Green Cooling in updated NDCs – Are we embarking on an ambitious path or a journey into a cooling crisis?

How to achieve more ambition with Green Cooling approaches

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Abbreviations

BAU	**Business as usual**
CFC	Chlorofluorocarbon
CO_2	Carbon dioxide
COP	Conference of the Parties to the UNFCCC
EE	Energy efficiency
GCI	Green Cooling Initiative
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GWP	Global warming potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
INDC	Intended nationally determined contribution
IPPU	Industrial processes and product use
MEPS	Minimum energy performance standards
MRV	Measuring, reporting and verification
NDC	Nationally determined contribution
RAC	Refrigeration and air conditioning
RTOC	Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee
TEAP	Technical and Economic Assessment Panel to the Montreal Protocol
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

1.2 The relevance of Green Cooling for achieving net zero

Green Cooling[1] plays an essential part in achieving a net zero greenhouse gas (GHG) transition and ensuring sustainable development. Climate change can affect regions that struggle with problems of energy demand and that are impacted by heat waves, making them more vulnerable and even unhabitable without cooling (IPCC 1998; Raymond et al. 2020). When wet bulb temperatures[2] exceed 35°C for a prolonged period, the life of millions of people without proper access to cooling is at risk (Raymond et al. 2020, graphically brought into fiction by Robinson 2020). According to Sustainable Energy for All, more than one billion people across 54 countries are vulnerable due to a lack of access to cooling (Gross et al. 2021). At the same time, without a shift to sustainable technical solutions, the growth in cooling demand will lead to a significant increase in emissions over the next decades, especially in sub-tropical and tropical developing countries (IEA 2018). Developed countries aiming to reach net zero emissions by 2050 without Green Cooling solutions are likely to take up to eight years longer to reach those targets (EIU 2020).

The cooling sector is increasingly contributing to direct and indirect GHG emissions by using climate-harming refrigerants, such as hydrofluorocarbons (HFCs), and consuming electricity based on fossil fuels (GIZ 2021). In 2017, direct (refrigerant-related) emissions plus indirect (energy-related) emissions accounted for 3.8 $GtCO_2e$ of GHG emissions worldwide and 2.7 Gt CO_2e in developing countries (GCI 2017). Under a business as usual (BAU) scenario, the sector is expected to reach 13% of global emissions by 2030 (GIZ 2021; Gross et al. 2021). The phase-out of hydrochlorofluorocarbons (HCFCs) under the Montreal Protocol on Substances that Deplete the Ozone Layer and the gradual phase-down of HFCs under its Kigali Amendment offer opportunities to adopt energy-efficient and climate-friendly solutions, such as the application of sustainable cooling equipment that uses natural refrigerants (GIZ 2021; EIA 2021). The successful mitigation of emissions from refrigerants alone could reduce the increase of temperatures by up to 0.4ºC by 2100 (Gross et al. 2021). Additionally, the implementation of efficient cooling appliances can accelerate the transition to net zero at a lower cost. According to an assessment carried out by Dreyfus et al. (2020), the introduction and utilisation of best available energy-efficient refrigeration and air conditioning (RAC) equipment can cumulatively avoid emissions of about 150-280 $GtCO_2e$ by 2060. Significant cost savings (investment and operating costs) of almost

[1] Green Cooling technology is defined as application or building which uses natural refrigerants (e.g. propane, isobutane, ammonia, CO_2) in combination with high energy efficiency (GCI 2021).

[2] Wet bulb temperature determines the heat and humidity in the air and reflects how the combination of both factors affects the human body. If the wet bulb temperature is higher than that of the human body, then the body is unable to cool down, leading to death (Anders 2021).

USD3 trillion could be achieved by 2050 just by increasing the efficiency of air conditioning systems by an average of 50% (IEA 2018). Therefore, the integration of measures targeting Green Cooling technologies, including passive cooling solutions, in updated nationally determined contributions (NDCs), particularly in developing countries with hot climates, plays an essential role in the pathway to sustainable cooling systems and a net zero future (EIU 2020).

1.2 Objectives and expected outcomes of the assessment of (updated) NDCs

The objective of the analysis is to assess INDCs, respectively first NDCs in the case that the INDC has been changed, and updated NDCs that were officially submitted in the context of the United Nations Framework Convention on Climate Change (UNFCCC) to identify whether countries' mitigation pledges for the cooling sector have changed and even increased. Therefore, the analysis seeks to

- give an overview of the current state of inclusion of the cooling sector in updated NDCs;
- provide a comparison between the initial targets of the INDCs/first NDCs and revised targets of updated NDCs and
- draw a link to the Kigali Amendment by identifying the approach of baseline setting in updated NDCs ("Is the Kigali Amendment baseline/schedule considered as NDC baseline?").

