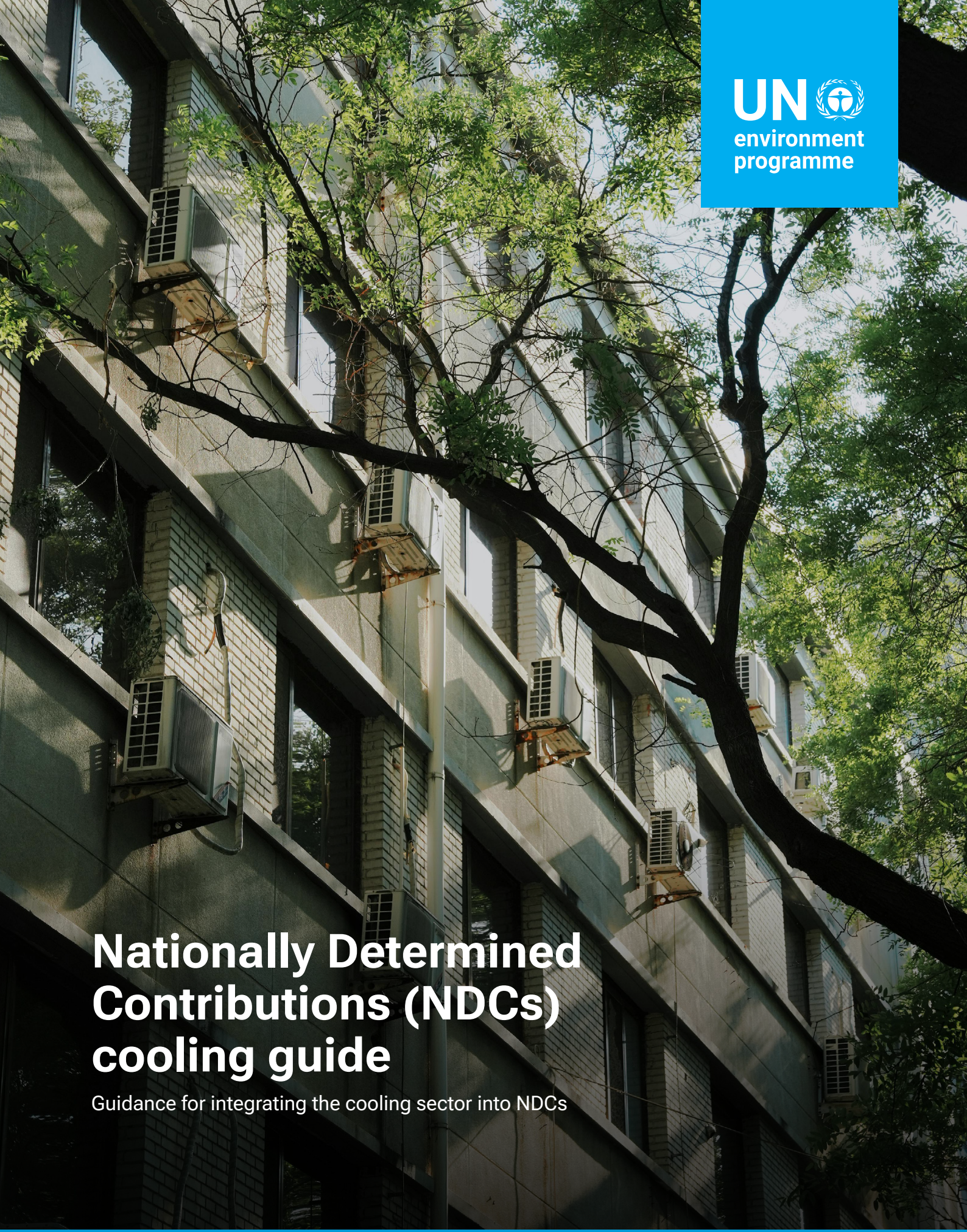

UN environment programme

Nationally Determined Contributions (NDCs) cooling guide

Guidance for integrating the cooling sector into NDCs

Cool Coalition

a UNEP convened initiative

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Executive summary

Cooling represents a critical and often-underestimated challenge in the global response to climate change. Currently responsible for seven per cent of global greenhouse gas emissions, the cooling sector's emissions are projected to double by 2050 if left unchecked. Compounding this issue, 1.1 billion people worldwide lack access to life-saving cooling, exacerbating risks to public health, food security and economic stability in the face of rising global temperatures. The impacts of inadequate cooling are also not gender-neutral; women, especially in low-income and rural communities, face distinct challenges and vulnerabilities that must be addressed. Addressing this dual challenge – reducing emissions while expanding access – requires the urgent and effective integration of sustainable cooling measures into Nationally Determined Contributions (NDCs) and national climate strategies.

Sustainable cooling offers a powerful dual benefit: mitigating climate change while enhancing resilience. The transition to energy-efficient technologies, adoption of low-global warming potential refrigerants and implementation of passive cooling strategies could reduce cooling-related emissions by up to 60 per cent by 2050. Simultaneously, expanding access to sustainable cooling protects vulnerable populations, including from the dangers of extreme heat, minimizes food loss by up to 30 per cent, and strengthens healthcare systems through reliable cold chains. To maximize impact, integrating gender-responsive approaches into cooling strategies is crucial for ensuring equitable access and enhancing resilience.

