y = Total electricity consumption in year y of the equipment replaced by the equipment used in the activity and for the operation of HFC destruction processes addressing equipment replaced by the equipment used in the activity (MWh/year)

EF_{elect} = Emission factor of the electricity consumed in year y (MWh/tCO_2e)

TDL_y = average technical grid losses in year y (%)

$FC_{i,y}$ = Fossil fuel consumption in year y at the facility (GJ/year)

$EF_{FF,i}$ = Emission factor of fossil fuel i used in (tCO_2e/GJ)

For calculation of the activity emissions and leakage, depending on the type of activity and its boundary, different emission sources need to be considered for the calculations. Major emission sources as well as leakage risks shall be identified. Furthermore, in order to lead to an accurate representation of emission reductions and credit volume, baseline, project and leakage emissions should be estimated following conservative principles. Therefore, estimation of standardized and further parameters relating to both baseline and activity emissions shall be conservative and uncertainties in calculations shall be identified and minimized, where applicable provisions shall be included. Methodologies shall also identify potential rebound effects on mitigation and shall conservatively take them into consideration


© Shutterstock / Andrii Zhezhera

8. Conclusion and recommendations

The cooling sector needs to become energy efficient and use refrigerants that have zero or low GWP in order not to jeopardize the attainment of the ambitious long term target to keep global warming below 1.5°C. At the same time cooling is key to allow people to adapt to the currently rapidly increasing temperatures. Given the high volume of already installed cooling equipment that utilizes high-GWP refrigerants, a better control of leakage emissions that occur during equipment operation as well as well as proper refrigerant destruction at the end of equipment life is important.

Hydroflurocarbons (HFCs), the second generation of replacements for ozone-depleting substances, have seen large increases in production and consumption. They are addressed by both the international ozone and climate regimes. Regarding the former, the KA to the MP regulates the step-wise reduction of countries' HFC production and consumption, with the most significant steps to be taken for developing countries in the 2040s. It is estimated that a successful phase-down will mitigate around 61% of HFC emissions by 2050. However, proper end-of-life treatment of RAC equipment is not tackled by the KA and the MLF which acts as funding mechanism for compliance with the ozone regime. Regarding the latter, HFCs are covered by the PA and hence, can be included in Parties' NDC mitigation targets. International carbon markets under Article 6 of the PA can serve as an important driver for mitigation activities in sectors or niches that are not addressed by other policy instruments, which often applies to the cooling sector. International carbon markets usually apply a baseline and crediting approach. Emission reductions of activities are determined against a baseline. Morover, activities have to prove to be 'additional', which means that they would not have happened under a BAU situation. Emissions credits would be issued after monitoring and verification of the emission reductions. Baseline and monitoring methodologies need to be robust and conservative in order to ensure the environmental integrity of credits issued. They need to be able to assess that activities are not mandated by national policies or incentivized by policy instruments aiming to achieve unconditional NDC targets, and that they would not have happened without the carbon credit revenue. Baselines need to be set below BAU as well as reflect the mitigation the host country needs to achieve its sectoral NDC target. An activity developer would have to choose the lower of the two baseline values. Below BAU could mean the use of stringent performance benchmarks based on BAT. An alternative would be the use of an 'ambition coefficient' whose value is determined by a country-level emissions path consistent with the 1.5°C long term target. The coefficient would start at 100% and reach 0% in the year the country needs to achieve net zero. It would be applied to the emissions intensity of the technology deemed to be the baseline technology.

Crediting baselines in market-based cooperation under Article 6 need to be consistent with NDC pathways and the RAC sector compliance with the mandatory KA phase down path. Different accounting approaches for HFC emissions under both regimes, the UNFCCC/PA and the MP/KA require a 'translation' of the HFC phase-down path of the KA into a HFC emissions scenario that can be integrated in countries' NDC and serve as reference level for establishing a crediting baseline. A correct translation is particularly important for the corresponding adjustments to the annual NDC emission balance that have to be carried out within the framework of Art. 6 market-based cooperation and which guarantee the prevention of double counting of any mitigation outcome. To limit the uncertainties for host countries, the NDC emission balance should include a robust approach to calculate and report RAC-sector emissions and crediting methodologies applied in the RAC-sector should be congruent with this approach.

The KA accounts for potential emissions under the assumption that any consumed substance will be fully emitted in the year of consumption. The approaches under the UNFCCC account for actual emissions. This means that compared to the KA a significant time lag between consumption and emissions exists which can reach decades, as refrigerant leaks out of equipment over time or is emitted when equipment is scrapped. Understanding how consumption accounted under the KA will eventually lead to emissions under the PA requires profound modelling of expected future trends in refrigerant choices and penetration for different technologies and sub-sectors, taking into account market growth rates, technological developments, lifetime of equipment and other national circumstances such as availability of certain appliances and refrigerants.

The starting level of the KA HFC phase down path of Article 5 countries is significantly influenced by the HCFC adder. According to the rules set in Article 5 of the KA, countries can add a default value of 65% of production and consumption of HCFCs in 2009 and 2010 to the average annual quantity of HFCs consumed and produced during a 3-year baseline period in the 2020s to specify the starting level of the phase-down path. Given that in many countries HCFC consumption has decreased significantly until 2020, the starting point of the HFC phase-down path will be substantially higher than the BAU HFC emissions trajectory in these countries. If now directly translated into NDC reference scenarios and Art. 6 baselines the environmental integrity of Art. 6 activities would be at risk. Consequently, in case the HCFC adder would lead to such inflated baseline levels, countries should not consider the 'full' HCFC adder in their NDC reference scenarios. Instead, a 'PA aligned HCFC adder' could be applied based on an equipment stock model and downward-adjusted HCFC adder which reflects the actual HCFC consumption levels in 2020–2022, and the future trend as per the continuation of the HCFC phase-out.

Since Art. 6 activities in the RAC sector ideally address both refrigerant and energy-related emissions, the emissions stemming from energy consumption need to be quantified when defining energy-related mitigation targets for this sector. A robust approach is required to ensure that double counting is avoided. This can be achieved by either determing the share of final electricity consumption of RAC appliances (top-down) or by establishing a bottom-up model based on equipment stock and sales data.

Many methodologies and tools for both mitigation activities improving energy efficiency of RAC equipment as well as activities that promote the abatement of HFC emissions are currently available. We assessed 24 methodologies and tools covering such activities, mainly from the CDM, ERF, JCM, CCOP, CAR and FES-CO_2. Typical approaches to define the baseline include a projected BAU emissions approach, a technology-specific benchmark and a default baseline scenario. None of the available approaches would result in a reference scenario below BAU and consider contribution to the NDC targets of the host country. Moreover, existing methodologies do not cover emissions from ODS (HCFC) banks and approx. half of the methodologies do not include both emission sources (direct and indirect) in their approach. Regarding additionality determination, it is evident that no existing additionality test is likely to meet the additionality requirements of Art. 6 cooperation.