2. The cooling sector and its two challenges: F-gases and energy efficiency

Green Cooling is based on two main approaches to reduce GHG emissions: the replacement of hydrofluorocarbons (HFC) and their preceding halogenated gases (ozone depleting substances (ODS) such as chlorofluorocarbons (CFC) and HCFCs) with natural refrigerants that have zero or an ultra-low global warming potential (GWP)[3], and the use of highly efficient RAC appliances and buildings. The first approach addresses direct GHG emissions, whereas the second one targets indirect emissions stemming from electricity consumption. Replacing HFC is quite effective in terms of GHG mitigation since they are up to 14,800 times more harmful than CO_2 and constitute around 33% of total RAC emissions. Natural refrigerants, such as propane, isobutane, CO_2, and ammonia, are considered a future proven climate and environmentally friendly alternative for HFC and ODS. It is equally important to develop and promote the use of energy-efficient cooling appliances since two thirds of the emissions from the cooling sector are related to energy consumption (GIZ 2015).

There are various measures that are crucial to prepare for the inclusion of RAC sector mitigation measures in (revised) NDCs. First or all, countries are advised to develop a comprehensive understanding of the current and projected future GHG emission levels stemming from the RAC sector in the form of a sectoral GHG inventory which includes both direct and indirect emissions. This helps to identify suitable technology options and roadmaps which are needed to define GHG mitigation scenarios, action plans and ultimately RAC NDC targets. A well-established measurement, reporting and verification (MRV) process facilitates the tracking of NDC implementation in the RAC sector (GIZ 2016).

So far, several countries have committed to reducing cooling emissions either in their enhanced NDCs or long-term plans. Some countries, such as Ghana (First NDC) and Jordan (First NDC), have taken it a step further and addressed cooling emissions by including mitigation actions particularly in the RAC sector. These countries are setting an example stressing that the cooling sector must be addressed to achieve the long-term goal of the Paris Agreement and limit temperature increase to 1.5°C.

Further, an increasing number of countries have progressed with regard to GHG mitigation policies and instruments in the cooling sector. Table **1** provides an overview of such measures.

[3] The Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC) and Technical and Economic Assessment Panel (TEAP) to the Montreal Protocol define ultra-low or negligible GWP as lower than 30 (classification of 100-year GWP levels; see RTOC 2014 and TEAP 2016). Natural refrigerants are considered the most sustainable and climate-friendly solution, as most of them have a GWP value of 3 or less.

Table 1: Overview of GHG mitigation policies and instruments in the cooling sector

	Overarching and combined approaches (energy and HFC-related emissions)	Energy-related emissions/ measures	HFC-related emissions/ measures
1) RAC sector inventories, strategies, and action plans	– National Cooling Action Plans/Strategies – Control, monitoring and data collection	– Energy efficiency programmes covering the RAC sector	– Accelerated HFC/ODS reductions
2) Policies and standards	– Building codes/standards	– Minimum Energy Performance Standard (MEPS) and labelling – Replacement subsidies	– Safety standards (equipment and buildings) – Levy and tax system related to GWP levels – Ban on high-GWP refrigerants
3) Technologies	– Passive cooling technologies – District-level cooling – Servicing, replacement, and disposal programmes	– Renewable energy-powered cooling systems/appliances – Production of more energy-efficient appliances	– Servicing and maintenance initiatives – Development of value chain for alternative zero or ultra-low GWP technology/refrigerants – Design/installation of cooling systems using natural refrigerants
4) Awareness and capacities	– Awareness building measures, such as (nation-wide) awareness campaigns and knowledge exchange	– Awareness building measures, such as (nation-wide) awareness campaigns and knowledge exchange	– Awareness building measures, such as (nation-wide) awareness campaigns and knowledge exchange – Enhancement of skills and capacities/training of technicians and custom officials

Source: authors based on GIZ 2016, K-CEP 2021

However, despite these examples, the cooling sector remains underestimated and is often not considered in NDCs, or at least not in detail. Not many countries have mentioned emissions from the RAC sector and even fewer how to address them. In the run-up to the Conference of the Parties to the UNFCCC (COP 26), several countries have revised their climate pledges. This is an opportunity for countries to raise their ambition by benefiting from examples that show success and the potential to reduce emissions in the cooling sector.

3. Assessment of the integration of the cooling sector in (updated) NDCs

3.1 Methodology and approach of the assessment

The assessment and comparison of INDCs, respectively first NDCs, and NDCs was carried out by screening all documents submitted to and published by the UNFCCC. For the screening, a list of relevant keywords (see Annex 2) related to the cooling sector was created and the specific questions of the analysis were defined and applied throughout the screening. The results were processed in a comparative analysis focusing on the following criteria:

- HFCs are covered;
- RAC sector is included in i) separate chapter, ii) under IPPU sector, iii) under energy sector, iv) in IPPU sector and energy sector, or v) elsewhere;
- Specific energy and/or HFC measures are included;
- Baseline has changed and the Kigali baseline is considered in the updated NDC.