This guide provides a six-stage methodology to facilitate the integration of sustainable cooling into NDCs. It outlines a process that begins with defining baselines for both hydrofluorocarbons (HFCs) and energy-related emissions and progresses to setting sector-specific targets aligned with broader national climate goals. The guide emphasizes the importance of developing a National Cooling Action Plan (NCAP) as the basis for NDC integration, establishing the data base and an implementation plan. Priority is given to key policies such as Minimum Energy Performance Standards – aligned with the United Nations Environment Programme United for Efficiency's Model Regulation Guidelines, urban greening initiatives and the phase-down of refrigerants in accordance with the Kigali Amendment. It also stresses the importance of establishing cross-ministerial governance structures to foster collaboration across the energy, health and agriculture sectors, alongside the development of robust monitoring, reporting and verification systems. Progress should be tracked using indicators such as CO_2 equivalent reductions and improvements in cooling access rates.

The guide provides country case studies that share their strategies. Nigeria, for example, integrated its NCAP into its NDCs, focusing on heat-resilient infrastructure and expanding energy access in rural areas. Grenada is working towards becoming the first HFC-free nation through initiatives focused on technician training and refrigerant recycling. The United Arab Emirates has embedded cooling considerations across multiple sectors, prioritizing district cooling and energy-efficient air conditioning to reduce emissions. These examples demonstrate the potential for context-specific strategies, supported by strong stakeholder collaboration, to achieve significant and measurable outcomes.

This NDC cooling guide is essential for prioritizing cooling within NCAPs. It urges countries to adopt measurable cooling targets and strengthen cross-sector governance. By transforming cooling from a growing climate liability into a cornerstone of low-carbon development, countries can deliver substantial health, economic and climate benefits for their most vulnerable communities, turning a global challenge into an opportunity for equitable resilience.

Table of contents

List of tables and figures

Tables

Figures

Abbreviations

BTR	Biennial Transparency Report
CCAC	Climate and Clean Air Coalition
CO_2eq	CO_2 equivalent
ETF	Enhanced Transparency Framework
DSM	Demand Side Management
GHG	greenhouse gas
GIZ	German Society for International Cooperation
GWP	global warming potential
HFC	hydrofluorocarbon
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IRENA	International Renewable Energy Agency
K-CEP	Kigali Cooling Efficiency Program
KIP	Kigali Implementation Plan
MEPS	Minimum Energy Performance Standards
MLF	Multilateral Fund for the Implementation of the Montreal Protocol
MRV	monitoring, reporting and verification
NAMA	Nationally Appropriate Mitigation Action
NCAP	National Cooling Action Plan
NDC	Nationally Determined Contribution
NIR	National Inventory Report
NOU	National Ozone Unit
ODS	ozone depleting substance
PRS	Product Registration System
RAC	refrigeration and air conditioning
SDGs	Sustainable Development Goals
SEforALL	Sustainable Energy for All
SMART	specific, measurable, achievable, relevant and time bound
UHIE	urban heat island effect
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization

1 Unlocking the cooling sector's potential: A pathway to climate action leadership

As countries update their Nationally Determined Contributions (NDCs) by 2025 (also known as NDCs 3.0), a critical yet often overlooked sector demands urgent attention: cooling. While essential for human well-being and economic development, cooling systems are significant contributors to greenhouse gas (GHG) emissions both from the use of electricity to run cooling equipment and from refrigerant gases that are potent GHGs. But there are solutions that can reduce cooling-related emissions significantly. Technological innovations, nature-based solutions, passive cooling strategies and rapid grid decarbonization can even make a net zero future in this sector possible!

As highlighted in the United Nations Secretary-General's Call to Action on Extreme Heat (2024), rising global temperatures are exacerbating heat-related risks for millions of people worldwide, with vulnerable populations in urban and rural areas facing the most severe impacts. Cooling is no longer a luxury; it has become a life-saving service in the face of the escalating climate crisis. By integrating sustainable cooling strategies into NDCs, countries take an important step towards mitigating emissions from energy-intensive cooling systems and contributing to adaptation efforts by protecting populations from the health and economic consequences of extreme heat.

This guide provides actionable frameworks that enable countries to develop resilient cooling solutions, particularly for the most vulnerable communities. It assists policymakers in prioritizing the integration of mitigation and adaptation strategies in the cooling sector into their NDCs.

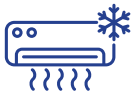
In other words, this guide is for you if:

- You are a policymaker seeking to understand the interconnections between climate action and cooling across sectors like buildings, agriculture and health. Recognizing these linkages can help update and strengthen NDCs, aligning them with broader development goals.
- You are seeking strategies and ways to enhance your country's climate ambition.
- You aim to address cooling, a rapidly growing source of emissions, in your country.
- You aim to align your national climate policies with international commitments under the Montreal Protocol on Substances that Deplete the Ozone Layer and its Kigali Amendment, the 2023 Global Cooling Pledge and the United Arab Emirates Consensus.
- You are interested in fostering innovation and securing economic and social co-benefits through climate action.

KEY STATS

7% of global GHG emissions

come from cooling, with projections showing this could double by 2050 without intervention (United Nations Environment Programme [UNEP] 2023).



The use of air conditioners and electric fans to stay cool is responsible for nearly

20% of the total electricity

used in buildings around the world today (International Energy Agency [IEA] 2018)

In hot regions like Southeast Asia or the Middle East, this number can be much higher, e.g.

over 50% in a typical building

in the United Arab Emirates (International Renewable Energy Agency [IRENA] 2019).

Purpose of this guide

This guide provides practical steps to integrate cooling strategies into NDCs, focusing on methodologies for assessing cooling emissions and case studies of successful NDC integration. While guidance on suitable policies and their prioritization is already provided in a wealth of publications, this guide focuses on the methodology needed to incorporate cooling sector targets into NDCs.