Thus, as the objective of methodologies to be applied under Art. 6 is to guarantee the environmental integrity of credits issued, existing methodologies need to be upgraded to ensure full coverage of activity types, technologies and GHG emissions and fulfillment of all requirements under Art. 6. Any methodology considered for an Art. 6 activitiy in the RAC sector needs to undergo a careful assessment. Robust approaches for additionality determination and baseline setting to safeguard environmental integrity, NDC achievement of the host country and consistency with the long-term target of the PA need to be developed.

References

Australian Government (2015): Carbon Credits (Carbon Farming Initiative—Refrigeration and Ventilation Fans) Methodology Determination 2015, https://www.legislation.gov.au/Details/F2015L01712 (accessed March 17, 2021)

Australian Government (2015): Carbon Credits (Carbon Farming Initiative—Industrial Electricity and Fuel Efficiency) Methodology Determination 2015, https://www.legislation.gov.au/Details/F2015C00783 (accessed March 17, 2021)

Australian Government (2015): Carbon Credits (Carbon Farming Initiative—High Efficiency Commercial Appliances) Methodology Determination 2015, https://www.legislation.gov.au/Details/F2016C00264 (accessed March 17, 2021)

Australian Government (2015): Carbon Credits (Carbon Farming Initiative—Commercial Buildings) Methodology Determination 2015 https://www.legislation.gov.au/Details/F2015L00058 (accessed March 17, 2021)

Azar, Antoine; Nosbers, Ramona (2018): Implications of natural refrigerants for cooling technologies – Converting from HFCs/HCFCs to natural refrigerants, GIZ, Bonn and Eschborn, https://www.green-cooling-initiative.org/fileadmin/user_upload/2018_Implications_of_natural_refrigerants_for_cooling_technologies_Converting_from_HFCs_HCFCs_to_natural_refrigerants.pdf (accessed March 23, 2021)

CAR (2012): Ozone Depleting Substances Protocol, https://www.climateactionreserve.org/how/protocols/ozone-depleting-substances/ (accessed March 17, 2021)

CAR (2021): Protocolo de halocarbonos para México – Versión 1.0 borrador, https://www.climateactionreserve.org/wp-content/uploads/2021/03/Mexico_Halocarbon_Protocol_Draft_V1.0_for_Workgroup_Comment_ESP.pdf (accessed March 17, 2021)

California Environmental Protection Agency (2014): Compliance Offset Protocol Ozone Depleting Substances Projects, https://ww3.arb.ca.gov/regact/2014/capandtrade14/ctodsprotocol.pdf (accessed March 17, 2021)

CDM (2009a): AMS-III.AB.: Avoidance of HFC emissions in Standalone Commercial Refrigeration Cabinets – Version 1.0 https://cdm.unfccc.int/methodologies/DB/GZRYKNFXDOFO6WWJ3DG87GU8I4H1EZ (accessed March 10, 2021)

CDM (2009b): AMS-III.N.: Avoidance of HFC emissions in rigid Poly Urethane Foam (PUF) manufacturing – Version 3.0, https://cdm.unfccc.int/methodologies/DB/1P2JT8SH9N4BE14JIL3641BQOB0FCR (accessed March 10, 2021)

CDM (2010a): AM0070: Manufacturing of energy efficient domestic refrigerators – Version 3.1.0, https://cdm.unfccc.int/methodologies/DB/R66P8LFQUC3OO9F2GX9Z9CTMN9B8W5 (accessed March 10, 2021)

CDM (2010b): AM0071: Manufacturing and servicing of domestic refrigeration appliances using a low GWP refrigerant – Version 2.0, https://cdm.unfccc.int/methodologies/DB/ZWFKA8F3U3CSHU75ST3VCPZMVN5VG0 (accessed March 10, 2021)

CDM (2010c): AMS-III.X.: Energy Efficiency and HFC-134a Recovery in Residential Refrigerators – Version 2.0 https://cdm.unfccc.int/methodologies/DB/983EQY2RSIYT5Q1KN4FIWHU2FL3MHP (accessed March 10, 2021)

CDM (2011): AM0001: Decomposition of fluoroform (HFC-23) waste streams – Version 6.0.0, https://cdm.unfccc.int/methodologies/DB/GAOZAY2DWIQHK71LJS027N6N4AV6SC (accessed March 10, 2021)

CDM (2012): AMS-II.O.: Dissemination of energy efficient household appliances – Version 1.0 https://cdm.unfccc.int/methodologies/DB/OE502PQ0NA9ETZ5IB6HLOZT2BBKZ35 (accessed March 10, 2021)

CDM (2015): Tool 26: Accounting eligible HFC-23 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-26-v1.pdf/history_view (accessed March 10, 2021)

CDM (2016a): AM0060: Power saving through replacement by energy efficient chillers – Version 2.0, https://cdm.unfccc.int/methodologies/DB/VL1F8D744ZJO9R1DGM2K0S4CRTRMEF (accessed March 10, 2021)

CDM (2016b): AMS-II.C.: Demand-side energy efficiency activities for specific technologies – Version 15.0 https://cdm.unfccc.int/methodologies/DB/7Y44EN2RTD02AJ78JVWCGARE8W64KP (accessed March 10, 2021)

CDM (2017a): AM0120: Energy-efficient refrigerators and air-conditioners – Version 1.0 https://cdm.unfccc.int/methodologies/DB/3USXGBI5RRLI5FXVG90SIYCOD9W9P1 (accessed March 10, 2021)

CDM (2017b): Tool 28: Calculation of baseline, project and leakage emissions from the use of refrigerants, https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-28-v1.pdf/history_view (accessed March 10, 2021)

CDM (2017c): Tool 29: Determination of standardized baselines for energy-efficient refrigerators and air-conditioners, https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-29-v1.pdf/history_view (accessed March 10, 2021)

CDM (2018): AMS-III.AE.: Energy efficiency and renewable energy measures in new residential buildings – Version 2.0 , https://cdm.unfccc.int/methodologies/DB/FUO73IQ9LLOKEQF2EL3BX8BFP38LJB (accessed March 10, 2021)

EMR (2021): Emissions Reduction Fund project register, http://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register (accessed March 17, 2021)