3.2 Results of the assessment

The assessment comprises 192 first NDCs and 120 updated NDCs which had been submitted by 13.10.2021. It must be noted that these figures include the NDC of the European Union (EU) with its 27 member states (respectively 28 in 2015 when the first NDC was submitted). The EU and its member states submitted a joint document which is counted as one NDC for each member state.

Regarding the availability of updated NDCs, it needs to be stressed that, so far, 63% (120 of 192) of the Parties presented their enhanced commitments to the UNFCCC. We therefore used two different approaches to assess the current status of the integration of the cooling sector and correlated the figures with i) the NDCs submitted so far as well as with ii) the total number of NDCs (including the NDCs still to be submitted). The following table presents the results of the analysis.

Table 2: Overview of the results of the assessment of first and updated NDCs

	INDCs/first NDCs		Updated NDCs		
	No.	**% of total**	**No.**	**% of NDCs submitted[4]**	**% of total[5]**
Total	**192**		**120**		
HFCs included					
yes	84	*44%*	88	*73%*	*46%*
no	108	*56%*	32	*27%*	*17%*
not submitted yet			72		*38%*
RAC sector mentioned					
elsewhere	13	*7%*	46	*38%*	*24%*
no	156	*81%*	39	*33%*	*20%*
separate chapter	1	*1%*	2	*2%*	*1%*
under energy sector	17	*9%*	16	*13%*	*8%*
under IPPU and energy sector	1	*1%*	3	*3%*	*2%*
under IPPU sector	4	*2%*	14	*12%*	*7%*
not submitted yet			72		*38%*
HFC mitigation measures for RAC sector included					
yes	12	*6%*	56	*47%*	*29%*
no	180	*94%*	64	*53%*	*33%*
not submitted yet			72		*38%*
Energy efficiency measures for RAC sector included					
yes	23	*12%*	33	*27.5%*	*17%*
no	169	*88%*	87	*72.5%*	*45%*
not submitted yet			72		*38%*

Source: authors

In the next section the results will be discussed and interpreted with a specific focus on the objectives listed under chapter 0. For the comparison of results, we looked at the respective number of NDCs in relation to the NDCs submitted so far (i.e. not correlated with the total numbers of NDCs).

Table 3 in annex 1 provides an overview of the countries that included the RAC sector in their NDCs.

[4] by 13.10.2021

[5] 192 NDCs in total

3.3 Interpretation and discussion of the results

The comparative analysis of first and updated NDCs clearly shows that there is a significant upwards trend in the coverage of HFCs. Three quarters of the submitted updated NDCs include HFCs in the scope of gases covered (in relation to 120 NDCs submitted by 13.10.2021), whereas in the first round of NDCs, not even half of the Parties considered HFCs to be part of their climate targets (see Figure 1 and Figure 2).

Figure 1: HFCs included in first NDCs

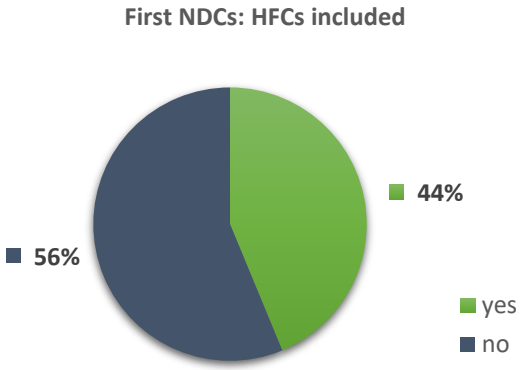
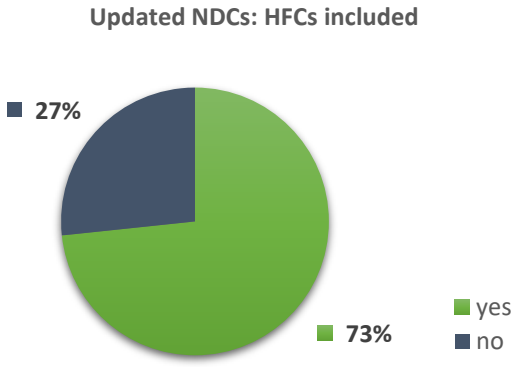


Figure 2: HFCs included in updated NDCs



Source: authors

In addition, there seems to be a stronger tendency to address the RAC sector in different ways in updated NDCs. Whereas under the first NDCs only 19% of the Parties included or at least mentioned the RAC sector in their national climate targets, the enhanced commitments give the impression that the cooling sector gained importance with regard to the emission reduction potential. Thus, out of the 120 updated NDCs analysed about two thirds (68%) integrated the RAC sector in different forms into their national targets. 38% of the NDCs mention the cooling sector without attributing it to a specific sector. With regard to the anchoring under a specific sector, many Parties integrate the RAC sector under the energy sector (13%), closely followed by the industrial (IPPU) sector (12%). Especially the latter, i.e. the integration of the RAC sector under the IPPU sector increased from 4 to 14 NDCs. In addition, two Parties dedicated a separate section of the NDC to the cooling sector.