The following sections will delve into:

- insights for policymakers on the importance of integrating cooling into NDCs
- methodologies for assessing and projecting cooling sector emissions (Chapter 2)
- case studies and a blueprint for integration of cooling in NDCs (Chapter 2).

1.1 Cooling: A growing climate challenge

The relationship between cooling and climate change presents a complex challenge. As global temperatures rise due to GHG emissions, the demand for cooling technologies increases. However, these very technologies contribute to further warming through both direct emissions of potent GHGs contained within refrigerants and indirect emissions from energy consumption. This feedback loop threatens to accelerate climate change unless decisive action is taken. The fact that when cooling technologies are not efficient or climate-friendly, they exacerbate climate change and, thus, create the need for even more cooling, has been referred to as the "vicious cooling cycle" (Villeneuve 2024).

According to the International Energy Agency, the cooling sector accounts for about 20 per cent of global electricity consumption (IEA 2018). It already represents approximately seven per cent of global GHG emissions (Kigali Cooling Efficiency Program [K-CEP] *et al*. 2021). In hot regions like the Middle East, cooling can account for over 50 per cent of the electricity demand of a building (IRENA 2019).

The authors of the *Global Cooling Watch 2023* report project that the installed capacity of cooling equipment globally will triple by 2050 (UNEP 2023). This growth would increase emissions from such equipment to 6.1 billion tons of CO_2eq per year – equivalent to more than 10 per cent of global projected emissions in 2050 under current policies (UNEP 2023). Emissions stem not only from energy consumption (indirect emissions) but also from the release of climate-harmful, fluorinated substances (so-called F-gases, mostly hydrofluorocarbons [HFCs]) used as refrigerants in cooling applications.

In addition to energy and climate change, access to cooling is closely linked to several Sustainable Development Goals (SDGs), as shown below. The challenge lies in meeting these needs and expanding access to cooling while simultaneously minimizing the environmental and climate impacts of the sector.

This highlights the importance of implementing sustainable cooling strategies.

- **SDG 1.** Sustainable cooling enables economic growth for those in poverty
- **SDG 2.** Cooling reduces food waste and increases the nutritional value of food that reaches people
- **SDG 3.** Cooling reduces heat stress and improves sleep, increasing physical and mental well-being
- **SDG 4.** Cool schools improve learning outcomes and reduce fatigue
- **SDG 5.** Cool cities, buildings and homes support equal opportunities for women and men
- **SDG 7.** Sustainable cooling reduces energy use and peak demand while enabling more reliable energy access
- **SDG 8.** Cooling increases worker productivity and increases profits
- **SDG 10.** Cool cities, cold chains and public institutions reduce inequalities based on gender, wealth or location
- **SDG 11.** Cool cities support urban populations by improving their health and productivity
- **SDG 12.** Sustainable cooling promotes responsible consumption and production patterns by improving energy efficiency, reducing reliance on climate-warming refrigerants, encouraging the reuse of refrigerants and minimizing food waste
- **SDG 13.** Sustainable cooling emits no or minimal energy-related and refrigerant emissions

> ### Expanding access to cooling while limiting the growth of CO_2 emissions?
>
> Analysis by CLASP found that doubling the efficiency of new air conditioners globally would increase access by a factor of six while constraining emissions growth to doubling in key markets like India, Indonesia and Nigeria (Boucher *et al*. 2024).

1.1.1 International climate policy and the cooling imperative

The Paris Agreement, adopted in 2015, set the ambitious goal of limiting global temperature rise to well below 2°C, preferably 1.5°C, compared to pre-industrial levels. Achieving this target requires rapid and deep reductions in GHG emissions across all sectors, including cooling. The agreement's mechanism of NDCs, laid out in Article 4, provides a critical framework for countries to outline their climate mitigation and adaptation plans. Besides updating NDCs every five years, all countries should formulate their long-term low-GHG emission development strategies (United Nations Framework Convention on Climate Change 2015).

Building on this foundation, the Global Cooling Pledge, launched at COP28 in 2023, represents a significant step forward in addressing cooling-related emissions. Signatories commit to work together with the aim of reducing cooling-related emissions by at least 68 per cent compared to 2022 levels by 2050 (UNEP and Cool Coalition 2023). It emphasizes the importance of sustainable cooling solutions, including passive cooling strategies, energy efficiency improvements and the management of refrigerants for the transition to low-global warming potential (GWP) refrigerants and emission reduction. From a different perspective, passive cooling strategies are also included in the United Nations Framework Convention on Climate Change (UNFCCC) Enhanced Lima Work Programme on Gender and its Gender Action Plan, which calls on countries to undertake gender-responsive climate actions. For example, ensuring that public spaces with passive cooling features are accessible and safe for women can enhance their comfort and well-being. Additionally, integrating gender-specific needs into urban greening initiatives can help address the unique vulnerabilities of women to extreme heat. Thus, countries can integrate gender-responsive passive cooling strategies into their NDCs.

The COP28 conference saw a groundbreaking commitment to triple global renewable energy capacity and double the rate of energy efficiency improvements by 2030, communicated as the United Arab Emirates' Consensus. These targets have profound implications for the cooling industry, which is a major consumer of electricity. Enhanced efficiency in the cooling sector can be a game changer for achieving the energy efficiency target.

In addition to the Paris Agreement, the Kigali Amendment to the Montreal Protocol plays a crucial role in global climate efforts by mandating the phasedown of HFCs. Countries that have ratified the Kigali Amendment (163 parties as of April 2025) are committed to specific timelines and targets for reducing HFC consumption and production. It is recommended that these phase-down plans must be reflected within countries' NDCs and low-carbon strategies to ensure consistency.