Environment Protection (Environmental Levies) (Amendment) Regulations (2021), S.I. 9 of 2021

European Parliament (2017): Parliamentary questions. Subject: Trifluoromethane (HFC-23) — discrepancies between Italian emissions inventories and Swiss research, https://www.europarl.europa.eu/doceo/document/E-8-2017-005759_EN.html (accessed March 15, 2021)

GIZ (2016): Advancing nationally determined contributions (NDCs) through climate-friendly refrigeration and air conditioning, Eschborn

International Energy Agency (2020): Cooling, IEA, Paris https://www.iea.org/reports/cooling (accessed March 19, 2021)

IPCC (2006): Emissions of fluorinated substitutes for Ozone Depleting Substances, in: 2006 IPCC Guideline for National Greenhouse Gas Inventories, Volume 3, Industrial Processes and Product Use. Chapter 7, p. 7.1 – 7.71, https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_7_Ch7_ODS_Substitutes.pdf (accessed February 15, 2021)

IPCC (2013): The Physical Science Basis, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge and New York

JCM (2015): ID_AM003: Installation of Energy-efficient Refrigerators Using Natural Refrigerant at Food Industry Cold Storage and Frozen Food Processing Plant – Ver2.0, https://www.jcm.go.jp/id-jp/methodologies/26 (accessed March 17, 2021)

JCM (2015): ID_AM004: Installation of Inverter-Type Air Conditioning System for Cooling for Grocery Store – Ver2.0, https://www.jcm.go.jp/id-jp/methodologies/27 (accessed March 17, 2021)

JCM (2015):ID_AM008: Installation of a separate type fridge-freezer showcase by using natural refrigerant for grocery store to reduce air conditioning load inside the store – Ver2.0, https://www.jcm.go.jp/id-jp/methodologies/29 (accessed March 17, 2021)

JCM (2019): MM_AM002: Installation of Energy-efficient Refrigerators Using Natural Refrigerant at Cold Storage – Ver1.0, https://www.jcm.go.jp/mm-jp/methodologies/99 (accessed March 17, 2021)

JCM (2017): TH_AM006: Installation of Displacement Ventilation Air Conditioning Unit in the Cleanroom of Semiconductor Manufacturing Factory – Ver1.0, https://www.jcm.go.jp/th-jp/methodologies/60 (accessed March 17, 2021)

JCM (2020): TH_PM013: Installation of Energy-efficient Refrigerators Using Natural Refrigerant at Cold Storage, https://www.jcm.go.jp/th-jp/methodologies/113 (accessed March 17, 2021)

JCM (2017): VN_AM002: Introduction of room air conditioners equipped with inverters – Ver1.1, https://www.jcm.go.jp/vn-jp/methodologies/71 (accessed March 17, 2021)

JCM (2017): VN_AM006: Introduction of air conditioning system equipped with inverters – Ver1.1, https://www.jcm.go.jp/vn-jp/methodologies/74 (accessed March 17, 2021)

K-CEP (2019): Guidance on incorporating efficient clean cooling into the enhancement of Nationally Determined Contributions, https://www.k-cep.org/wp-content/uploads/2019/07/Guidance-on-Incorporating-Efficient-Clean-Cooling-into-the-Enhancement-of-Nationally-Determined-Contributions.pdf (accessed March 10, 2021)

Keller, Christoph, A.; Brunner, Dominik; Henne, Stephan; Vollmer, Martin K.; O'Doherty, Simon; Reimann, Stefan (2011): Evidence for under- reported western European emissions of the potent greenhouse gas HFC- 23, Geophysical Research Letters Vol. 38, L15808, doi:10.1029/2011GL047976

Licenses (Miscellaneous Services) (Amendment) Regulations (2021), S.I. 7 of 2021

Michaelowa, Axel; Laßmann, Daniela; Espelage, Aglaja; Moreno, Lorena; Feige, Sven (forthcoming): The 'HCFC adder' in the Kigali Amendment baseline calculation – risks to environmental integrity of the Paris Agreement, GIZ

Michaelowa, Axel (2009): Interpreting the additionality of CDM projects: Changes in additionality definitions and regulatory practices over time, in: Freestone, David; Streck, Charlotte (eds.): Legal aspects of carbon trading, Oxford University Press, Oxford, p. 248–271

Michaelowa, Axel; Ahonen, Hanna-Mari; Espelage, Aglaja (2021): Setting credible baselines under Article 6 of the Paris Agreement, Background paper of the Carbon Market Mechanisms Working Group, Perspectives Climate Research, Freiburg

Michaelowa, Axel; Brescia, Dario; Wohlgemuth, Nikolaus; Galt, Hilda; Espelage, Aglaja; Moreno Lorena (2020a): CDM method transformation: updating and transforming CDM methods for use in an Article 6 context, Perspectives Climate Group, Freiburg

Michaelowa, Axel; Espelage, Aglaja; Müller, Benito (2020b): Negotiating cooperation under Article 6 of the Paris Agreement, Policy Brief, European Capacity Building Initiative, https://www.perspectives.cc/fileadmin/user_upload/Article_6_2020_PCG.pdf (accessed February 6, 2021)

Michaelowa, Axel; Espelage, Aglaja; 't Gilde, Lieke ; Chagas, Thiago (2020c): Promoting transparency in Article 6: designing a coherent and robust reporting and review cycle in the context of operationalising Articles 6 and 13 of the Paris Agreement. Study commissioned by the Swedish Energy Agency. Perspectives Climate Group, Freiburg.

Michaelowa, Axel; Michaelowa, Katharina (2021): Towards net zero: Dynamic baselines for international market mechanisms, CIS Discussion Paper 107, University of Zurich, Zurich

Michaelowa, Axel; Shishlov, Igor; Hoch, Stephan; Bofill, Patricio; Espelage, Aglaja (2019): Comparison of existing carbon crediting schemes, Nordic Initiative for Cooperative Approaches (NICA), Helsinki

Michaelowa, Axel; Espelage, Aglaja; Hoch, Stephan; Acosta, Mariana (2018): Interaction between Art.6 of the Paris Agreement and the Montreal Protocol/Kigali Amendment, GIZ

MITECO (n.d.): Metodología para sustitución de HFCs utilizados como espumantes por otros gases de menor potencial de calentamiento atmosférico, https://www.miteco.gob.es/es/cambio-climatico/temas/fondo-carbono/hfcs-agentes-espumantes-ex-ante-2015_tcm30-129817.pdf (accessed March 17, 2021)