Concerning the incorporation of particular mitigation measures focusing on direct (HFC-related) emissions, a remarkable development can be observed (see Figure 3 and Figure 4). Here, the number of NDCs that list HFC-related measures for the cooling sector, being it at a rather general level or concrete actions, rose from 12 to 56. However, it must be said that about half of the 56 revised targets that define HFC mitigation actions relate to EU member states who are pursuing a common goal

through the introduction of the EU F-gas regulation.[6] Consequently, if the EU NDC is excluded, this is equivalent to a rise from 12 to 29.

Figure 3: HFC mitigation measures in first NDCs

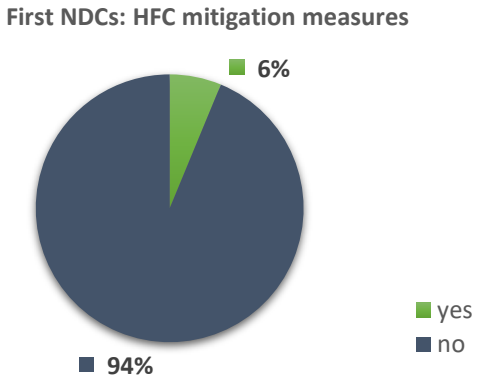
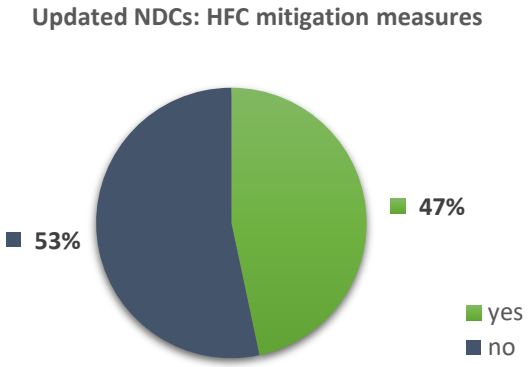


Figure 4: HFC mitigation measures in updated NDCs



Source: authors

For emission reduction measures targeting the energy efficiency (EE) of cooling equipment, the increase was not as steep. In their enhanced targets, only ten further Parties (33 compared to 23 in the first NDCs) list plans or measures to reduce indirect (energy-related) emissions by improving the energy efficiency of cooling equipment (see figures below).

Figure 5: EE mitigation measures in first NDCs

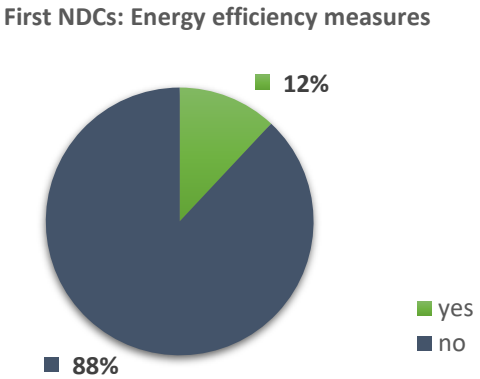
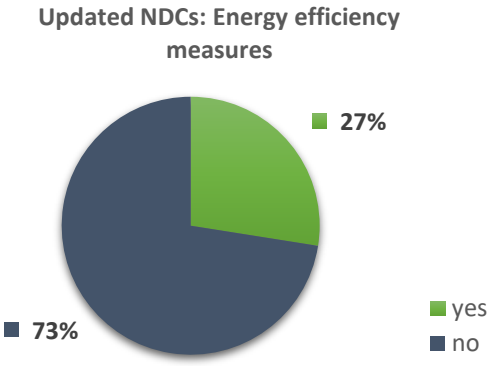


Figure 6: EE mitigation measures in updated NDCs



Source: authors

[6] Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006

As mentioned before, the level of detail and quantification of the mitigation potential for both HFC and energy-related emissions vary to a large extent between the different revised NDCs. For instance, there is rather a small number of countries that have in place specific measures, plans or strategies, including quantified targets. Amongst those is Cambodia that foresees to tackle emissions of the RAC sector by implementing an entire repertoire of policy, demonstration and capacity-building measures including a National Cooling Action Plan (Government of Cambodia 2020). Other notable examples for the inclusion of National or Urban Cooling Action Plans are Jordan, Pakistan and Vietnam (K-CEP 2021).

Lastly, almost half the countries (52; 43%) mention the HFC phase-down according to the Kigali Amendment in their enhanced NDC. Again, this includes the EU NDC with the 27 Member States. Most of these NDCs consider complying with the Kigali schedule as a contribution to the achievement of their mitigation targets. It often remains unclear against which baseline the emission reduction is calculated or will be accounted for. Nevertheless, there are at least two Parties, namely the Seychelles and Namibia, that show outstanding ambition by setting the baseline of their HFC mitigation measures in line with the HFC phase-down schedule as mandated by the Kigali Amendment. The NDC of the Seychelles and Namibia as best practice examples for the integration of the cooling sector are examined in more detail in the next chapter.

