NAMAs in the refrigeration, air conditioning and foam sectors.

A technical handbook.

giz 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

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

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Layout
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Printed and distributed by
Top Kopie GmbH, Frankfurt
Printed on 100 % recycled paper, certified to FSC standards

Place and date of publication
Eschborn, October 2013

Serial number
G-S01-2013-en-01

Proklima

Proklima is a programme of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Since 2008 Proklima has been working successfully on behalf of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) under its International Climate Initiative (ICI) to promote ozone-and climate friendly technologies.

Proklima provides technical assistance for developing countries since 1996, commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) to implement the provisions of the Montreal Protocol on substances that deplete the Ozone Layer.

This publication has been compiled in the project "Development of NAMAs in the refrigeration, air conditioning and foam manufacturing sectors" funded by the BMU International Climate Initiative.

www.giz.de/proklima

The International Climate Initiative

Since 2008, the International Climate Initiative (ICI) of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has been financing climate and biodiversity projects in developing and newly industrialising economies, as well as in countries in transition. Based on a decision taken by the German Parliament (Bundestag), a sum of EUR 120 million is available for use by the initiative annually. The ICI is a key element of Germany's implementation of fast start financing. The Energy and Climate Fund launched by the German Government in 2011 is a further source of funding for international climate protection projects, and for activities to conserve biodiversity. Part of that funding is deployed through the ICI. That fund is replenished from the auctioning of emission permits. This innovative source makes Germany well-prepared to deliver long-term financing for climate and biodiversity projects worldwide.

The ICI is active in four areas: Mitigating greenhouse gas emissions, adapting to the impacts of climate change, conserving natural carbon sinks with a focus on reducing emissions from deforestation and forest degradation (REDD+), as well as conserving biological diversity.

www.international-climate-initiative.com

Contents

EXECUTIVE SUMMARY

This handbook aims to serve policy makers and practitioners in developing countries as a comprehensive guideline for the preparation and implementation of nationally appropriate mitigation actions (NAMAs) in the refrigeration, air conditioning and foam (RAC&F) sectors. To date it is the only comprehensive compendium addressing the RAC&F sectors with respect to NAMAs, or, more generally, cost-effective mitigation actions on a sectoral level.

NAMAs are voluntary policies or activities to reduce greenhouse gas emissions that

- are appropriate for the specific implementing country
- recognise different capabilities and capacities of each country, and
- combine the development agenda with climate protection targets.

As demand for cooling rises worldwide, the market for refrigeration, air conditioning and insulation equipment expands rapidly. More cooling equipment, however, consumes more resources and causes substantial amounts of greenhouse gas (GHG) emissions that are both damaging to the climate and the ozone layer.

Globally, unabated direct and indirect emissions in the refrigeration, air conditioning and foam sectors will grow from currently about 4 GT CO_2eq (equivalent) to 12 GT CO_2eq by 2050[1]. Key factors for the emission increase are a growing population, economic development, effects of wealth and lifestyle, growing urbanisation and increasing ambient temperatures.

In order to meet the 2°C target, assuming that global emissions are not allowed to peak much later than 2020, it will be necessary to achieve emission reductions of at least 3.8 % per annum from 2020 to 2050[2]. The effort for emission reductions requires the collaboration of all countries, including developing countries, and all sectors.

Effective mitigation also requires the reduction of emissions in the RAC&F sectors. The GIZ Proklima RAC&F roadmap suggests a pathway where emissions in 2030 will be about 7 GT CO_2eq below their business-as-usual (BAU) level (GIZ Proklima, 2012). The mitigation potential against the BAU level can be achieved both through the replacement of high with low global warming potential (GWP) refrigerants and foam blowing agents and, by lowering the carbon footprint of the energy supply, i.e. through increased energy efficiency and the decarbonisation of the energy supply. Applicable, low GWP technical options are available for all key RAC&F sectors and ready for use in developing countries.

NAMAs in the RAC&F sectors address the limitation and mitigation of direct and indirect emissions of these sectors:

- Direct emissions result from the use of refrigerants in cooling systems as well as from foam blowing agents for insulation material. Chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFC) refrigerants and foam blowing agents are effectively being phased out within the framework of the Montreal Protocol in developed and developing countries In the case of CFCs, they were phased out completely by 2010. HCFCs are still to be phased out in developing countries by 2030. Hydrofluorocarbons (HFC) are frequently used as replacement for CFCs and HCFCs as they are not ozone depleting. However, HFCs are also powerful greenhouse gases with a global warming potential (GWP) between 700 and 11700 (R23) (GESTIS, 2013). They are regulated under the framework of the United Framework Convention on Climate Change (UNFCCC). CFCs, HCFCs and HFCs are also named fluorinated gases (F-gases).

- Indirect emissions result mainly from the energy consumption required to power the RAC&F systems and appliances. Currently, in most countries the energy supply is predominantly from fossil fuels with resulting carbon dioxide (CO_2) emissions. Therefore, energy efficiency of equipment and processes are key parameters for mitigation actions.





1 GIZ Proklima (2012). Refrigeration, air conditioning and foam blowing sectors technology roadmap. http://unfccc.int/ttclear/sunsetcms/storage/contents/stored-file-20130422153302319/GIZ_RM.pdf
2 Ecofys (2012). Why the Durban Outcome is not sufficient for staying below 2°C, Policy Update. Issue III. February 2012, http://www.ecofys.com/files/files/ecofys_policy_update_iii_02_2012_02.pdf, 28 June 2013

Approach and structure of the handbook

The approach of this handbook is sector specific for the RAC&F sectors and its subsectors as illustrated in Table 1. In addition to the guidelines and concepts on how to prepare sector specific NAMAs, this handbook is complemented by several practical tools and methodologies for policy makers.

TABLE 1
Overview of the RAC&F sectors and their subsectors

Sectors and subsectors (S)	Appliance systems or Applications
S1: RAC, Unitary air conditioning	Self-contained air conditioners Split residential air conditioners Split commercial air conditioners Duct split residential air conditioners Commercial ducted splits Rooftop ducted Multi-splits
S2: RAC, Chillers	Air conditioning chillers Process chillers
S3: RAC, Mobile AC	Car air conditioning Large vehicle air conditioning
S4: RAC, Domestic Refrigeration	Domestic Refrigeration
S5: RAC, Commercial Refrigeration	Stand-alone equipment Condensing units Centralised systems for supermarkets
S6: RAC, Industrial Refrigeration	Integral Condensing units Centralised systems
S7: RAC, Transport Refrigeration	Refrigerated trucks/trailers
S8: Foams	PU Flexible Foam Continuous PU Flexible Foam Discontinuous PU Flexible Moulded Foam PU Integral Skin Foam PU Continuous Panel PU Continuous Flexible panel PU Discontinuous Panel PU Appliance Foam PU Continuous Block PU Discontinuous Block PU Spray Foam PU Pipe-in-Pipe PU OCF (bottle foam) PU Rigid foam all other applications XPS Extruded Polystyrene boards
S9: Other sectors	Electrical power systems (Gas insulated switch gear and circuit breakers) Aerosols Metered dose inhalers Solvent cleaning Fire suppression

The handbook is structured into ten modules. Modules 1-5 are related to establishing the GHG emissions baseline and reduction scenarios. Modules 6-10 contain guidance on how to prepare suitable roadmaps and to provide for enabling policy, market and financing environments. Further the modules offer guidelines for the development of implementation plans including aspects for the realisation of co-benefits and the monitoring, reporting and verification (MRV) of emission reductions.