MITECO (2020): Metodología para sustitución de HFCs utilizados como refrigerantes por otros gases de menor potencial de calentamiento atmosférico, https://www.miteco.gob.es/es/cambio-climatico/temas/fondo-carbono/metodologiaproyectosclima-sustitucionhfcs_exante_tcm30-420253.pdf (accessed March 17, 2021)

MITECO (2020): Metodología de seguimiento para proyectos clima sustitución de HFCs utilizados como refrigerantes por otros gases de menor potencial de calentamiento atmosférico – Versión 3, https://www.miteco.gob.es/es/cambio-climatico/temas/fondo-carbono/metodologiaseguimientoproyectosclima-sustitucion-hfcs_expost_tcm30-420245.pdf (accessed March 17, 2021)

Michaelowa, Axel; Ahonen, Hanna-Mari; Espelage, Aglaja (2021): Setting crediting baselines under Article 6 of the Paris Agreement, Discussion paper of the Carbon Market Mechanisms Working Group, Perspectives Climate Research, Freiburg

Montzka, Stephen; Dutton, Geoffrey; Portmann, Robert. et al. (2021): A decline in global CFC-11 emissions during 2018–2019, in: Nature, 590, p. 428–432

Öko-Institut (2021): Evaluation and impact assessment for amending Regulation (EU) No 517/2014 on fluorinated greenhouse gases. Briefing paper for the stakeholder workshop: Preliminary findings, https://ec.europa.eu/clima/sites/default/files/f-gas/legislation/docs/20210506_briefing_en.pdf (accessed May 14, 2021)

Rahman, M.M.; Rahman, H.Y. (2012): Hydrocarbon as refrigerant for domestic air conditioner: a comparative study between R22 and R290, in: Thermal Engineering 53 (2012) 11976–11979

UNFCCC (2020): Reference manual for the enhanced transparency framework under the Paris Agreement: understanding the enhanced transparency framework and its linkages to nationally determined contribution accounting, United Nations Climate Change Secretariat, https://unfccc.int/sites/default/files/resource/ETFReferenceManual.pdf (accessed March 22, 2021)

UNFCCC (2019a): Draft text on matters relating to Article 6 of the Paris Agreement: Guidance on cooperative approaches re-ferred to in Article 6, paragraph 2, of the Paris Agreement. 1st Iteration, paper presented at the UN Climate Change Conference, Madrid, Spain, December 13, 2020

UNFCCC (2019b): Draft text on matters relating to Article 6 of the Paris Agreement: Guidance on cooperative approaches re-ferred to in Article 6, paragraph 2, of the Paris Agreement. 2nd Iteration, paper presented at the UN Climate Change Conference, Madrid, Spain, December 14, 2020

UNFCCC (2019c): Draft text on matters relating to Article 6 of the Paris Agreement: Guidance on cooperative approaches referred to in Article 6, paragraph 2, of the Paris Agreement. 3rd Iteration, paper presented at the UN Climate Change Conference, Madrid, Spain, December 15, 2020

UNFCCC (2018): Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, decision 18/CMA.1, https://unfccc.int/documents/193408 (accessed July 3, 2020)

Usinger, Jürgen; Röser, Frauke; Kurdziel, Marie-Jeanne (2018): Coordinating finance for sustainable refrigeration and air conditioning, GIZ, Eschborn

Wooders et al. (2016): Supporting Energy Pricing Reform and Carbon Pricing Policies Through Crediting, IISD, Genf

Sharma, Anju; Michaelowa, Axel; Espelage, Aglaja; Allan, Jennifer; Müller, Benito (2020): COP25 Key outcomes, https://www.perspectives.cc/fileadmin/Publications/ECBI_COP25_Key_Outcomes.pdf, ecbi, Oxford

Seidel, Steve; Ye, Jason; Andersen, Stephen; Hillbrand, Alex (2016): Not-in-kind alternatives to high global warming HFCs, Center for Climate and Energy Solutions, Arlington

Sovacool, Benjamin; Griffiths, Steve; Kim, Jinsoo; Bazilian, Morgan (2021): Climate change and industrial F-gases: a critical and systematic review of developments, sociotechnical systems and policy options for reducing synthetic greenhouse gas emissions, in: Renewable and Energy Reviews 141, https://doi.org/10.1016/j.rser.2021.110759

UN (1989): Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal

UNEP Ozone Secretariat (2020): Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer. Fourteenth Edition, Nairobi

Value Added Tax (Amendment of First Schedule) Regulations (2021), S.I. 6 of 2021

Weikman, Romain; van Asselt, Harro; Roberts, J. Timmons (2020): Transparency requirements under the Paris Agreement and their (un)likely impact on strengthening the ambition of nationally determined contributions (NDCs), in: Climate Policy 20, p. 511–526

Wooders, Peter; Gass, Philip; Bridle, Richard; Beaton, Christopher; Gagnon-Lebrun, Frédéric; Michaelowa, Axel; Hoch, Stephan; Honegger, Matthias; Matsuo, Tyeler; Villa, Vanessa; Johnson, Mark; Harries, James (2016): Supporting Energy Pricing Reform and Carbon Pricing Policies Through Crediting, IISD, Geneva

Annex: Existing methodologies and tools for HFC reduction and related energy efficiency improvement

Table 8: Existing methodologies for HFC reduction and related energy efficiency improvement

Methodology	Standard / Mechanism	Type (scale)[1]	Sectoral scope	Activity type(s)	Baseline setting approach and additionality determination	MRV approach	Key parameters	No. of projects registered
AM0001 Decomposition of fluoroform (HFC-23) waste streams	CDM	Large	Fugitive emissions from production and consumption of halocarbons and SF_6	Project activities which capture and decompose HFC-23 formed in the production of HCFC-22.	HFC-23 is typically released to the atmosphere because a decomposition facility entails capital and operating costs. Therefore, the baseline scenario is the continued release of HFC-23 up to the amount that is allowed by applicable regulations	For monitoring, meters should be installed, maintained and calibrated according to applicable standards. All data collected as part of the monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period	Average annual HCFC-22 equivalent production level in specific HCFC-22 production line Quantity of HFC-23 generated as a by-product in specific HCFC-22 production line	19 projects
AM0071: Manufacturing and servicing of domestic and/or small commercial refrigeration appliances using a low GWP refrigerant	CDM	Large	Fugitive emissions from production and consumption of halocarbons and SF6	Project activities that are switching from a high GWP to low GWP refrigerant while manufacturing and refilling domestic and/or small commercial refrigeration appliances.	Project participants shall undertake the following steps to identify the baseline: • Step 1: identify possible alternative baseline scenarios (independently for domestic refrigeration appliances and small commercial refrigeration appliances. • Step 2: identify barriers and assess which alternative scenarios are prevented by these barriers. • Step 3: compare the economic or financial attractiveness of the alternative scenarios remaining after Step 2 by conducting an investment analysis. • Step 4: demonstrate that the project activity is not a common practice	All measurements should be conducted with calibrated measurement equipment according to relevant industry standards. All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period.	Number of units produced for each refrigeration appliance model, The refrigerant charge for each model The number of refrigeration appliances serviced involving the refrigerant refilling, the amount of refrigerant procured for manufacturing and the amount of refrigerant contained in cylinders at time of shipping for refilling.	0

---

[1] Small-scale projects: emission reductions are less than or equal to 60 kt CO_2 equivalent annually.