1.1.2 The critical role of NDCs in addressing cooling emissions

NDCs are the cornerstone of global climate action under the Paris Agreement. They represent each country's efforts to reduce national emissions and adapt to the impacts of climate change. The 2025 NDC update for the period 2026–2031 presents a crucial opportunity for countries to enhance their climate ambition and address key sectors that may have been overlooked in previous iterations.

Integrating comprehensive cooling strategies into NDCs can yield significant benefits:

- Increased ambition: Many countries have yet to fully account for cooling sector emissions in their NDCs. By doing so, they can substantially increase their overall mitigation targets.
- Holistic approach: Addressing cooling allows countries to tackle both direct emissions from refrigerants and indirect emissions from energy use, providing a more comprehensive climate strategy. At the same time, it supports increased access to cooling as well as resilience and adaptation.
- Better understanding of baselines, targets and financing needs: Collaboration amongst climate and energy policymakers and National Ozone Units (NOUs) increases knowledge, improves reporting of HFCs and

> **On a national level, the mitigation potential varies but is consistently significant. For example:**
>
> "The opportunity exists to reduce emissions from the cooling sector by a total of 129 million tons of CO_2eq by 2040," concludes Indonesia's National Cooling Action Plan (NCAP) (Indonesia, Ministry of Energy and Mineral Resources 2024).
>
> The European Union's F-gas regulations, which address refrigerants, are projected to cut emissions by 310 million tons of CO_2eq by 2050 (European Commission 2024; European Union 2024).
>
> Kenya's NCAP found that implementing stringent efficiency standards and low-GWP refrigerants could save cumulatively 23 million tons of CO_2eq by 2050 (Kenya, Ministry of Environment Climate Change and Forestry 2023) — approximately 25 per cent of Kenya's current annual GHG emissions.
>
> If India implemented Minimum Energy Performance Standards (MEPS) for room air conditioners and residential and commercial refrigeration, the country could save almost 97 TWh of electricity annually by 2040, which equals almost 118 million tons of CO_2eq (United for Efficiency 2022) — equivalent to Algeria's annual electricity consumption. Find this and more MEPS country assessments here.

cooling sector-related emissions from energy, and fosters specific target setting. Understanding and defining the scope also helps signal the financing needs to meet the country's climate ambitions.
- Multiple co-benefits: Sustainable cooling solutions offer numerous advantages beyond emissions reduction, including improved energy security, reduced air pollution and enhanced resilience to heat waves as adaptation co-benefits.
- Economic opportunities: Investing in efficient, climate-friendly cooling technologies can drive innovation, create jobs and reduce long-term energy costs.

1.1.3 Mitigation potential of the cooling sector

The potential for emissions reduction in the cooling sector is substantial. According to the *Global Cooling Watch 2023* report, implementing best practices in cooling could reduce 2050 GHG emissions from the sector by 60 per cent in 2050 compared to business-as-usual projections. Key measures include enhancing energy efficiency, accelerating the phase-down of HFCs and other potent GHGs used in cooling systems, and promoting passive cooling. This amounts to around 3.8 billion tons of CO_2eq emissions avoided annually. Combined with rapid electricity grid decarbonization, a 96 per cent reduction in cooling-related emissions is in reach by 2050 (UNEP 2023).

1.1.4 Adaptation potential of the cooling sector

Previously a blind spot, action on extreme heat and delivering sustainable and equitable cooling is increasingly recognized as a key mitigation and adaptation issue. Any cooling sector strategy must balance emission reduction goals with the fundamental need for thermal comfort and protection from extreme heat, especially as global temperatures continue to rise.

The NDCs 3.0 represent an opportunity to align national development policies with climate commitments. According to Sustainable Energy for All (SEforALL) Chilling Prospects analysis, 1.12 billion people living in high-temperature countries and regions were at high risk due to a lack of access to cooling in 2023. This includes 306 million rural poor who lack electricity and live in extreme poverty, often engaging in subsistence farming without access to intact cold chains, and 815 million urban poor with limited or no electricity access, living in thermally poor housing and facing intermittent electricity supplies.

Parties to the Paris Agreement are encouraged to increase the adoption of passive and nature-based cooling strategies across cities, buildings and cold chains, helping communities adapt to rising temperatures and extreme heat. Strengthening accessible cold chains for agriculture and healthcare is vital for safeguarding food security and public health, especially during heat waves. Adaptation measures must reach those most at risk from the impacts of climate change. Therefore, ensuring access to necessary cooling – regardless of socioeconomic status, geographic location or other factors, and particularly for vulnerable populations – is essential.

1.2 Evolution of cooling in NDCs

In 2021, the German Society for International Cooperation (GIZ) examined how the refrigeration and air conditioning (RAC) sector was addressed in both the first round of NDCs and their first updates submitted under the UNFCCC (GIZ 2021). The study focused on:
- Coverage of HFCs: Whether countries explicitly included HFCs in their GHG inventories and targets
- Energy efficiency measures: The extent to which countries proposed improvements in cooling equipment efficiency
- Specific RAC sector actions: The depth of policies or targets for transitioning away from high GWP refrigerants and reducing indirect emissions from cooling.

Overall, GIZ found a clear upward trend in the share of updated NDCs that explicitly mention the cooling sector and include measures to address HFCs. However, few countries provided detailed measures for both phasing down HFCs and improving cooling efficiency.