Module 1: Inventory

Module 1 provides guidance on how to set up a national F-gas inventory that serves as the basis for the design of a NAMA. A detailed emission inventory is the first step in any political action to reduce emissions. GHGs for the national reporting to the UNFCCC are regulated under the Kyoto Protocol. They include F-gases such as HFCs, which are used as refrigerants and foam blowing agents.

Despite the increasing use of F-gases in many countries, relevant emissions data is often not available, in particular in Non-Annex I countries. These developing countries frequently lack the know-how and experience to set up HFC inventories and establish the reporting of resulting emissions. The Intergovernmental Panel on Climate Change (IPCC) has published guidelines on preparing National Greenhouse Gas Inventories. Annex 1 countries are requested to report their HFC-emissions from 2014 on (COP 17). The guidance provided in this handbook recommends following the IPCC Tier 2 inventory methodology where emissions and emission abatement are measured on a per unit stock basis.

The application of this methodology for the RAC&F sectors allows
(1) accounting for direct and indirect emissions and
(2) the establishment of a sound basis for monitoring, reporting and verifying (MRV) of quantitative emissions abatement actions.

The handbook provides a Data Input Sheet (DIS) for the proper collection of data necessary to set up an inventory which guides developing countries through the inventory data collection process. Annex 1 of this module explains the calculation steps for demand, bank and emission of fluorinated substances based on data from the completed DIS. This provides the basis for the design of the BAU scenario.

Module 2: Cooling Needs Assessment

Module 2 provides an approach to estimate the stock of RAC&F systems in a country based on assessing the country-specific cooling needs. The stock of the systems in a country is the key indicator to estimate current and future emissions from the sector. The experience in many developing countries shows that stock data collected empirically is incomplete or lacks consistency.

The approach in Module 2 identifies key factors for the current and future demand for RAC&F systems such as population, number of households, Gross Domestic Product (GDP) per capita, cooling degree-days and electrification and urbanisation rates. With the emergence of the urban middle class, typically, the demand for RAC&F systems rises rapidly, especially in developing countries.

The handbook offers an excel-based tool to estimate the stock units in the RAC&F subsectors. The resulting unit stock data can be useful to validate and crosschecking empirically collected inventory data.

Module 3: Technical Options

Module 3 contains guidance on identifying technical options (TOs) for all RAC&F sectors suitable for reducing direct and indirect emissions within a country. The most relevant TOs are analysed, including the replacement of substances, reduction of leakages and improvements in energy efficiency as well as their availability. In addition, barriers such as safety-related restrictions, implementation costs and technical implications are addressed together with how to overcome these barriers by deploying key measures (safety standards, system specific training).

Module 4: Economic Assessment

Module 4 focuses on assessing the costs of the individual abatement options. It helps stakeholders to identify the most suitable cost-effective options selected for mitigation actions. The marginal abatement costs are analysed for the selection of the most suitable TOs,. For the majority of RAC systems, the introduction of TOs will result in incremental upfront costs of not more than 10 %. Once the increased energy efficiency on the operation of the systems is also taken into account, climate-friendly technologies are on average 20-60 % cheaper than conventional systems. The marginal abatement costs per t CO_2eq avoided are negative, representing net savings (after the removal of barriers) for most systems.

Module 5: Mitigation Scenarios

Module 5 guides users in generating mitigation scenarios. Mitigation scenarios are developed on the basis of the projected number of systems per RAC&F sector with their respective BAU and emissions reduced. The BAU emissions are shown for standard systems. Mitigated emissions result from the penetration of TOs, which are selected by considering cost-effectiveness (EUR/t CO_2). Demonstrating different emission pathways and calculating the mitigation potential is a key element of NAMAs. The module includes a mitigation and cost tool that allows the calculation of the BAU and mitigation scenarios for specific appliances and various technical options. Additionally, the marginal abatement costs are provided for each technology option.

Module 6: Technology Roadmap

Module 6 supports policy makers in developing sector specific technology roadmaps for the RAC&F sectors as a strategic tool for planning and decision-making. The module contains milestones on a sector and subsector specific emission reduction pathway and provides goals to support regulatory, technology and market environments.

Country specific RAC&F emission pathways and emission reduction goals can be based on the recommendations of the global RAC&F roadmap developed by GIZ Proklima. This global roadmap suggests aligning national roadmaps with the national climate action plans and global emissions targets[3]. Accordingly, HFC based refrigerants and foam blowing agents may be phased out along with HCFC, and energy efficiencies continuously improved.

3 More specifically, it is recommended to take into account the 2°C target and the UN Sustainable Energy for All (SE4ALL) goals on energy efficiency and the penetration of renewable energies. Details on the SE4ALL objectives and specific target per area are available at http://www.sustainableenergyforall.org/objectives.

The technology enabling environment plays a crucial role in the introduction of the phase-down and phase-out of HFCs, the promotion of natural refrigerants and foam blowing agents as well as mandatory energy efficiency standards for RAC&F systems. Through the introduction of the appropriate technology enabling environment political decision makers can promote the introduction of safety standards for natural refrigerants, penetration targets for specific systems with supported R&D efforts and technology co-operation. Appropriate fee and rebate systems to provide incentives for the transformation of the stock and, in particular, to overcome the barrier of the higher initial investment costs of most TOs through lower operating costs can contribute to creating a favourable market environment for a climate-friendly technology.

Module 7: Sector Specific MRV

Module 7 outlines a measuring, reporting, verifying approach that is specific to the RAC&F sectors. The approach suggested is sufficiently stringent to meet the requirements of donors for supported NAMAs. The approach is aligned with the stock based inventory of the Tier 2 methodology developed by IPCC in 2006.

The MRV policy framework recommended for the RAC&F sectors includes

- Mandatory reporting on bulk HFC for imports, production and exports,
- Reporting on HFCs in pre-charged equipment imported and exported,
- Reporting of HFC distributors on HFC types provided to the various RAC&F subsectors, and
- Reporting on systems sold, imported, exported and produced with the collection of technical data on refrigerant and foam blowing charges and re-fillings, type and GWP of refrigerant and foam blowing system life spans, capacities, operation times and energy consumption.