Methodology	**Standard / Mechanism**	**Type (scale)[1]**	**Sectoral scope**	**Activity type(s)**	**Baseline setting approach and additionality determination**	**MRV approach**	**Key parameters**	**No. of projects registered**
AM0060: Power saving through replacement by energy efficient chillers	CDM	Large	Energy demand / energy efficiency	Project activities that replace existing less efficient electricity-driven chillers with more efficient electricity-driven chillers. If HCFC-22 is used as refrigerant under the project activity and/or in the baseline, then HFC-23 emissions occurring as a by-product from the production of HCFC-22 shall be accounted as leakage emissions	This methodology is applicable only if the identified baseline scenario is the continued use of the existing chiller without any retrofitting. Project participants shall undertake the following steps to identify the baseline: • Step 1: identify possible alternative baseline scenarios (independently for domestic refrigeration appliances and small commercial refrigeration appliances. • Step 2: identify barriers and assess which alternative scenarios are prevented by these barriers. • Step 3: compare the economic or financial attractiveness of the alternative scenarios remaining after Step 2 by conducting an investment analysis. • Step 4: demonstrate that the project activity is not a common practice	An electronic database (e.g., spreadsheets) shall be established for the purpose of the project activity. This database should contain the measurement results of the relevant parameters for each period t and may serve to calculate the emission reductions based on the measurement results. The database should be part of monitoring reports.	Electricity consumption of the chiller The operation parameters of the chiller The quantity of refrigerants used in the project activity	2 PoAs (validation terminated)
AM0070: Manufacturing of energy efficient domestic refrigerators	CDM	Large	Manufacturing industries/energy efficiency	Project activities undertaken by manufacturers of refrigerators that increase the energy efficiency of manufactured refrigerators. Under this methodology emission reduction credits cannot be claimed for reducing refrigerant emissions by switching from a refrigerant or a foam blowing agent with a higher GWP to a substance with a lower GWP	A benchmark approach is applied to establish the baseline scenario and demonstrate additionality. A benchmark approach is used because project activities under this methodology can involve a range of energy efficiency improvement measures, implementation of which will be spread over the duration of the crediting period.	All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards	Number of units sold in different refrigerator classes and in different electricity grids per annum Annual electricity consumption data for the each refrigerator class	2 projects (registered)

Methodology	**Standard / Mechanism**	**Type (scale)**[1]	**Sectoral scope**	**Activity type(s)**	**Baseline setting approach and additionality determination**	**MRV approach**	**Key parameters**	**No. of projects registered**
AM0120: Energy-efficient refrigerators and air-conditioners	CDM	Large	Energy demand / energy efficiency	Project activities that involve the installation of new, energy-efficient (RACs) for residential/household applications as replacement or new sales projects. This methodology credits emission reductions due to the reduction in electricity consumption from use of new and more efficient units as well as the avoidance of use of high GWP refrigerants in the refrigeration and air conditioning equipment.	Under this methodology, a benchmark approach is applied for the identification of the baseline scenario and demonstration of additionality for new sales RACs. For project activities that involve replacement of existing refrigerators, the baseline scenario is the continuing operation of the existing equipment.	Annual/biennial checks that refrigerators are still working should be done with a statistically significant sample of end-users	Number of refrigerators of each model of each volume class introduced by the project activity operating per year Number of refrigerators of each model replaced operating per year Average cooling capacity of the air conditioners	1 project (at validation)
AMS-III.N. Avoidance of HFC emissions in poly urethane foam (PUF) manufacturing	CDM	Small	Manufacturing industries/energy efficiency	Project activities that use a non-GHG blowing agent (e.g., pentane) to replace HFC gases used as a blowing agent (e.g. HFC-134a, HFC-152a, HFC-365mfc and HFC-245fa) during the production of PUF in an existing or a new manufacturing facility.	The baseline includes HFC emissions during PUF manufacturing and HFC emissions during PUF usage (i.e., HFC stored in the cells of the foam materials). The disposal emissions of the foam are excluded from calculations.	The monitoring of the total quantity of PUF being manufactured is monitored on daily basis (the blowing agent usage is a direct function of the PUF being manufactured)	Emission factors for each foam type (in the absence of availability of country specific data, the IPCC default data can be used)	3 projects (registered)
AMS-III.X. Energy efficiency and HFC-134a recovery in residential refrigerators	CDM	Small	Energy demand / energy efficiency Fugitive emissions from production and consumption of halocarbons and SF_6	Project activities that replace existing, functional domestic refrigerators by more-efficient units and recover/destruct HFCs from the refrigerant and the foam.	The baseline scenario is the continued use of existing inefficient refrigerators without refrigerant recovery. Baseline emissions for the avoided HFC-134a emissions are calculated using the total quantity of reclaimed HFC-134a	Monitoring consists of counting the HFC-134a refrigerators entering the recycling facility, weighing reclaimed HFC-134a in liquid form and chemical analysis of HFC-134a samples and lubricant samples	Number of refrigerators distributed under the project activity	0