4. Best practices for the inclusion of the cooling sector in enhanced NDCs

In the context of the Green Cooling Initiative (GCI) project, GIZ Proklima supported several countries in including the contribution of the cooling sector in their NDC update processes. Amongst those were Ghana, Kenya, Namibia, and the Seychelles. In the following, we take a closer look at the NDCs of the Seychelles and Namibia and draw conclusions from the update processes in the supported countries.

4.1 Seychelles

The Seychelles submitted their first NDC in 2016 and a revised version in 2021. The country is committed to reducing absolute GHG emissions in all sectors of the economy by 293.8 $ktCO_2e$ by 2030. This represents an overall reduction of 26.4% compared to BAU. By operationalising the mitigation measures included in the different sectors, the country strives to achieve a net zero emissions economy by 2050. This shall be mainly accomplished by boosting electricity generation from renewable energies (RE), shifting progressively to low-carbon transport, and securing a sustainable and resilient water management system, among other measures.

One of the key sectors covered in the NDC is the RAC sector which was given its own section in the mitigation component. Overall, the total accumulated mitigation potential of the RAC sector is estimated to be 77 $ktCO_2e$ by 2030. Direct emissions are expected to be reduced by a cumulated 24 $ktCO_2e$ for the period between 2021 and 2030, whereas for indirect emissions the cumulated emission reduction potential is estimated at 53 $ktCO_2e$ by 2030. The government stated that an additional mitigation potential can be achieved through leapfrogging towards cooling appliances that use natural refrigerants.

The emissions stemming from the use of cooling equipment shall be addressed by implementing policies that promote energy-efficient and climate-friendly solutions, along with skill enhancement programmes for RAC technicians (with a special focus on natural refrigerants). In this context, the Seychelles identified three prioritised sub-sectors in the RAC sector which account for a major share of emissions: split air conditioners (ACs), domestic refrigerators, and stand-alone refrigerators for commercial operation.

The main strategies and policy instruments presented by the Seychelles in its updated NDC to achieve the mitigation targets in the cooling sector are:

- Transformation of all sub-sectors towards energy-efficient and climate-friendly appliances;
- Implementation and enforcement of regulations to promote the transition towards low-GWP refrigerants through a staggered levy system and VAT exemptions;

- Banning high-GWP refrigerants for domestic and commercial refrigerators from 2025 and for split ACs from 2030;
- Introduction of MEPS and labels to tackle emissions from electricity consumption and introduction of skill development programmes for RAC technicians in compliance with relevant regulatory measures (Republic of Seychelles 2021).

Text box 1: The cooling sector in the Seychelles' updated NDC at a glance

Cooling Sector in Seychelles' updated NDC

✓ Separate section for the RAC sector

Quantified targets:

Direct emission reductions: 6.2 $ktCO_2e$ in 2030 = 27.6 % reduction

Indirect emission reductions: 19.9 $ktCO_2e$ in 2030 = 6.5 % reduction

Prioritised sub-sectors:

Split air conditioners (split ACs)

Domestic refrigerators

Stand-alone refrigerators (commercial refrigeration)

Mitigation measures target the transformation of these sub-sectors towards energy-efficient and climate-friendly appliances:

- Regulations which incentivize the transition to low-GWP refrigerants through
  - a staggered levy system
  - VAT exemptions (both in effect since February 2021)
  - a ban on high-GWP refrigerants starting in 2025 (domestic and commercial refrigerators) and 2030 (split ACs)
- MEPS and labels
- Skills enhancement programmes for RAC technicians and custom officials

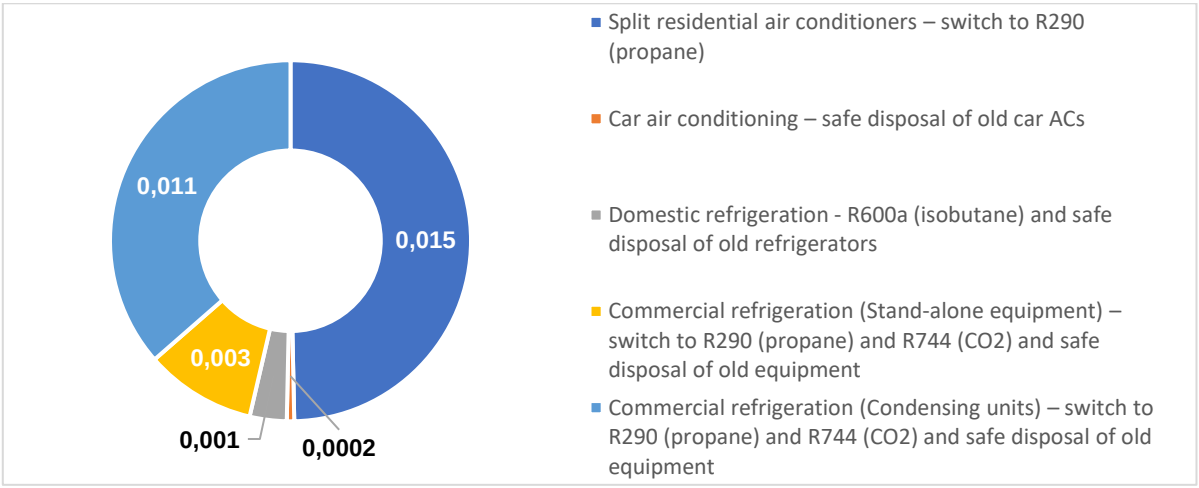
Total accumulated mitigation potential (direct and indirect emissions):
77 $ktCO_2e$ for the period until 2030