Module 8: Policy and Financing Options Framework

Module 8 is divided in two sections and guides policy makers on policy and financing options for RAC&F NAMAs.

Module 8.1:

The policy tools recommended are based on a review of international best practices, in particular from the implementation and practical enforcement of the European F-Gas legislation. Furthermore, the tools recommended are aligned with the policy instruments of the Montreal Protocol addressing particularly the use of HCFCs in refrigeration and foam systems.

The suggested policy tools cover a range of different instruments (informative, legal, economic), including the introduction of

- Legal requirements and regulations on the use of systems, e.g. placing on the market, bans, leakage control measures, certification of servicing, safety standards, and recycling standards or definition of end-of-life status,
- Reporting requirements for users, importers, exporters and producers,
- Labelling of products, e.g. on the use of refrigerants and energy consumption, relevant both for importers and producers,
- Financial incentives or taxes.

Module 8.2:

Unilateral, supported and possible future credited NAMAs are analysed with a view to recommending financing tools. It is suggested that international financing for supported NAMAs be sought for higher ambition levels on mitigation beyond commonly adopted policies, standards and technologies.

The RAC&F sectors qualify for supported financing with ambitious and comprehensive sectoral targets for

- the phase-down of HFC based refrigerants,
- The introduction of new, natural refrigerant based technology options in combination with minimum energy efficiency standards, and
- Capacity building on supported enabling environments.

Supported financing particularly addresses the high incremental up-front investment costs of TOs.

Module 9: Implementation Plan

Module 9 contains a model implementation plan for RAC&F NAMAs. The model plan includes five elements:

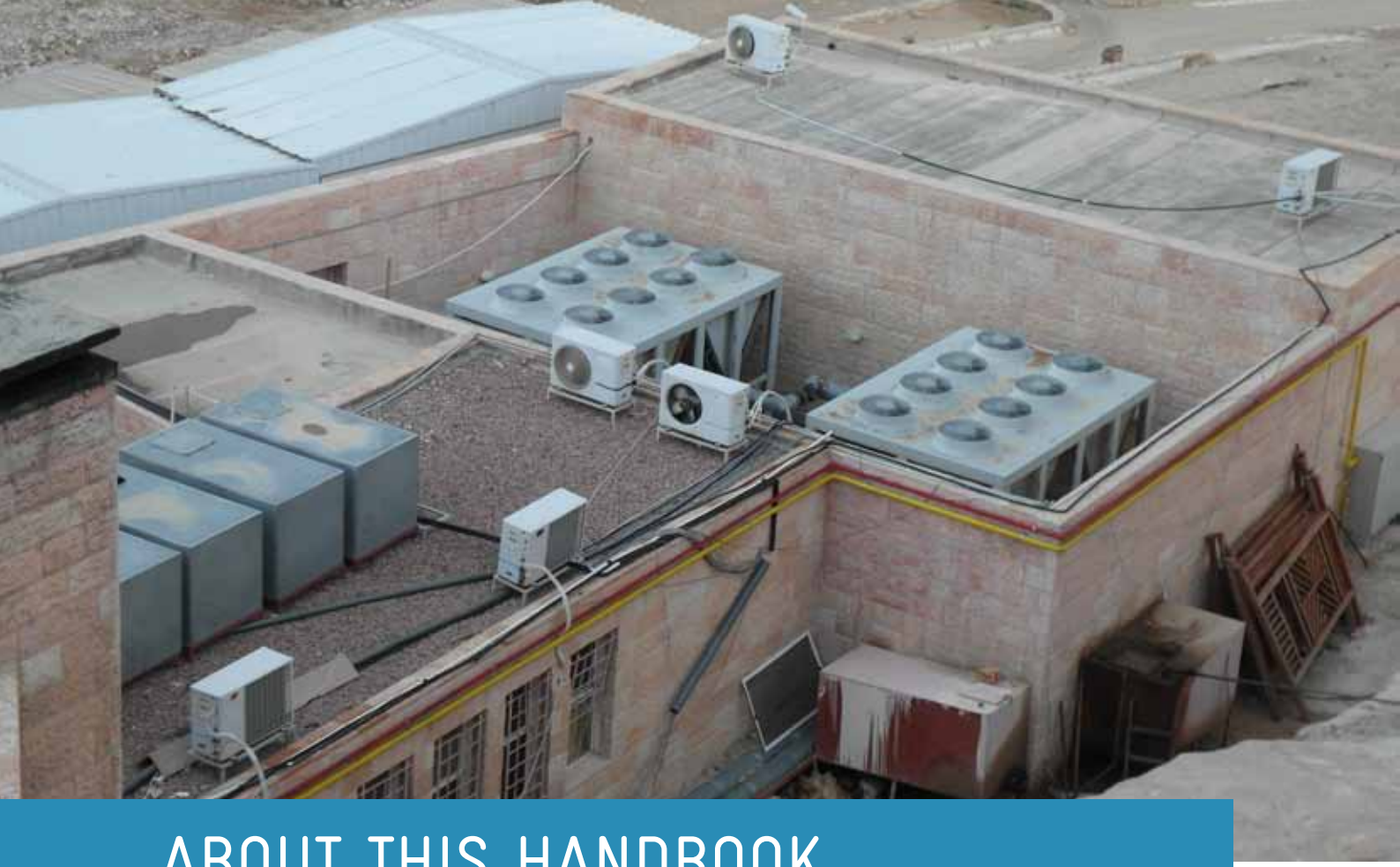
(1) A sectoral plan in order to establish a sound inventory basis, emission pathways and to identify the policy gaps and enabling environments necessary to overcome the major barriers to reaching the mitigation targets,
(2) Milestone based time framework, staged in different phases; within each NAMA phase specific tools are provided to define milestone plans, a result framework and annual working plans,
(3) Inter-ministerial based governance structure to set up an inter-ministerial steering group and to identify implementing institutions and relevant stakeholders,
(4) Funding and financing plan listing the requirements of the NAMA registry and donors on the minimum information to be provided for the NAMA financing plan,
(5) MRV system.

Module 10: Co-benefits for the NAMA Country

Module 10 provides an analytical framework and tools to estimate and illustrate the co-benefits for RAC&F NAMAs. Co-benefits are of major importance for the acceptance of a RAC&F NAMA, motivating and engaging stakeholders. Further, they are key elements in supporting sustainable development within a country.

The module highlights several co-benefits including:

(1) Environmental protection; e.g. improved waste management, improved energy supply,
(2) Economic development; e.g. economic growth, increased skills and competitiveness of companies,
(3) Social development; e.g. better education and employment, creation of jobs, better housing conditions and improved health services.



ABOUT THIS HANDBOOK

Objectives

To date this handbook is the only document that provides a comprehensive approach for NAMAs in the RAC&F sectors. This handbook has the **general objective** of promoting GHG mitigation actions on a sectoral level. It serves to support developing countries in the preparation and implementation of sectoral NAMAs.