Methodology	**Standard / Mechanism**	**Type (scale)[1]**	**Sectoral scope**	**Activity type(s)**	**Baseline setting approach and additionality determination**	**MRV approach**	**Key parameters**	**No. of projects registered**
AMS-III.AB. Avoidance of HFC emissions in standalone commercial refrigeration cabinets	CDM	Small	Fugitive emissions from production and consumption of halocarbons and SF_6	Project activities resulting in the avoidance of hydro-fluro-carbon (HFC 134a) emissions during the life cycle of commercial standalone refrigeration equipment. Retrofit of HFC 134a cabinets to use alternative low GWP refrigerants is not eligible under this methodology.	Baselines emissions include: • Emissions during manufacturing (HFC refrigerant emitted to the atmosphere during initial charging of the refrigeration cabinets in the manufacturing site) • HFC emission during usage and servicing. • HFC emission during disposal of refrigeration cabinets at the end of useful life.	A project database shall record all required parameters (i.e., Number of units of each model of cabinets procured and put into service, refrigerant charge for each model, etc.) During the validation or verification DOE shall check on site a random sample of the cabinets in each boundary: manufacturing, in use, servicing, and disposal. During this verification, a hydrocarbon detector will be used to verify the gas used as a low GWP refrigerant	Number of refrigeration cabinets of the type i (entering the manufacturing boundary, serviced, decommissioned / disposed) The refrigerant charge for each model	0
AMS-II.C.: Demand-side energy efficiency activities for specific technologies	CDM	Small	Energy demand / energy efficiency	Project activities that involve the installation of new, energy-efficient equipment (e.g. lamps, ballasts, refrigerators, motors, fans, air conditioners, pumping systems, and chillers) at one or more project sites. Retrofit as well as new construction (Greenfield) projects are included under this methodology. This methodology credits emission reductions only due to the reduction in electricity and/or fossil fuel consumption from use of more efficient equipment. However, the calculation of project emissions shall include any incremental emissions, as compared to the baseline, associated with refrigerants used in the project equipment	Projects involving electricity savings: Option 1 – Constant load equipment Option 2 – Variable load device(s), regression approach Option 3 – Production efficiency/specific energy consumption approach Projects involving fossil fuel savings: the energy baseline is the existing level of fuel consumption or the amount of fuel that would be used by the technology that would have been implemented otherwise	If the equipment installed replaces existing equipment, the number and "power" of a representative sample of the replaced equipment shall be recorded in a way that allows for a physical verification. For electricity or fossil fuel savings projects, monitoring shall include annual checks of a sample of non-metered systems to ensure that they are still operating	Power of the project equipment installed Number of pieces of equipment replaced or that would have been replaced Number project devices operating in time interval t year y	12 projects and 10 PoAs (registered) 5 projects and 6 PoAs (at validation)

Methodology	Standard / Mechanism	Type (scale)[1]	Sectoral scope	Activity type(s)	Baseline setting approach and additionality determination	MRV approach	Key parameters	No. of projects registered
AMS-II.O.: Dissemination of energy efficient household appliances	CDM	Small	Energy demand /energy efficiency	Project activities that increase sales dissemination of new household appliances, specifically refrigerating appliances (refrigerators) that have very high efficiencies and are more energy-efficient than baseline refrigerators that are assumed to have lower baseline benchmark efficiencies. Only appliance models utilising refrigerants and foam blowing agents having no ODP and low GWP	The baseline scenario is a new refrigerator that is less efficient than the project refrigerator, and which would have been purchased by the same residential end-use consumer instead of the project refrigerator for the same application	Data shall be recorded at the time of the dissemination activity and compiled at least annually. The source of data depends on the nature of the project activity	Number of refrigerators of each model type disseminated Electricity consumption of each refrigerator model disseminated under the project activity	0
AMS-III. AE. Energy efficiency and renewable energy measures in new residential buildings	CDM	Small	Energy demand /energy efficiency	Project activities that lead to reduced consumption of electricity in new, grid connected residential buildings (single or multiple-family residences1) through the use of one or more of the following measures: efficient building design practices, efficiency technologies, and renewable energy technologies. Examples include efficient appliances, high efficiency heating and cooling systems, passive solar design, thermal insulation, and solar photovoltaic systems.	Option 1: Baseline emissions are determined based on benchmark using the top-20% best performing buildings Option 2: Baseline emissions as measured in the comparison group	Use electricity meters installed at the electricity consumption sources. Continuous measurement and at least monthly recording	Electricity consumed by the project building unit j in building unit category i in year y (MWh) Annual electricity savings from project activity residences in year y for residence type i, (MWh)	
Refrigeration and Ventilation Fans Methodology Determination 2015	Australian ERF	Not specified	Energy Efficiency	Project activities that include the installation, modification or replacement of refrigeration fans or ventilation fans or both; and that involve undertaking either or both of the following: (i) or more high efficiency fan installations; (ii) 1 or more small motor fan upgrade	The abatement amount for each fan is determined by comparing the energy consumption of that fan with the energy consumption of a market average fan of the same type and power and is proportional to the reduction in energy consumption of the fan as compared to this benchmark.	An offsets report for a reporting period must identify each installed HE fan and each installed SM fan that was included in a calculation	Number of installed HE fans/SM fans over which abatement is calculated for the reporting period Motor/fan input power	1

Methodology	Standard / Mechanism	Type (scale)[1]	Sectoral scope	Activity type(s)	Baseline setting approach and additionality determination	MRV approach	Key parameters	No. of projects registered
Industrial Electricity and Fuel Efficiency Methodology Determination 2015	Australian ERF	Not specified	Energy Efficiency	Project activities that can improve the efficiency of installed energy consuming equipment, and thereby reduce emissions from that equipment.	Baseline emissions are those that would have occurred if there had been no equipment upgrade or replacement. The baseline emissions are estimated using a statistical technique called regression analysis which models energy use prior to the project and uses this model to calculate the baseline emissions after the implementation has been completed. This means the baseline emission are adjusted to reflect the production conditions that are experienced in the reporting period.	The offsets report should include details of the completion of the implementation of each implementation that was completed during the reporting period	The total quantity of fuel type i combusted that is the relevant energy for implementation for the time interval The total emissions from the consumption of electricity that is the relevant energy for implementation for the time interval	50
High Efficiency Commercial Appliances Methodology Determination 2015	Australian ERF	Not specified	Energy Efficiency	Project activities that result in lower energy usage than would result if high efficiency equipment units were not used for the relevant heating or cooling	The baseline efficiency level is calculated using the average of similar units listed on the GEMS register.	An offsets report for a reporting period must identify each installed equipment unit	The class of equipment unit to which it belongs Number of equipment units over which abatement is measured for the reporting period	2
Commercial Buildings Methodology Determination 2015	Australian ERF	Not specified	Energy Efficiency	Projects activities that reduce emissions by improving the energy performance of buildings that are rateable under the National Australian Build Environment Rating System (NABERS). Eligible building types are limited to offices, shopping centres and hotels.	The baseline emissions for a building are the emissions that would have been attributable to the building had the project not occurred. The baseline emissions include electricity and fossil fuels consumption.	The offsets report must include the description of the activities that were undertaken at the building during the reporting period.	Consumption of fuel type i at the building in the measurement period Renewable electricity generated and consumed onsite at the building in the measurement period	4
ID_AM003 Installation of Energy-efficient Refrigerators Using Natural Refrigerant at Food Industry Cold Storage and Frozen Food Processing Plant	JCM (Japan)	Not specified	Energy Efficiency	Project activities that install cooling system at food industry cold storage and frozen food processing plants for the purpose of chilling the food products to below -20° C.	Reference emissions are GHG emissions from the usage of reference refrigerators, calculated by using data of power consumption of project refrigerator, ratio of COPs of reference/project refrigerators and CO_2 emission factor for electricity consumed. Emissions associated with the loss of refrigerant are not counted in the emission reduction calculation	Measured data is automatically sent to a server where data is recorded and stored. Measuring equipment is required to be calibrated. Recorded data is checked its integrity once a month by responsible staff.	Amount of electricity consumed by project refrigerator. Electricity imported from the grid, where applicable. Operating time of captive electricity generator, where applicable.	2