4.2 Namibia

Namibia submitted its first NDC in 2016 and an updated version in 2021. The country aims to reduce its GHG emissions by 22 $MtCO_2e$ (reduction of 91%) by 2030 compared to the BAU scenario. The IPPU sector, which covers the RAC sector, represents 0.6% of the total mitigation potential. The updated NDC of Namibia considers the cooling sector as an essential part of the country´s mitigation pledge, including direct and indirect emission reductions. The latter are expected to be achieved by introducing climate-friendly refrigeration and air conditioning equipment.

As part of the direct emission reductions, Namibia aims at implementing early actions to phase-down HFC gases replacing them with climate-friendly alternatives, low-GWP technologies, and natural refrigerants, in particular. For the reduction of both refrigerant- and energy-related emissions, the main instrument will be the introduction of regulations and standards. Concrete measures comprise the banning of high-GWP equipment and the introduction of MEPS that can generate indirect emission reductions. This is combined with the training of technicians on adequate handling and servicing of low-GWP refrigerants. It is estimated that these measures lead to a penetration of 60% climate-friendly and energy-efficient air conditioners and refrigerators for residential and commercial use by 2030. The expected mitigation potential of HFC emissions is estimated at 0.031 $MtCO_2e$ by 2030, with an additional emission reduction potential of 0.048 $MtCO_2e$ for energy efficiency-related mitigation measures (Republic of Namibia 2021).

Figure 7: Distribution of estimated GHG mitigation potential of RAC measures (in $MtCO_2e$)



Source: authors, based on Republic of Namibia 2021

Text box 2: The cooling sector in Namibia's updated NDC at a glance

Cooling Sector in Namibia's updated NDC

✓ RAC sector included in the IPPU sector

Quantified targets:

Direct emission reductions: 0.031 $MtCO_2e$ in 2030

Additional mitigation potential of EE measures: 0.048 $MtCO_2e$ in 2030

Prioritised sub-sectors:

Split ACs: switch to propane (0.015 $MtCO_2e$)

Domestic refrigerators: switch to isobutane and safe disposal of old refrigerators (0.001 $MtCO_2e$)

Stand-alone refrigerators (commercial refrigeration): switch to propane and CO_2 and safe disposal of old equipment (0.003 $MtCO_2e$)

Condensing units (commercial refrigeration): switch to propane and CO_2 and safe disposal of old equipment (0.011 $MtCO_2e$)

Car ACs: safe disposal of old car ACs (0.0002 $MtCO_2e$)

Introduction of climate-friendly and energy-efficient appliances through

Ban on high-GWP refrigerants

MEPS

Training of technicians on the proper handling of low-GWP refrigerants

The measures aim to achieve a penetration of 60% climate-friendly and energy-efficient residential air conditioners, as well as domestic & commercial refrigeration units by 2030.

Source: Republic of Namibia 2021

Supporting the aforementioned countries in their NDC update processes and, in particular, in the integration of the cooling sector entailed some important insights and lessons. Key success factors for the effective incorporation of the cooling sector range from the development of a profound data basis to the design of holistic mitigation approaches which reflect the linkages with other sectors. Thus, key elements and success factors which supported the mainstreaming of the RAC sector and related actions in the updated NDCs can be summarised as follows:

- A profound and solid data basis in the form of a sectoral GHG inventory provided necessary data and helped to identify the most relevant sub-sectors and applications in the cooling sector;
- A forward-looking and timely planning with regard to long-term goals and strategies in the sector allowed to include policy instruments that are already being discussed, accepted or even in place (e.g. levy system and VAT exemptions) and;
- A holistic approach which considers both energy- and refrigerant-related emissions combined with an integrated coordination process of the NDC that involved all relevant stakeholders allowed to anchor the sector as a separate part of the mitigation component.

5. Conclusions and recommendations

The assessment and comparative analysis of the coverage of the cooling sector in INDCs, respectively first NDCs, and updated NDCs revealed that:

1. Many countries have recognised the importance of HFCs and, to some extent, the cooling sector in the context of their climate targets. Almost 75% of submitted updated NDCs include HFCs in the scope of gases covered by their commitments.
2. More than half of the enhanced NDCs submitted to date mention the cooling sector in some way and the countries handle its integration in different ways. For example, the sector is almost equally assigned to the energy sector, the IPPU sector or both.
3. Still few countries present detailed plans and measures including holistic mitigation approaches that address both HFCs and energy-related emissions as well as quantified targets in their climate objectives.
4. However, there are several good practice examples that serve as helpful orientation when integrating the cooling sector in enhanced NDCs.
5. The alignment of mitigation targets under the Paris Agreement and the Kigali Amendment and the question of how to establish the baseline in a way that reflects both regimes is (still) not addressed by most countries in their NDCs.