As such, this handbook aims to generate a better understanding of the practical measures needed to promote and implement climate-friendly technologies in the RAC&F sector and to document their mitigation impact. Furthermore it aims at

- Raising awareness and providing information on the large mitigation potential in the RAC&F sectors and the need to take sector specific mitigation actions,
- Providing solid methodologies and practical tools tailor-made for designing RAC&F NAMAs in developing countries.

The **specific objectives** of this handbook are to

- Enable policy makers to set up a national F-gas inventory in accordance with the IPCC requirements,
- Deliver a methodology for cooling needs assessments to estimate future sectoral emissions,
- Help identify appropriate and cost-effective alternative technologies in the RAC&F sectors,
- Provide a methodology and tool for calculating mitigation scenarios,
- Support long-term strategic planning and benchmarking in mitigation actions,
- Provide guidelines to establish MRV systems,
- Explain possible effects of deploying policy instruments, including economic and regulatory instruments,
- Help establishing a solid implementation plan for a sector specific NAMA.

Addressees

This handbook was prepared to assist policy makers involved in designing mitigation actions related to the RAC&F sectors. The publication may also be of relevance for the various stakeholders involved in the preparation of NAMAs in the specific sectors, including industry, associations, NGOs and civil society.

Structure

This handbook is divided into ten modules, the ten main aspects of NAMAs in the RAC&F sectors. Each module addresses and guides the user in a step-by-step manner towards the implementation of applicable activities and the application of methodologies and tools.

All modules have an executive summary and are structured into three main parts:

(1) **introduction**, providing an introductory explanation of the specific aspects covered by the module
(2) **methodology**, containing a detailed explanation of the methodological approach for the specific application, including the discussion of different methodologies available,
(3) **practical application** representing a step-by-step guideline

In addition, the handbook includes several **country examples** to illustrate practical experiences and good practice. Reference is made to a number of tools which are provided together with this study. These tools complement the modules and provide helpful practical support to planning and conducting a sector specific RAC&F NAMA.

GIZ Proklima has acknowledged in its approach key methodological concepts of the GIZ Capacity Works framework (GIZ, 2011).

How to use this handbook

Working through all ten modules will give the user comprehensive guidance on how to design a NAMA in the RAC&F sectors. All modules contain cross-references to other modules. Every module is conceived as a stand-alone module and offers definitions, methodological insights, recommendations and examples.

RATIONALE FOR DEVELOPING NAMAS IN THE RAC&F SECTORS

Air conditioning keeps buildings cool. Cold chains ensure food and medical supply. It has become standard to have more than one refrigerator per household in many countries around the world: As demand for cooling rises worldwide, the market for refrigeration, air conditioning and insulation equipment expands rapidly. More cooling equipment, however, consumes more resources and causes substantial amounts of GHG emissions that are damaging the climate and the stratospheric ozone layer.

The handbook aims at aiding policy makers to develop Nationally Appropriate Mitigation Actions in the refrigeration, air conditioning and foam sectors. NAMAs in the RAC&F sectors address the limitation and mitigation of direct and indirect emissions: Direct emissions result from the use of refrigerants in cooling systems and foam blowing agents for insulation material. Indirect emissions mainly result from the energy consumption needed to power these systems. Energy is predominantly generated from fossil fuels with resulting carbon dioxide emissions.

The trend: Rising HFC emissions

The Montreal Protocol effectively controls the use of ozone depleting substances (ODS), such as refrigerants and foam blowing agents (Usinger and Kuijpers, 2008). The use of CFCs has been forbidden worldwide. HCFCs that were initially used as substitutes for CFCs will also be phased out in most developed countries[4] by 2030[5]. As a substitute, HFCs have been introduced in many applications. These substances have no ozone depleting potential (ODP) and are therefore not controlled under the Montreal Protocol. However, HFCs are highly potent greenhouse gases. As such they are included in the list of substances to be reported to the UNFCCC.

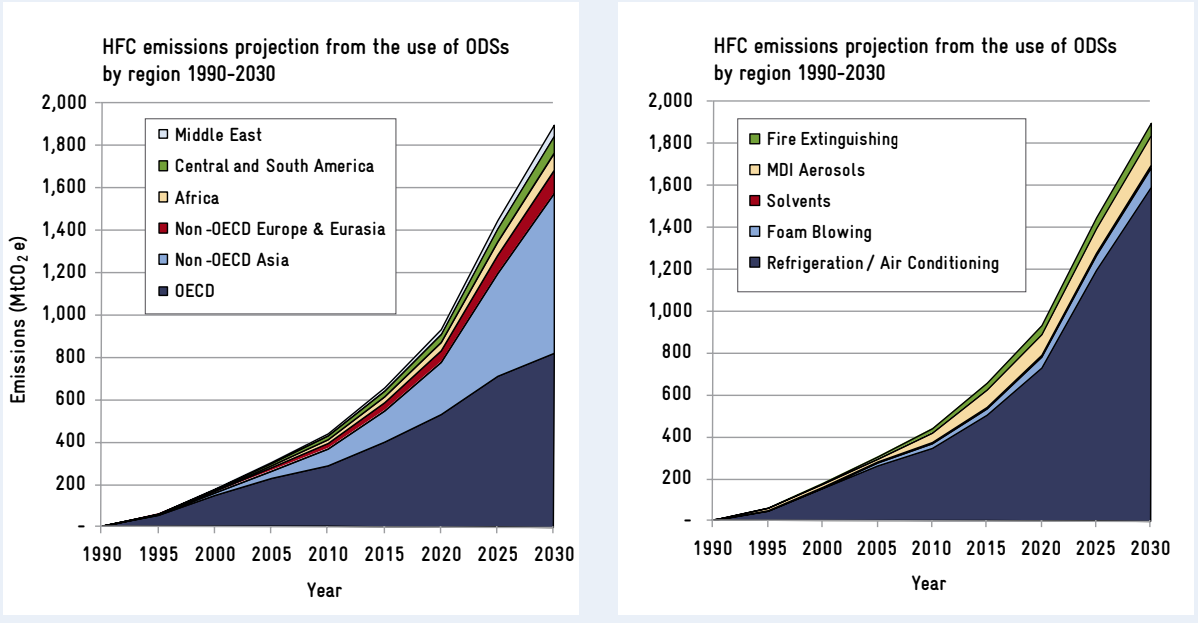
HFCs make up the dominant proportion of global GHG emissions from F-gases. They are mostly used in the RAC&F sectors. Apart from refrigeration, the use of blowing agents in foam is the second most important sector of HFC emissions. In addition, the production of HFC containing insulation foams is closely linked to the manufacturing process and efficiency of refrigeration equipment, buildings and cold stores.