Methodology	Standard / Mechanism	Type (scale)[1]	Sectoral scope	Activity type(s)	Baseline setting approach and additionality determination	MRV approach	Key parameters	No. of projects registered
ID_AM004 Installation of Inverter-Type Air Conditioning System for Cooling for Grocery Store	JCM (Japan)	Not specified	Energy Efficiency	Project that aims for saving energy by introducing inverter-type air conditioning system for cooling for grocery store in Indonesia.	Reference emissions are GHG emissions from using reference air conditioning system, calculated with power consumption of project air conditioning system, ratio of COPs of project/reference air conditioning system, and CO_2 emission factor for consumed electricity.	Measuring equipment is installed to measure power consumption of air conditioning system. The monitoring system can be automated or measured data on monitoring equipment can be read and recorded manually.	Power consumption of project air conditioning system	1
ID_AM008 Installation of a separate type fridge-freezer showcase by using natural refrigerant for grocery store to reduce air conditioning load inside the store	JCM (Japan)	Not specified	Energy Efficiency	Project activity that aims for saving total energy of in-store showcase and air conditioning system by introducing a separate type natural refrigerant fridge-freezer showcase for grocery store in Indonesia, which leads to GHG emission reductions, through the reduction of air conditioning electricity load demand by not releasing waste heat inside the store	Reference emissions are GHG emissions from both the reference built-in type fridge-freezer showcase and the reference air conditioning system.	Measuring equipment is installed to measure power consumption of fridge showcase Monitoring frequency: Monthly The monitoring system can be automated or measured data on monitoring equipment can be read and recorded manually.	Electricity consumption of the project fridge showcase and electricity consumption of the project freezer showcase	1
MM_AM002 Installation of Energy-efficient Refrigerators Using Natural Refrigerant at Cold Storage	JCM (Japan)	Not specified	Energy Efficiency	Energy-efficient refrigerators using natural refrigerant is introduced for energy saving at the food industry cold storage.	Reference emissions are GHG emissions from reference refrigerators, calculated by using data of power consumption of project refrigerator, ratio of COPs of reference/project refrigerators and CO_2 emission factor for consumed electricity	Data is measured by measuring equipment. The measuring equipment is replaced or calibrated at an interval following the regulations in the country. Data is collected and recorded from the invoices by the fuel supply company.	Amount of electricity consumed by project refrigerator	0

Methodology	Standard / Mechanism	Type (scale)[1]	Sectoral scope	Activity type(s)	Baseline setting approach and additionality determination	MRV approach	Key parameters	No. of projects registered
TH_AM006: Installation of Displacement Ventilation Air Conditioning Unit in the Cleanroom of Semiconductor Manufacturing Factory	JCM (Japan)	Not specified	Energy Efficiency	Installation of displacement ventilation air conditioning unit to improve energy efficiency of supplying conditioned air to the cleanroom of semiconductor plant leads to reduction of power consumption for ventilation.	Reference emissions are calculated by multiplying power consumption of mixing ventilation air conditioning unit, the proportion of motive power of reference mixing ventilation air conditioning unit and project displacement ventilation air conditioning unit, and CO_2 emission factor for electricity consumed.	On-site measurement by measuring equipments. The meter is certified in compliance with national/ international standards on electrical power meter. Measuring and recording: 1) Measured data is recorded and stored in the measuring equipments. 2) Recorded data is checked its integrity once a month by responsible staff.	The amount of power consumption by project displacement ventilation air conditioning unit The amount of fuel consumption and the amount of electricity generated by captive power,	1
TH_PM013: Installation of Energy-efficient Refrigerators Using Natural Refrigerant at Cold Storage	JCM (Japan)	Not specified	Energy Efficiency	Project activities introducing energy-efficient refrigerators using natural refrigerant at the cold storage	Reference emissions are GHG emissions from reference refrigerators, calculated by using data of power consumption of project refrigerator, ratio of COPs of reference/project refrigerators and CO_2 emission factor for consumed electricity. Emissions associated with leakage of refrigerant are not counted in the emission reduction calculation	Data is measured by measuring equipment. The measuring equipment is replaced or calibrated at an interval following the regulations in the country in which the measuring equipment is commonly used or according to the manufacturer's recommendation	Power consumption of project refrigerator	0
VN_AM002: Introduction of room air conditioners equipped with inverters	JCM (Japan)	Not specified	Energy Efficiency		GHG emissions associated with electricity consumption of reference RACs are calculated based on the monitored electricity consumption of project RACs, the ratio of the energy efficiency of reference and project RACs, and the CO_2 emission factor of the electricity consumed by project RACs	Electricity consumption is measured by an electricity meter recorded monthly. Measurement is recorded either manually or electronically. The electricity meter is calibrated or replaced, in line with relevant Vietnamese national standards, international standards, or manufacturer's specification	Electricity consumption of project RACs Project energy efficiency (CSPF of project RACs) Reference energy efficiency (CSPF of reference RACs)	1