Consequently, for a successful incorporation of the cooling sector and corresponding mitigation measures countries are recommended to:

- Develop integrated approaches and long-term strategies for the cooling sector which factor in the obligations under the Kigali Amendment and ideally enhance ambition by additional or accelerated action in terms of emissions stemming from both refrigerant and energy use;
- Build a solid data base, such as a detailed RAC sector GHG inventory, which can serve as a starting point for the above-mentioned approaches and strategies;
- Consider how the identified plans and measures are linked to other sectors such as the energy sector, for instance, and start in a timely manner to develop generally accepted mitigation policy instruments with the respective responsible (governmental) actors, and
- Try to position the cooling sector well from the beginning of the update process so that its relevance becomes clear to all key stakeholders and that key stakeholder groups can jointly reflect on where the sector is best integrated.

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Annex 1

Table 3**:** Overview of the countries that included the RAC sector in their updated NDCs (2020/2021)

Country	HFCs included	RAC sector mentioned	HFC mitigation activities for RAC sector included	Energy efficiency measures for RAC sector included	KA mentioned
Andorra	yes	no	no	no	no
Angola	no	no	no	no	no
Antigua and Barbuda	yes	elsewhere	no	no	no
Argentina	yes	under energy sector	no	no	yes
Armenia	yes	elsewhere	yes	no	yes
Australia	yes	no	no	no	no
Austria*	yes	elsewhere	yes	no	yes
Bangladesh	yes	under energy sector	no	no	no
Barbados	yes	under energy sector	yes	yes	yes
Belgium*	yes	elsewhere	yes	no	yes
Belize	no	under IPPU sector	no	no	no
Bhutan	no	no	no	no	yes
Bosnia and Herzegovina	yes	elsewhere	no	yes	no
Brazil	yes	no	no	no	no
Bulgaria*	yes	elsewhere	yes	no	yes
Cabo Verde	yes	elsewhere	no	yes	no
Cambodia	yes	separate chapter	yes	yes	yes
Canada	yes	under energy sector	no	yes	no
Chile	yes	no	no	no	yes
Colombia	yes	under IPPU and energy sector	yes	yes	yes
Congo	yes	under energy sector	no	yes	no
Costa Rica	yes	under energy sector	no	yes	yes
Croatia*	yes	elsewhere	yes	no	yes
Cuba	no	no	no	no	no
Cyprus*	yes	elsewhere	yes	no	yes
Czechia*	yes	elsewhere	yes	no	yes
Democratic People's Republic of Korea	no	no	no	no	no
Denmark*	yes	elsewhere	yes	no	yes
Dominican Republic	yes	under energy sector	yes	yes	yes
Estonia*	yes	elsewhere	yes	no	yes
Ethiopia	no	no	no	no	no
European Union	yes	elsewhere	yes	no	yes
Fiji	yes	no	no	no	no
Finland*	yes	elsewhere	yes	no	yes

Country	HFCs included	RAC sector mentioned	HFC mitigation activities for RAC sector included	Energy efficiency measures for RAC sector included	KA mentioned
France*	yes	elsewhere	yes	no	yes
Gambia	yes	under IPPU sector	yes	no	no
Georgia	yes	no	no	no	no
Germany*	yes	elsewhere	yes	no	yes
Greece*	yes	elsewhere	yes	no	yes
Grenada	yes	under IPPU sector	no	no	yes
Guinea	no	no	no	no	no
Honduras	yes	elsewhere	no	no	no
Hungary*	yes	elsewhere	yes	no	yes
Iceland	yes	no	no	no	no
Indonesia	no	no	no	no	no
Ireland*	yes	elsewhere	yes	no	yes
Italy*	yes	elsewhere	yes	no	yes
Jamaica	yes	no	no	no	no
Japan	yes	under IPPU sector	yes	yes	no
Kenya	yes	no	no	no	no
Lao People's Democratic Republic	yes	no	no	no	no
Latvia*	yes	elsewhere	yes	no	no
Lebanon	yes	elsewhere	yes	yes	no
Liberia	yes	under IPPU sector	yes	yes	no
Lithuania*	yes	elsewhere	yes	no	yes
Luxembourg*	yes	elsewhere	yes	no	yes
Malawi	no	elsewhere	no	no	no
Malaysia	yes	no	no	no	no
Maldives	no	no	no	no	no
Mali	no	elsewhere	no	no	no
Malta*	yes	elsewhere	yes	no	no
Marshall Islands	no	under energy sector	no	yes	no
Mauritius	yes	under IPPU sector	yes	no	yes
Mexico	yes	elsewhere	yes	no	yes
Monaco	yes	elsewhere	yes	no	no
Mongolia	yes	no	no	no	no
Montenegro	yes	under energy sector	yes	yes	yes
Morocco	yes	elsewhere	yes	yes	yes
Myanmar	no	under energy sector	no	yes	no
Namibia	yes	under IPPU sector	yes	yes	yes
Nepal	no	no	no	no	no
Netherlands*	yes	elsewhere	yes	no	yes
New Zealand	yes	no	no	no	no