Other F-gases include perfluorocarbons (PFC) and sulphur hexafluoride (SF_6) which are of minor relevance in the RAC&F sectors. **HFCs are the most important source of climate-damaging F-gas emissions and are therefore the focus of this handbook**.

HFCs are emitted during manufacturing, operation, servicing and from the disposal of waste equipment and refrigerant containers. HFCs used in the RAC&F sectors have exceptionally high global warming potentials (GWP) considering a 100 year time horizon. For example, HFC-134a, which is one of the most common HFCs, has a GWP of 1,430. This means that HFC-134a is 1,430 times as harmful to the climate as CO_2. An overview of the most commonly used refrigerants and blowing agents and their GWP and ODP values is given in Table A1 in the annex (cf. also IPCC/TEAP, 2005; IPCC, 2007).

According to the US Environmental Protection Agency (US EPA, 2011), global HFC-based emissions from ODS substitutes increased from around 60 Mt CO_2eq to ca. 310 Mt CO_2eq during the period from 1995 to 2005 (Figure 1). This growth is primarily driven by the transition to HFCs as substitutes for HCFCs in OECD nations, which accounted for three quarters of the 2005 emissions. Emissions in 2030 are projected to reach nearly 2 GT CO_2eq (Figure 1). Gschrey and Schwarz (2009) even predict emissions of 4 GT CO_2eq by 2050 under a business-as-usual scenario.**In the year 2050, the contribution of HFCs emissions in comparison to global CO_2 emissions is estimated at 45 % provided the 2°C target is met and all other GHG emissions are reduced. For a BAU scenario the HFC emissions would account for 9-19 %** (Velders et al., 2009).

FIGURE 1
HFC emissions projection by region and sector 1990–2030 (US EPA, 2011)



4 This handbook refers to developing and developed countries where the designations "developed" and "developing" do not necessarily imply a judgment on the state of the development process in a certain country. The designations avoid having to differentiate between the slightly differing classifications under the Montreal Protocol and the UNFCCC and are, therefore, used for the easier comprehension of this handbook.

5 A residual consumption of HCFCs will be allowed until 2040.

Figure 1 also illustrates the contribution of regions and sectors to the overall HFC emissions. **Apparently, refrigeration and air conditioning are the most important sectors** (Figure 1, right). The accelerated regional trend in emissions from non-OECD countries is driven by demand for RAC&F equipment in developing countries. Concurrently, a transition to low-GWP alternatives in OECD countries will reduce the share of OECD contributions to the overall HFC emissions (Figure 1, left). In contrast, non-OECD countries will play an increasingly important role (US EPA, 2011).

Emission reductions in the RAC&F sectors

Emission reductions in the RAC&F sectors can be achieved by replacing high-GWP refrigerants with low-GWP refrigerants and introducing energy efficiency measures to reduce energy consumption. An overview of refrigerants and their ODP and GWP classification is provided in Figure 2. Indirect emissions will also decrease with the decarbonisation of the energy supply. **Particularly the reduction of direct emissions through the use of natural refrigerants offers a significant environmental benefit and cost effective potential.**

Opportunities and challenges for policy makers

✓ Mitigation activities under the Clean Development Mechanism (CDM) of the Kyoto Protocol have been project-based emission reductions. Mitigation efforts under the Montreal Protocol focus on controlling the consumption of ODS without considering GHG emissions. **The concept of NAMAs is different in that it provides a more holistic approach, combining not only individual projects but also including sound policies most suited to the needs of individual sectors and countries.**

✓ **NAMAs in the RAC&F sectors enable national policy makers to actively support the enforcement process**. They pave the way for promoting investments in innovative technologies and a supporting technical framework that does not only rely on technical assistance to the industries but also sets demanding low carbon standards and benchmarks. Initially, hydrocarbons (HC) such as propane or isobutane and other climate-friendly alternatives to HCFCs and HFCs, were considered as valid options only for a certain and small number of appliances in the RAC&F sectors. However, the EU and national governments have fostered the progress of technologies based on natural refrigerants and low-GWP appliances in the market. Competition and the drive for green consumer products have supported the market shift to these alternatives.

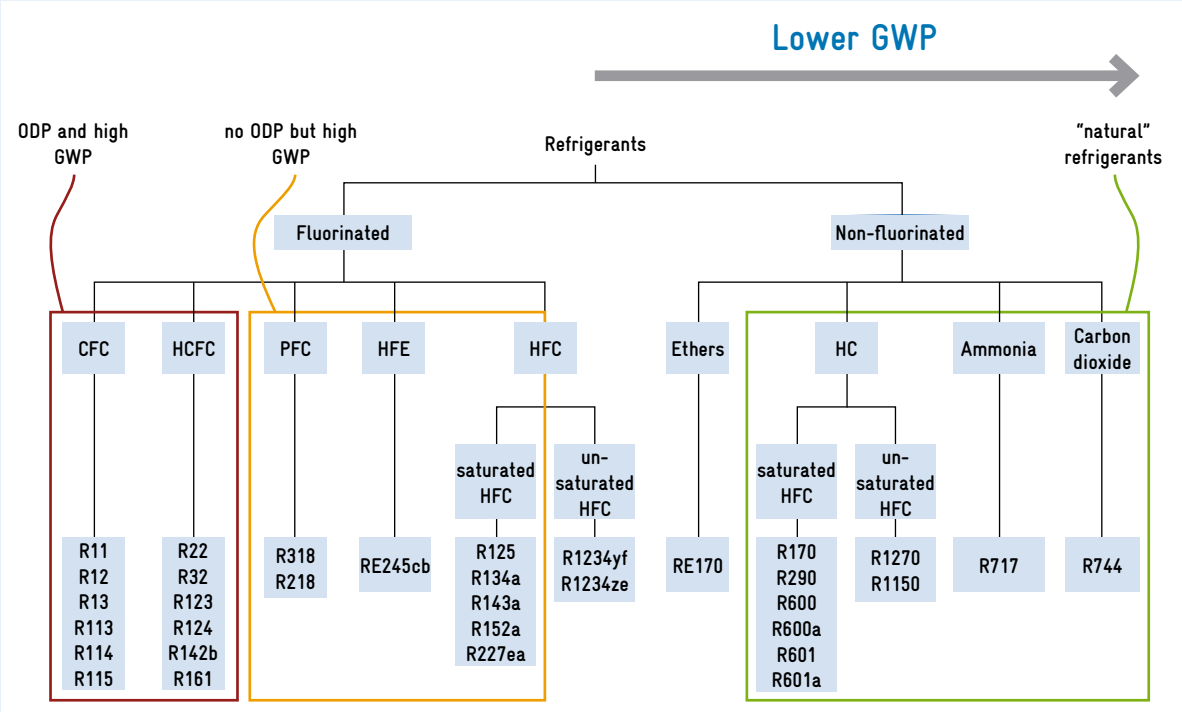
✓ Climate-friendly technology has also been adopted in some developing countries but a large potential for its implementation remains. **National governments and policy makers are in the position to enable a wider market penetration of low-GWP systems. International, regional and local governmental and non-governmental initiatives can further promote the transition process towards low-GWP alternatives**. As an example, member companies of the Consumer Goods Forum (CGF) have made a committment to phase out HFC refrigerants as of 2015 in their global operations.