Key aspect	First NDCs	Updated NDCs
HFCs included	44%	73%
RAC sector mentioned	19%	68%
HFC mitigation measures included	6%	47%
Energy efficiency measures included	12%	27%

Notable best-practice examples (e.g. Seychelles, Namibia) showed how to integrate HFC phase-down commitments, training programs and tax or financial incentives into overall climate strategies, often referencing the Kigali Amendment. Nevertheless, the majority had only partial coverage of cooling-specific measures.

Since the GIZ review in 2021, many countries have continued to update their NDCs. According to the UNFCC NDC Registry, numerous Parties have submitted second or third NDCs. However, in 2025, all countries are encouraged to submit their NDCs 3.0. The new submissions are vital for assessing global progress toward the Paris Agreement's 1.5°C or "well below 2°C" goal. The NDCs 3.0 should include more detailed mitigation and adaptation strategies, reflecting each country's evolving national circumstances and ambition levels.

The submitted third NDCs include that of the United Arab Emirates (UAE), submitted in November 2024 (UAE, Ministry of Climate Change and Environment 2024), which can be examined through the same lens GIZ applied in 2021. Key findings include:

Key aspect	United Arab Emirates NDC 3.0	Comparison with 2021 trends
HFC coverage	The United Arab Emirates explicitly includes F-gases (including HFCs) in its overall climate targets and aligns with the Kigali Amendment to the Montreal Protocol. • "The United Arab Emirates's Third NDC sets economy-wide targets that cover all domestic sectors including Carbon Dioxide (CO_2), Methane (CH_2), Nitrous Oxide (N_2O), and now Fluorinated Gases (F-gases). Following the United Arab Emirates's ratification of the Kigali Amendment to the Montreal Protocol, the country has committed to addressing F-gases effectively." (p. 19)	HFCs are explicitly included.
RAC sector mentioned	The NDC highlights cooling in multiple sections – particularly in the buildings and industrial sectors – through energy efficiency, refrigerants and sector-specific initiatives. The national and emirate-level Demand Side Management (DSM) Programme is highlighted extensively. Examples: • "As part of the DSM Programme, there are periodic updates to building codes to enhance the efficiency of new constructions and retrofit existing buildings. Measures include the increased use of efficient cooling systems, rooftop photovoltaic systems, and solar water heating." (p. 33) • "The national efficient cooling system initiative aims to enhance district cooling systems' efficiency by standardizing related standards and incorporating smart systems and modern technology. This initiative strives to improve air conditioning performance, reduce maintenance costs, and lower emissions from the building sector." (p. 44)	Clear attention to sustainable cooling across sectors.
HFC mitigation measures	The United Arab Emirates details specific measures for phasing down HFCs, including regulations and incentives to promote the transition to low-GWP refrigerants in the building sector. These include: • "state-of-the-art technology in environmentally friendly cooling technologies and reduction of refrigerant use, such as the use of heat (e.g., geothermal and waste heat), the use of waste or recycled water, or that of low Global Warming Potential (low-GWP) and zero Ozone Depletion Potential (zero-ODP) refrigerants." (p. 44)	Specific measures mentioned.
Energy efficiency measures	The United Arab Emirates's third NDC places a strong emphasis on improving air conditioning efficiency, expanding district cooling and upgrading building codes. These policies seek to reduce indirect emissions while complementing the country's HFC phase-down efforts. Examples include: • "The Ministry of Industry and Advanced Technology continues to develop standards within its Water and Energy Efficiency program. This star-rating program is expanded and updated annually to include standards for more electrical appliances or update the energy/water consumption efficiency criteria on existing standards. It currently covers a number of products including high-capacity and low-capacity air conditioners..." (p. 22) • "The United Arab Emirates has approved additional policies to accelerate the decarbonization of buildings, including revising building codes for efficiency, rolling out building energy labels, and ramping up retrofitting rates. The policy package also aims to promote the installation of solar thermal and efficient cooling systems, complemented by awareness for energy consumption to encourage conservation." (p. 32)	Strong focus, concrete measures identified.

The United Arab Emirates' third NDC shows a substantially more detailed and concrete treatment of the cooling sector compared to what was typically found in the NDCs analysed in the 2021 GIZ report. It does not dedicate a separate chapter to cooling but integrates cooling throughout various sectors, specifically in relation to buildings. This NDC 3.0 clearly recognizes the importance of both HFC phase-down and energy efficiency in the cooling sector, and it references the Global Cooling Pledge (p. 82). This advancement reflects a shift towards more comprehensive, sector-specific strategies aligned with the most recent and urgent calls for climate action. While more specific targets for F-gases could still be elaborated, the United Arab Emirates' new NDC may already serve as a good practice example for other countries developing their third round of NDCs, particularly in regions with high cooling demands.

BOX 1: SHARED OBJECTIVES, DIFFERENT APPROACHES, ONE GOAL: REDUCING EMISSIONS FROM COOLING

Insights from interviews conducted by the Cool Coalition in the preparation of this guide reveal how different approaches have led to the integration of cooling in NDCs:

- Viet Nam: Policymakers involved in NDC development evaluated various measures to define which ones would be prioritized for NDC implementation. It was from this angle that due to its large impact on energy use and emissions, cooling was identified as a priority sector, and the related measures were consequently incorporated in the NDC update planning.
- In Nigeria, the development of a NCAP was considered a key driver for including cooling in its NDC. Different stakeholders came together for the integration of cooling targets in the NDC, which advanced collaboration across various ministries, depending on a clear definition of roles and responsibilities.
- In the United Arab Emirates, with its intensive use of air conditioning, cooling was a main target when a country-wide demand-side management programme was set up in 2021. Engagement of the private sector as well as collaboration with research institutions were identified as key aspects for success, as these stakeholders are driving technological developments and conducting awareness-raising campaigns. The structures and processes developed in the context of the DSM Programme have been instrumental in integrating cooling targets with national climate policies such as the NDCs.