Country	HFCs included	RAC sector mentioned	HFC mitigation activities for RAC sector included	Energy efficiency measures for RAC sector included	KA mentioned
Nicaragua	no	under IPPU sector	yes	no	yes
Nigeria	yes	under energy sector	yes	yes	yes
Norway	yes	no	no	no	no
Oman	no	under energy sector	no	yes	no
Panama	yes	under energy sector	yes	yes	yes
Papua New Guinea	yes	under energy sector	no	yes	no
Paraguay	yes	under IPPU sector	yes	yes	yes
Peru	yes	no	no	no	no
Poland	yes	elsewhere	yes	no	yes
Portugal	yes	elsewhere	yes	no	yes
Qatar	no	elsewhere	no	yes	no
Republic of Korea	yes	no	no	no	no
Republic of Moldova	yes	elsewhere	no	yes	no
Romania	yes	elsewhere	yes	no	yes
Rwanda	yes	under IPPU sector	yes	no	yes
Saint Lucia	no	elsewhere	no	yes	no
Samoa	no	no	no	no	no
Sao Tome and Principe	no	no	no	no	no
Seychelles	yes	separate chapter	yes	yes	yes
Sierra Leone	yes	under IPPU sector	yes	no	yes
Singapore	yes	no	no	no	no
Slovakia	yes	elsewhere	yes	no	yes
Slovenia	yes	elsewhere	yes	no	yes
Solomon Islands	no	no	no	no	no
Somalia	no	elsewhere	no	no	no
South Africa	yes	no	no	no	no
South Sudan	no	under IPPU sector	no	yes	no
Spain	yes	elsewhere	yes	no	yes
Sri Lanka	no	elsewhere	no	yes	no
State of Palestine	no	under IPPU sector	no	no	no
Sudan	no	no	no	no	no
Suriname	no	no	no	no	no
Sweden	yes	elsewhere	yes	no	yes
Switzerland	yes	no	no	no	no
Thailand	yes	no	no	no	no
The Republic of North Macedonia	yes	elsewhere	no	no	no
Tonga	no	under energy sector	no	yes	yes
Tunisia	yes	under IPPU and energy sector	yes	yes	yes
Ukraine	yes	no	yes	no	no

Country	HFCs included	RAC sector mentioned	HFC mitigation activities for RAC sector included	Energy efficiency measures for RAC sector included	KA mentioned
United Arab Emirates	no	under energy sector	no	yes	no
United Kingdom	yes	elsewhere	yes	yes	yes
United Republic of Tanzania	no	no	no	no	no
United States of America	yes	no	yes	no	no
Vanuatu	no	no	no	no	no
Viet Nam	yes	under IPPU and energy sector	yes	yes	no
Zambia	no	no	no	no	no
Zimbabwe	yes	under IPPU sector	yes	no	yes

Annex 2

Table 4: Overview of keywords used for the screening of INDCs, first NDCs and updated NDCs

	RAC sector mentioned	HFC mitigation activities for RAC sector included	Energy efficiency measures for RAC sector included	Baseline changed (KA baseline considered)
ENG	- (climate-friendly) cooling - RAC - refrigeration - refrigerant - HFC - HCFC	- air conditioning/AC - space cooling - refrigerator(s) - freezer(s) - cold chain - cold room	- Energy efficiency - Minimum energy performance standards - MEPS - (Energy) labelling	- Montreal Protocol - Kigali Amendment - Kigali Amendment baseline - Kigali schedule - HFC phase-down
FR	- refroidissement (respectueux du climat) - climatisation - réfrigérant - HFC - HCFC	- AC - réfrigérateur - congélateur - chaîne du froid - chambre froide	- Efficacité énergétique - Normes minimales de performance énergétique - MEPS - Étiquetage (énergétique)	- Protocole de Montréal - Amendement de Kigali - Base de référence de l'amendement de Kigali - Calendrier de Kigali - Réduction des HFC
SP	- refrigeración (respetuosa con el clima) - RAC - refrigeración - refrigerante - HFC - HCFC	- aire acondicionado/ AC - refrigeración de espacios - frigorífico(s) - congelador(es) - cadena de frío - cámara frigorífica	- Eficiencia energética - Normas mínimas de rendimiento energético - MEPS - Etiquetado (energético)	- Protocolo de Montreal - Enmienda de Kigali - Línea de base de la Enmienda de Kigali - Horario de Kigali - Eliminación de los HFC

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