✓ **Preconditions for NAMAs in the RAC&F sectors are a sound data basis and the examination of existing national policies as well as a Technology Needs Assessment (TNA)** (UNDP, 2010). Stakeholders should develop a NAMA plan and targets in the specific sector. Ideally, an overarching RAC&F NAMA plan includes the strategy for reducing ODS and GHG emissions, as well as a link to the current ongoing HCFC phase-out management plan (HPMP).

✓ **NAMAs should be in line with other existing plans or activities that aim at reducing emissions and enhancing sustainable development**. These strategic visions are also known as Low Carbon Development Strategies (LCDS); NAMAs should be part of a country's LCDS (see Box 1).

FIGURE 2
ODP and GWP classification of refrigerants

Source: Daniel Colbourne



BOX 1
LCDS and NAMA

A range of different names have been given to the idea of national development plans for mitigating and adapting to climate change. Among these are the LCDS and NAMA. There is no official definition, but both concepts have similar features.

The EU coined the terms Low Carbon Development Strategy (LCDS) or Low Emission Development Strategy (LEDS) in their submissions to the UNFCCC in 2008, within the context of a shared vision to ensure ambitious collective action on climate change (Clapp et al., 2010). The UNFCCC uses this terminology when encouraging developing countries to develop low-carbon development strategies or plans in the context of sustainable development (Cancun decision 1/CP.16, para 65).

A LCDS supports a country in its efforts to follow a development path that aims to achieve a low-carbon and climate-resilient economy and sustainable development. It contains both a long-term component that includes a strategic and comprehensive vision, and a short- or medium-term component that demonstrates the specific actions (Hermwille, 2011). In this context the LCDS shows similarities with the concept of NAMA.

The 2007 Bali Action Plan (BAP) coined the term NAMA, describing it as encompassing actions by developing countries to mitigate climate change, with or without financial or technical support from developed countries. In contrast to LCDS, NAMAs focus on specific sectors and the enhanced implementation of mitigation actions and sustainable development through a longer-term consideration of the supporting institutional and policy framework (UNIDO, 2009).

Some countries might lack the capacity to develop an LCDS, but can start with formulating NAMAs addressing specific sectors such as RAC&F, waste or agriculture, and later consider moving towards a more comprehensive LCDS. Therefore NAMAs may be considered as components of an overall low emission strategy plan and should be formulated in that way (GIZ, 2012; LCDS, 2010).

Benefits for countries

NAMAs offer the possibility for both mitigation actions and the pursuit of sustainable economic and social development in the countries (Van Asselt et al., 2010). A NAMA in the RAC&F sectors will bring economic and social benefits for the implementing countries. The main benefits that can be expected are the use of more economic, substantially less toxic refrigerants and energy savings through improved energy efficiencies of the appliances and products. **Natural refrigerants as alternative low-GWP refrigerants will not only generate immediate climate benefits but also avoid a double transition – from HCFCs to HFCs first, and then from HFCs to HFC-free refrigerants – and thus save huge investment and implementation costs in the long run**. Other benefits for the countries include less economic dependence on the import of licensed chemicals, reduced costs, and reduced toxic waste problems.

BOX 2
Benefits and co-benefits of RAC&F NAMAs for implementing countries

The implementation of NAMAs in the RAC&F sectors provides direct and indirect benefits for the implementing country. Economic, social and environmental benefits are created from both a short and long-term perspective, including

- ✓ ccost-efficient climate and ozone layer protection,
- ✓ international visibility and documentation of the country's efforts and achievements, including compliance with MRV standards,
- ✓ international financial and technical support for the preparation and implementation of mitigation actions,
- ✓ effective and sustainable transformation of the RAC&F sectors using low GWP refrigerants and avoiding a "double transformation" of systems,
- ✓ reduced expenditures and dependence on import of expensive F-gases,
- ✓ implementation of green and energy efficient technology and support for the development of energy supply,
- ✓ reduced and less harmful waste generation during production, operation, maintenance of systems,
- ✓ management of less hazardous waste is less cost-intensive and better for the environment, the potential for recycling is increased,
- ✓ establishment and institutionalisation of partner networks with different administrative levels, implementing authorities, industry, NGOs and civil society,
- ✓ capacity and institutional building,
- ✓ know-how transfer,
- ✓ influencing sustainable market development ("green growth") and creation of jobs,
- ✓ better food quality through improved management of cold chains,
- ✓ improved health and living conditions.

GIZ Proklima supports NAMA development in the RAC&F sectors

Commissioned by the German Federal Government, the GIZ programme Proklima[6] has successfully supported partner countries in implementing RAC&F sector projects since the mid-1990s, with partner countries in Africa, Asia, Latin America and the Caribbean. With over 240 projects in almost 40 countries and a total budget of about USD 30 million, the programme has contributed to an annual reduction of more than 10,000 tonnes of ODS. It has helped partner countries to comply with their reduction obligations particularly under the Montreal Protocol. Proklima's projects have also successfully reduced GHG emissions of over 100 million tonnes CO_2eq.

Proklima has implemented demonstration and pilot projects in nearly all relevant RAC&F subsectors globally. For example, the projects include the introduction of natural refrigerants in domestic and commercial refrigeration in Southern Africa, the production and conversion of domestic and commercial air-conditioning systems in Indonesia, China and India, foam technology demonstration and conversion projects and the introduction of a comprehensive refrigerator recycling programme in Brazil.

Proklima's integrated approach combines advice for policy and administration and support through capacity building and technology transfer. Proklima's experience provides a well-established foundation for NAMAs in the RAC&F sectors.

Further reading

Selection of GIZ Proklima publications:

GIZ (2012). Guidelines for the safe use of flammable blowing agents in the production of extruded polystyrene boards (XPS). A handbook for engineers, technicians, trainers and policy-makers – For a climate-friendly insulation. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

GIZ (2012). Guidelines for the safe use of flammable refrigerants in the production of room air-conditioners. A handbook for engineers, technicians, trainers and policy-makers – For a climate-friendly cooling. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

GIZ (2011). Production conversion of domestic refrigerators from halogenated to hydrocarbon refrigerants A guideline. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

GIZ (2011). Operation of split air conditioning systems with hydrocarbon refrigerant. A conversion guide for technicians, trainers and Engineers. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

GIZ (2010). Good practice in refrigeration. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

GIZ (2010). Guidelines for the safe use of hydrocarbon refrigerants. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

All GIZ Proklima publications are publically available online at: www.giz.de/Proklima

DEVELOPMENT OF NAMAS IN THE RAC&F SECTORS

With the conclusions of the Conferences of the Parties to the UNFCCC in Durban (COP17) and Doha (COP18), member states were requested to agree by 2015 on mitigation pledges and emission pathways to hold global temperature increase below 2°C and 1.5°C above pre-industrial levels. Such efforts will very likely require enhanced mitigation actions by all countries globally and in all sectors.