Find more detailed information and additional case studies in section 2.7.

1.3 The way forward: Assessing the status quo and setting up a governance structure

With the increasing ambition of NDCs, as well as more granularity of baseline and target data and an increasing number of NCAPs published, countries do not have to reinvent the wheel when it comes to setting up a process or governance structure for incorporating cooling measures into the NDC. Thirty-eight countries have been developing their NCAPs, and 16 have already been published (UNEP and Cool Coalition 2023). Some country experiences have been collected in the preparation to compile this guide. In terms of what to do next, once the decision to integrate cooling into an NDC (or enhance if it has been mentioned but not fully integrated) has been taken, two aspects shall be highlighted:

1. **Taking stock of the current situation:** The questions and flow charts in section 1.3.1 can help policymakers assess their current situation and identify key action areas for integrating the cooling sector into their NDCs.
2. **Setting up a governance structure:** All interviews with policy stakeholders who have been involved in NCAPs and are integrating cooling in NDCs have highlighted collaborative processes that had been set up to tackle this genuinely interdisciplinary issue. Section 1.3.2 elaborates on a potential collaboration framework.

1.3.1 Integration of cooling sector into NDCs – Key questions for policymakers to assess the current situation

Before integrating – or enhancing – the coverage of cooling in an NDC, it is helpful to map out the status of governance, data and existing policies (e.g. NCAP) in the country. The table below summarizes essential questions and includes recommended next steps depending on whether the answer is "yes" or "no."

Step	Question	If YES	If NO
1	Is there clarity on which ministry or agency leads the NDC process?	Ensure those lead agencies coordinate across relevant ministries (e.g. environment, energy).	Clarify and assign roles. Engage all ministries critical to cooling (e.g. industry, buildings, health).

2	Has a specific focal point or team for the cooling sector been identified?	Integrate the cooling focal point with key areas (energy efficiency, cold chain, HFC emissions, gender).	Designate a new focal point or cross-ministerial task force to coordinate cooling effort, ensuring that gender considerations are actively included in the process. Check the Gender in NDCs briefs (NDC Partnership 2022, NDC Partnership n.d.) for additional insights.
3	Is sustainable cooling (HFCs/ RAC/heat pumps, energy efficiency, passive cooling, nature-based solutions) explicitly addressed in the current NDC?	Map the existing cooling-related measures (e.g., building efficiency) and update them as needed.	Identify gaps; plan to expand the NDC by including specific cooling policies and targets, as well as reference to Kigali Amendment, NCAP, the Cooling Pledge, etc.
4	Are HFC emissions tracked separately in the national GHG inventory?	Are HFC banks considered in the inventory? Are specific emission reduction targets defined for HFCs and do they align with the Kigali Amendment?	Begin tracking HFC emissions, ideally both from equipment that is in operation as well as from HFC banks. Coordinate with the NOU.
5	Do you have a NCAP or similar policy framework?	Align NCAP measures with NDC, ensuring consistency in targets and timetables.	Consider developing an NCAP or incorporate cooling strategies into existing energy or climate policies (see NCAP methodology guide by UNEP *et al*. 2021).
6	Are emissions from electricity generation (linked to cooling) disaggregated?	Use this data to identify mitigation potential related to sustainable cooling (energy efficiency, passive cooling, renewable energy) in the power sector (e.g. peak load management).	Update sectoral (space cooling, cold chain) breakdowns for more accurate calculations of cooling-related electricity demand.
7	Is there an inventory of existing ozone depleting substance (ODS)/HFC banks (e.g. old equipment or stockpiles)?	Integrate management of these banks into mitigation plans.	Establish an inventory of ODS/HFC banks; coordinate with customs, recycling and waste services. Check out the GIZ guidelines for this (GIZ 2023).

1.3.2 Governance recommendations

Many countries have already set up multi-stakeholder consultative processes for the elaboration of NCAPs that can be capitalized for harmonizing cooling sector climate targets with countries' national energy and climate mitigation and adaptation plans.

If this is not in place yet, to successfully integrate cooling into NDCs, countries should consider setting up a national steering committee, i.e. a multi-stakeholder group to oversee the integration process, including representatives from relevant ministries, industry and civil society as shown in Table 1.

This group will be instrumental in determining key focus areas within the cooling sector (e.g. energy efficiency, refrigerant transition, passive cooling, cold chains), supporting the decision on priority targets and setting indicators to track progress in reducing cooling-related emissions based on national circumstances.

Apart from the NCAP governance framework, countries can start with assigning a cooling focal point in the NDC development governance framework who can coordinate among line ministries. Further, specialized technical committees/sub-groups are a good option to involve the various stakeholders, including non-governmental agencies.

It should also be ensured that the established working group and processes continue after the submission of an NDC. Ideally, they become a permanent driver to enhance the integration of cooling measures into the national climate agenda, build on lessons learnt from previous measures and incorporate any new technology developments or policy tools. This way, they will be well suited to increase ambition along with the NDC update process.

For example: Collaborative multi-stakeholder elaboration of NCAPs

Rwanda: The Rwanda Environment Management Authority with technical assistance from UNEP's United for Efficiency conducted a market assessment and prepared the findings and recommendations for cooling, which were reviewed by a cross-ministerial working group for the country's National Cooling Strategy, which was approved by the cabinet and informed its NDC update (UNEP and Rwanda, Ministry of Environment 2019).