Methodology	Standard / Mechanism	Type (scale)[1]	Sectoral scope	Activity type(s)	Baseline setting approach and additionality determination	MRV approach	Key parameters	No. of projects registered
VN_AM006: Introduction of air conditioning system equipped with inverters	JCM (Japan)	Not specified	Energy Efficiency	This methodology applies to the project that aims for saving energy by introducing air-conditioning system with inverter for cooling in Vietnam.	GHG emissions associated with electricity consumption of reference air conditioning system are calculated based on the monitored electricity consumption of project air conditioning system, the ratio of COPs of reference/ project air conditioning system, and the CO2 emission factor of the electricity consumed by project air conditioning system.	Measuring equipment is installed in each outdoor unit of air conditioning system to measure power consumption. Measured data is automatically transmitted to the server for recording. Measuring equipment is required to be calibrated	Electricity consumption of outdoor unit of project air conditioning system Total electricity consumption of indoor units of project air conditioning system	2
Compliance Offset Protocol Ozone Depleting Substances Projects	CCOP (USA)	Not specified	ODS Projects	Project activities that are designed to reduce GHG emissions by the destruction of eligible ODS at a single qualifying destruction facility. This project category includes ODS used in both foam blowing agent and in refrigeration or air conditioning equipment.	Baseline emissions must include the estimated CO_2e emissions that would have occurred over the ten-year crediting period: • From the destroyed ODS that would have been used in existing refrigeration or air conditioning equipment. • As the result of foam disposal. Projects must satisfy the following tests to be considered additional: 1. The Legal Requirement Test (to ensure that the GHG reductions achieved by a project would not otherwise have occurred due to federal, state, or local regulations, or other legally binding mandates. 2. The Performance Standard Test (meeting a performance threshold, evaluation "common practice" for managing ODS)	The point of origin of all ODS must be documented. The Offset Project Operator or, if applicable, Authorized Project Designee must collect and maintain documentation on the chain of custody and ownership of the ODS beginning at the point of origin until destruction. The destruction facility must track certain parameters continuously during the ODS destruction process	Mass of ODS, including ineligible ODS and contaminants, at each transaction Number of appliances processed	201

Methodology	Standard / Mechanism	Type (scale)[1]	Sectoral scope	Activity type(s)	Baseline setting approach and additionality determination	MRV approach	Key parameters	No. of projects registered
The United States Ozone Depleting Substances (ODS) Protocol	CAR (USA)	Not specified	Destruction of eligible ODS	Project activities undertaken by a single project developer resulting in the destruction of eligible ODS at a single qualifying destruction facility over a 12-month period. : ODS must be sourced from the U.S. or its territories and destroyed within the U.S. or its territories	Baseline emissions must include the estimated CO_2e emissions that would have occurred over the ten-year crediting period Projects must satisfy the following tests to be considered additional: 1. The Legal Requirement Test (to ensure that the GHG reductions achieved by a project would not otherwise have occurred due to federal, state, or local regulations, or other legally binding mandates. 2. The Performance Standard Test (meeting a performance threshold, evaluation "common practice" for managing ODS)	Project may report and undergo verification annually or sub-annually.	Mass of ODS, including ineligible ODS and contaminants, at each transaction	
Mexico Halocarbon Protocol	CAR (USA)	Not specified	Destruction of eligible ODS	Project activities that will destruct ODS sourced from Mexico and destroyed at facilities in Mexico.	Total baseline emissions for the reporting period must be estimated by calculating and summing the emissions from all relevant baseline sources, sinks, and reservoirs. This includes emissions from stockpiled refrigerants and end-of-life refrigerants that would have occurred over the ten-year crediting period. Projects must satisfy the following tests to be considered additional: 1. The Legal Requirement Test (to ensure that the GHG reductions achieved by a project would not otherwise have occurred due to federal, state, or local regulations, or other legally binding mandates. 2. The Performance Standard Test (meeting a performance threshold, evaluation "common practice" for managing ODS)	At a minimum, the Monitoring and Operations Plan shall stipulate the frequency of data acquisition; a record keeping plan; and the role of individuals performing each specific monitoring activity; and a detailed project diagram	Total weight of material destroyed (including eligible and ineligible material)	Draft version still under development

Methodology	Standard / Mechanism	Type (scale)[1]	Sectoral scope	Activity type(s)	Baseline setting approach and additionality determination	MRV approach	Key parameters	No. of projects registered
Methodology for substitution of HFCs used as foaming agents by other gases of less Global Warming Potential	FES-CO_2	Not specified	Substitution of HFCs	Project activities that promote a substitution of HFCs used as foaming agents for other foaming gases with a lower GWP. This methodology is conceived only for the replacement of alternative foaming gases to HFCs in insulating foams used in buildings. This methodology cannot be applied to other applications such as electrical appliances, insulating panels, refrigerators, freezers, etc.	Systems where 5% of the weight content is a foaming gas with a GPW up 794. The percentage of leaks at the time of application is estimated to be 10%.	At least once a year, the project developer must develop a monitoring report. The report should include the parameters obtained through the application of the Monitoring Plan and the emission reductions achieved in a specific period of operation of the project.	Maximum thermal energy absorbed by the cooling equipment Total amount of refrigerant in the equipment	13

Table 9: Existing tools for HFC reduction and related energy efficiency improvement

Tool	Sectoral scope	Activity type(s)	Baseline setting approach	MRV approach	Key parameters
Tool 26: Accounting eligible HFC-23	Fugitive emissions from production and consumption of halocarbons and SF_6	Project activities that apply versions 1 to 5 of the approved methodology AM0001	The purpose of this methodological tool is to provide criteria for the determination of the quantity of HFC-23 eligible for crediting.	CERs can be issued for a monitoring period shorter than one year A monitoring period can be of a shorter duration than a year, but all the monitoring periods within a year y of the crediting period should add up to the duration of the year	The HFC-23 that is stored at the end of the year y-1 and that is eligible for storage and subsequent destruction Quantity of HFC-23 generated in year y Quantity of HCFC-22 produced in year y The maximum annual HCFC-22 production that is eligible for crediting
Tool 28: Calculation of baseline, project and leakage emissions from the use of refrigerants	Fugitive emissions from production and consumption of halocarbons and SF_6	Project activities involving the use of refrigerant gases in refrigeration and air-conditioning systems	Baseline emissions from physical leakage of refrigerants are calculated based on the average annual quantity of refrigerant used in the baseline to replace the refrigerant that has leaked and the GWP baseline refrigerant	The source of data could be: 1. Inventory data by the project participants of refrigerant cylinders consumed in year y. 2. Manufacturers data and/or as printed on appliance label and documented in technical specifications. 3. The value specified in the Appendix of the document	Average annual quantity of refrigerant used in the baseline to replace the refrigerant that has leaked Average annual quantity of refrigerant used in year y to replace refrigerant that has leaked during the year
Tool 29: Determination of standardized baselines for energy-efficient refrigerators and air conditioners	Energy efficiency	Project activities using distributing or selling RAC equipment for residential/household applications	The baseline for emissions from the refrigerants contained in baseline RAC equipment is based on the cooling capacity of air-conditioners and respective charge rates of specific refrigerants (e.g., HCFC-22, HFC-134a, R-410A).	N/A	Quantity of different type of refrigerants and blends used in the reference period. Total cooling capacity (kW) of the air-conditioners in a market or market segment

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 36 + 40
53113 Bonn, Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1 – 5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

E info@giz.de
I www.giz.de