The main elements of a NAMA are explained in the following. They apply also to sector specific NAMAs and therefore have to be considered when developing a RAC&F NAMA.[7]

The UNFCCC NAMA context

Mitigation action by all nations was already outlined in Article 4 of the UNFCCC which was ratified by 195 nations and has been in effect since 1994. NAMAs are voluntary policies or activities to reduce greenhouse gas emissions that

- are appropriate for the specific implementing country, and
- recognise different capabilities and capacities of each country.

The concept was further developed during the course of the recent Conferences of the Parties (Table 2):

7 see also GIZ NAMA tool 8.6 Step 4 (GIZ, 2012b)



TABLE 2
COPs referring to mitigation action

COP	Main content related to NAMAs
13	Bali Action Plan: Mitigation action undertaken by both developed and developing countries; request to developed countries to support developing countries' mitigation actions with technology, financing and capacity building in a measurable, reportable and verifiable manner.
15	Copenhagen Accord: Request to all countries to submit NAMAs
16	Cancun Agreements: Set up of the institutional framework for NAMAs including the registry, NAMA reporting within National Communications, Measurement, Reporting and Verification (MRV) and International Consultations and Analysis (ICA)
17	Durban Platform: Further details on NAMAs in Biennial Reports (National Communications) and Prototype Registry to match action and support

The concept of NAMAs

The development of a NAMA is classified in three phases: the concept, proposal and implementation phases (cf. also GIZ, 2012a). The RAC&F NAMA approach is a technology-based approach, including all refrigeration, air conditioning and foam blowing applications and cross-cutting classical sectors including transport, buildings and industry.

NAMAs should include strategic, policy and action elements aiming to establish a frame for reducing emissions (Wang-Helmreich et al., 2011):

- The strategic elements include a comprehensive plan of measures based on market or regulatory strategies.
- The policy element describes NAMAs as government-led programmes intended to be included in national legislation. Policies support an enabling environment in which barriers can be removed and emissions reduced in the long term and in a sustainable way. National governments need to create these enabling environments that will allow cooling technologies to meet environmental criteria at the lowest cost. Policies need to address existing regulatory and technical barriers. Tailored to local circumstances, national roadmaps help to drive market expansion, advance system development and integration and enhance collaboration.
- The action element implies that NAMAs are policies, programmes and projects leading to direct emission reductions. Actions target shorter term emission reductions, with a clear target date such as the year 2020 or 2030. Actions include the scope and measures, for example, how many units of air conditioners are to be converted in specific projects.

In the RAC&F context both policies and actions aim at the reduction of direct emissions through the effective reduction of HFCs, and indirect emissions through improved energy efficiency including improvements on insulation. The increasing use of HFCs can be halted and possibly reversed in a country through a variety of practices and technical options that have been successfully proved in other places. A steadfast way to reduce emissions from energy production is the introduction of minimum efficiency rules by policy makers. This is usually supported by legislation, standards and labelling.

Emission reductions can be measured either against a baseline, i.e. emissions at a starting point and year or a reference period, or a BAU scenario which assumes future development without mitigation action. Emission reductions are measured, reported and verified within the MRV context. Countries are requested to report on NAMAs in their Biennial Update Reports (BURs) and in their National Communications[8]. BURs are subject to the International Consultation and Analysis (ICA) process of the UNFCCC. Within the BURs countries report on their progress and steps taken towards emission reductions.

Classification of NAMAs

The classification of NAMAs distinguishes between unilateral and supported NAMAs (Bakker and Würtenberger, 2010). Ideally, they are registered at the UNFCCC prototype registry, which was established in 2012, though this is not obligatory (cf. also Sterk, 2010; UNEP, 2010). **Unilateral NAMAs** are domestically funded and implemented. **Supported NAMAs** are implemented with the financial, technology and capacity building support of Annex-1 countries. The registration of NAMAs is a voluntary measure. Unilateral NAMAs can be registered for the purpose of recognition. Supported NAMAs can be registered for the purpose of seeking support. The main function of the registry is the matchmaking function between countries seeking financial support and donors (Table 3).

TABLE 3
Classification of NAMAs

NAMA type	Unilateral	Supported
Description	Domestically funded and implemented	Implemented with financial, technology and/or capacity building support from developed countries
Registry	Registered for the purpose of recognition	Registered for the purpose of seeking support

There is a third type of NAMA, the **credited NAMA**, which has been discussed but not adopted under the UNFCCC. Credited NAMAs are also being discussed under the New Market Mechanism (NMM) where mitigation actions can generate carbon credits for sale.

NAMA components and requirements

As yet, there are no strict NAMA requirements, either for the mitigation actions or for their co-benefits. They will most likely depend on individual cases and on the levels and types of actions that countries opt for. But any support for mitigation actions will entail certain requirements. Thus, whatever actions are undertaken they should demonstrate emission reductions and the means for justifying those reductions – being measurable, reportable and verifiable in the form of a MRV system.

8 Relevant guidelines/manuals related to NCs and BURs from non-Annex I Parties are available at: http://unfccc.int/national_reports/non-annex_i_natcom/guidelines_and_user_manual/items/2607.php

The MRV system is a key aspect of supported NAMAs. **A sound MRV system allows countries to get international recognition for their mitigation actions**. International support on the MRV system and expert advice on opportunities enhance actions for improvement and help the country with its implementation. Having accurate, up-to-date and credible information will provide countries with the basis to document the impact of their policies and identify areas for more targeted efforts.

Who drives the NAMA process?

The key actors to drive the NAMA process belong to a government entity. This entity will be accountable for the overall management, including financial and substantial elements of the implementation of the NAMA. Putting in place such a management structure requires the definition of roles and responsibilities of key government bodies.

The participation of relevant stakeholders is a key element. This involves the identification of all relevant stakeholders and the establishment of a stakeholder dialogue. As they will be affected by the NAMA, the stakeholders' engagement is crucial for its successful implementation. They should be consulted in all major steps and be informed about project status, progress and barriers at all times (Figure 3).

"For the government, having a fair and equal representation of all major stake-holders in the process of establishing a NAMA ensures the opportunity to identify, reflect and integrate supportive and opposing views into the NAMA development" UNFCCC (2012).