India: The development of the Cooling Action Plan was a multi-stakeholder, consultative process with working groups for seven thematic areas, with a steering committee that guided the process and reviewed the work of the working groups (India, Ozone Cell 2019).

Table 1: Stakeholders and their potential role in integration and governance of cooling in NDCs

Institution	Role
Steering Cooling Committee or equivalent	High-level coordination committee/commission – involving key ministries and industry stakeholders involved in the cooling sectors to periodically review the progress on cooling targets implementation and provide strategic direction based on the country's priorities and commitments.
Ministry of Climate Action/ Environment	Lead the overall coordination and integration with national climate policy and alignment with international commitments.
Ministry of Energy	Focus on energy efficiency improvements, grid decarbonization, and integration with renewable energy plans and demand-side management programmes.
National Ozone Unit	Provide specific knowledge and data on cooling and refrigerant phase-down, access to existing resources and data, e.g. on emissions from HFC banks.
Ministry of Industry	Regulate cooling technology standards, promoting sustainable industrial practices and fostering a market transformation.
Ministry of Finance	Develop incentives and explore financing mechanisms; allocate funding for cooling projects and integration into economic plans, including sub-national governments.
Ministry of Health	Ensure access to cooling in healthcare and protect population from heat-related issues.
Ministry of Agriculture	Develop sustainable cold chains for food preservation and food security.
Ministry of Housing/Urban Development	Promote sustainable cooling in urban planning and green building designs.
Ministry of Education	Incorporate sustainable cooling into vocational training programs, school curricula and public awareness campaigns.
Ministry of Women, Children, Social Affairs	Ensure inclusivity is addressed in NDCs 3.0, embedding gender equality, just transition principles and participation of marginalized groups. Specific actions could include conducting gender impact assessments of cooling policies, ensuring that women are represented in decision-making processes and developing targeted programs to support women in the cooling sector. For instance, the Ministry can collaborate with other stakeholders to promote gender-sensitive training and capacity-building initiatives.
Private sector (manufacturers, industry, etc.)	Contribute to technical working/advisory groups, and conduct awareness campaigns.
Customs and other regulatory authorities	Bring in the perspective of enforcement of policies.

1.4 Essential (select) guidance documents and resources for cooling and NDC integration

Explore these key publications to support your country's cooling sector integration into NDCs.

Publication	Why it's relevant
HFC Emission Baseline Tool (GIZ 2025)	The HFC Emission Baseline Tool introduces a practical methodology that leverages existing consumption data to establish robust HFC emission baselines for inclusion in NDCs. Access resource
Guidance on Sustainable Cooling Approaches for Enhanced NDCs (UNEP -Convened Climate and Clean Air Coalition Secretariat 2024)	Policy roadmap Outlines a roadmap for NDC preparation teams to identify goals, measures, resource needs and benefits in the cooling sector, from gathering and evaluating current initiatives and opportunities for action, followed by the evaluation and identification of measures to include in the next NDC. It also introduces a recommendation to apply a lifecycle refrigerant management approach to the cooling sector in an NDC. Access resource
Global Cooling Watch 2023 (UNEP 2023)	UNEP report This comprehensive report provides the latest data on cooling sector emissions, projections and potential mitigation pathways. It is essential for understanding the global context and scale of the challenge. Access resource
Resources on energy-efficient and climate friendly air conditioners, refrigerators, commercial refrigeration and fans	Policy and model regulations United for Efficiency provides Model Regulation Guidelines and policy guides on energy-efficient appliances including refrigerators, air conditioners, commercial refrigeration and fans as well as country assessments showing the potential financial, environmental, energy and societal benefits that are possible with a transition to energy-efficient refrigerators and room air conditioners. Access resource
Raising ambition in NDCs through holistic mitigation approaches in the cooling sector – Guidance for policymakers (GIZ 2022)	Policy and technical guidance This guide provides a step-by-step approach for policymakers to address both direct (refrigerant-related) and indirect (energy-related) emissions from the cooling sector. Detailed insights into key measures and technology options, methods for selecting effective policy instruments, and ways to set ambitious reduction targets are included. Access resource Additional resources and tools A whole collection of related documents and tools is available on the Green Cooling Initiative's website "NDC helpdesk" section, including a tool for quick self-analysis to evaluate cooling sector-related targets and measures for NDCs. Access resource
Regional standards and roadmaps for cooling products	**Technical standards** Regional economic blocs have undertaken coordinated efforts to harmonize technical regulations and performance standards for cooling products, notably through the alignment of MEPS and the adoption of specifications for low-GWP refrigerants. To ensure coherence and maximize mitigation potential, NDCs should explicitly incorporate these regional commitments, facilitating cross-border consistency, market transformation and alignment with international climate and environmental agreements. Recent examples of regional initiatives include: ASEAN (Association of Southeast Asian Nations) SADC (Southern African Development Community) EAC (East African Community)
National Cooling Action Plan Methodology (UNEP *et al*. 2021)	Methodology This resource outlines a structured approach for countries to develop an NCAP, from assessing cooling needs and projecting future demand to developing tailored, sector-specific solutions that align with their climate and development goals. Access resource