FIGURE 3
Involvement of stakeholders during the NAMA development and implementation process

Workplan

Part I: Inventory/Stakeholder Engagement	Step 1	Stakeholder (Industry) Engagement	Institutional development and stakeholder engagement
	Step 2	Establishment of Inventory	
Part II: Preparing NAMA Description Document (NAMA-DD)	Step 3	Defining Sector BAU and Mitigation Scenarios	
	Step 4	Identification of Subsectors for Mitigation Action	
	Step 5	Alternative Technologies + Barrier Removal	
	Step 6	Policy and Financing	
	Step 7	Roadmap	
	Step 8	Upload NAMA – DD for Registration	
Part III: NAMA Implementation	Step 9	Enabling implementation of measures	
	Step 10	NAMA support framework	
	Step 11	NAMA Progress and verification of emission reductions	

The active stakeholders are those who play an active role in implementation while secondary stakeholders are affected by, but not involved in, the NAMA activities. For the RAC&F sectors, active stakeholders include governmental bodies and the private sector.

On the governmental side, this may include the Ministry for Environment as NAMA focal point, the National Ozone Unit, Ministry for Industry, and others. The national environmental or energy agencies may also be relevant stakeholders. Private sector stakeholders may include industrial associations, key manufacturers, end-users of equipment, distributors, private banks and other businesses with relevant interests. Non-governmental organizations (NGOs) and civil society should also be included.

If the NAMA seeks international support, bilateral partners for development cooperation, banks and implementing agencies, need to be addressed as well. In order to attract donors, policy makers may upload an information note to the UNFCCC NAMA registry.

For project implementation and especially for data collection in the RAC&F sectors, it is important to involve local technical experts who are familiar with the sectors. Academia and research institutes have a generic interest in the subject and can contribute to the stakeholder dialogue. Therefore, it is not only recommendable to involve technical experts for information sharing purposes but also to establish networks to the industry sectors in order to collect data. A local organisation with good relations to industrial representatives as well as to relevant governmental authorities should manage and coordinate the stakeholder consultation process.

It is advisable to start national stakeholder consultations on a planned NAMA proposal in an early phase of the design and implementation plan. Later, consultations need to continue throughout the process to ensure stakeholders' participation and the acceptance of the NAMA.

UNEP Risoe Centre has compiled a NAMA Idea Note template (NINO)[9] to assist in communicating NAMA ideas to potential stakeholders.

Further reading

GIZ (2012a): National Appropriate Mitigation Actions – A Technical Assistance Source Book for Practitioners; Version 1.0. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH; http://www.adelphi.de/files/uploads/andere/pdf/application/pdf/nama_source_book.pdf

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ANNEX

Table A1 gives an overview of the commonly used refrigerants and blowing agents with global warming potential (GWP) and ozone depleting potential (ODP) values.

TABLE A1
GWP and ODP values of commonly used refrigerants and blowing agents in the RAC&F sectors

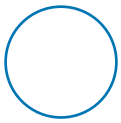
	Lifetime (years)	GWP for a given time horizon			ODP	Source
		20	100	500		
Blowing agents						
HFC-245fa	8	3 380	1 030	314	0	IPCC, 2007
HFC-365mcf	9	2 520	794	241	0	IPCC, 2007
HCFC-141b	9	2 250	725	220	0.11	IPCC, 2007
Cyclopentane, HC	0.44	***	<25	***	0	IPCC/TEAP, 2005
Methylal	***	***	<25	***	0	US EPA, 2010
Methyl Formate	***	***	<25	***	0	US EPA, 2010
HFO-1234ze	***	***	6	***	0	US EPA, 2010
Refrigerants						
R-32	5	2 330	675	205	0	IPCC, 2007
R-22	12	5 160	1 810	549	0.055	IPCC, 2007
R-134a	14	3 830	1 430	435	1	IPCC, 2007
R-1234yf	***	***	4	***	0	US EPA, 2010
R-1270	negligible	negligible	1.8	0	0	IPCC/TEAP, 2005
R-290	negligible	negligible	3.3	0	0	IPCC/TEAP, 2005
R-404a	***	6 010	3 922	1 328	0	Various
R-407a	***	4 358	2 107	655	0	Various
R-407c	***	4 115	1 774	548	0	Various
R-502	***	5 237	4 657	5 383	0.334	Various
R-507a	***	5 090	2 465	767	0	Various
R-600a	negligible	negligible	3	0	0	IPCC/TEAP, 2005
R-717	Few days	0	0	0	0	IPCC/TEAP, 2005
R-744	1	1	1	1	0	IPCC, 2007

***No available data

Overview of modules

Module	Focus	Practical tools*
Module 1: Inventory	• Methodologies and instruments for country-specific HFC emissions inventory (including direct emissions and indirect emissions from energy supply and energy consumption/energy efficiency) • Guidance on how to set up a national F-gas inventory according to IPCC Tier 2 stock based methodology	• Data Input Sheet (DIS-tool) • HFC Inventory and Projection Tool
Module 2: Cooling Needs Assessment	• Approach for the projection of future stock in RAC subsectors at country level based on key demand drivers and benchmarking figures	• Stock projection tool
Module 3: Technical Options	• Description of key technical options (guideline for comparative analysis), including the replacement of refrigerants or blowing agents, reduction of leakages and improvements of energy efficiency, • Indication of barriers, solutions and availability of TOs in various subsectors	
Module 4: Economic Assessment	• Assessing the economic impacts of technical options • Guidelines to identify the most suitable cost-effective options based on marginal abatement costing	• Mitigation and Cost tool
Module 5: Mitigation Scenarios	• Guidelines to set up emission scenarios including the business-as-usual (BAU) projection • Description on how the introduction of technical options is translated into emission reductions	• HFC Inventory & Projection Tool • Mitigation and Cost tool
Module 6: Technology Roadmap	• Guidelines on developing a technology roadmap for strategic planning and decision-making for a period of 10 to 20 years • Guideline on setting milestones and defining enabling environments	
Module 7: Sector Specific MRV	• Guidance on setting up a MRV system for a NAMA in the RAC&F sectors, compatible with UNFCCC definitions and guidelines	
Module 8: Policy and Financing Options Framework	Module 8.1: • Overview of political actions to enable or enforce NAMA measures in the RAC&F sectors • Guidelines on how to select appropriate policy measures to implement emission reduction targets • Best practice examples Module 8.2: • Introduction on the concept of unilateral, supported and credited NAMA in the RAC&F sector • Case studies	
Module 9: Implementation Plan	• Step-by-step guideline to design a NAMA implementation plan for the RAC&F sector particularly for Supported NAMA proposals	
Module 10: Co-benefits for the NAMA Country	• Identification and assessment of potential co-benefits of a NAMA in the RAC&F sectors	• Co-benefits tool

*All practical tools are available upon request.



All modules of this handbook and annexes are attached to this publication on a CD and additionally online available at www.giz.de/proklima.

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