How countries can enhance Nationally Determined Contributions in 2021 with climate-friendly cooling (K-CEP *et al*. 2021)	Policy guidance and examples This document provides specific guidance on how to incorporate cooling measures into NDC updates, with examples and best practices. Access resource
Guidance on Incorporating Efficient, Clean Cooling into the Enhancement of Nationally Determined Contributions (K-CEP 2019)	Policy guidance & examples This practical guide offers step-by-step advice and examples on incorporating cooling strategies into national climate plans and policies while addressing the growing demand for cooling services. Access resource
The Future of Cooling: Opportunities for Energy-Efficient Air Conditioning (IEA 2018)	Background reading A comprehensive "must-read" report about the implications of rising cooling demand and policy interventions to curb demand, raise efficiency and bring long-term energy savings from improved building performance. Access resource
Mepsy: The Appliance & Equipment Climate Impact Calculator (CLASP)	Additional resources and tools CLASP's Mepsy tool can help model the effect of energy efficiency policies for a range of appliances including cooling appliances. Access resource
Net Zero Appliances NDC Toolkit (CLASP)	Additional resources and tools CLASP's toolkit provides clear instructions for incorporating appliance efficiency into NDCs. Access resource
Chilling Prospects Series (SEforALL)	Additional resources and tools An analysis series to track global access to cooling gaps annually. It provides a framework to evaluate the cooling needs and quantify the population at risk due to the lack of cooling, including gender-based factors for accessing cooling. Access resource Access resource

2 Methodology guide

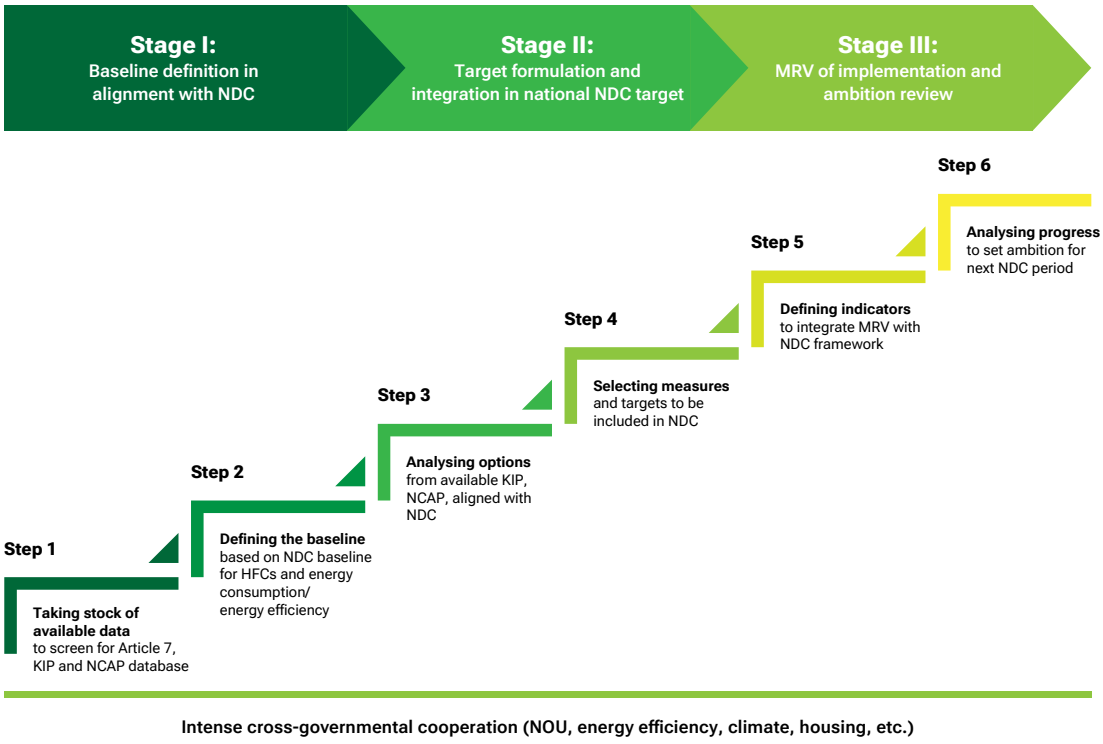
This section provides methodology guidance for including cooling-related mitigation and adaptation measures in NDCs. It aims to guide policymakers as well as NDC planners and implementors through the process of identifying, assessing and incorporating cooling sector targets and actions as integral elements within the NDC. A stage-wise approach is proposed to guide the process of baseline setting, mitigation/adaptation scenario definition and progress tracking. Depending on work already undertaken e.g. during the preparation of a NCAP, a country might tackle some steps easily. However, a consecutive procedure is recommended. As the methods for mitigation and adaptation differ, they are described separately in consecutive sections.

While the basic question for mitigation is how to make a currently existing (or growing) service/infrastructure less climate damaging (by reducing emissions) for adaptation, the question is what service/infrastructure is required to alleviate a risk that is caused/or aggravated by climate change. That means that adaptation measures may lead to more emissions by providing better access to cooling. This should be taken into account when defining cooling sector targets, including efficient mechanical cooling as well as passive cooling and urban planning as possible measures. Especially with the latter, a clear-cut distinction between mitigation and adaptation is difficult. For example, the greening of building facades leads to lower local temperature, which in turn reduces the need for mechanical cooling, which reduces emission. At the same time, it also alleviates heat stress in and around the building and supports biodiversity, evaporation, etc., contributing to a more comfortable micro-climate.

Is the green facade a mitigation measure to reduce cooling emissions with adaptation co-benefits, or is it an adaptation measure to alleviate heat stress in and around the building and the reduced emission from less mechanical cooling is a mitigation co-benefit?

This framing is a national decision and can be relevant for accessing funding and streamlined reporting.

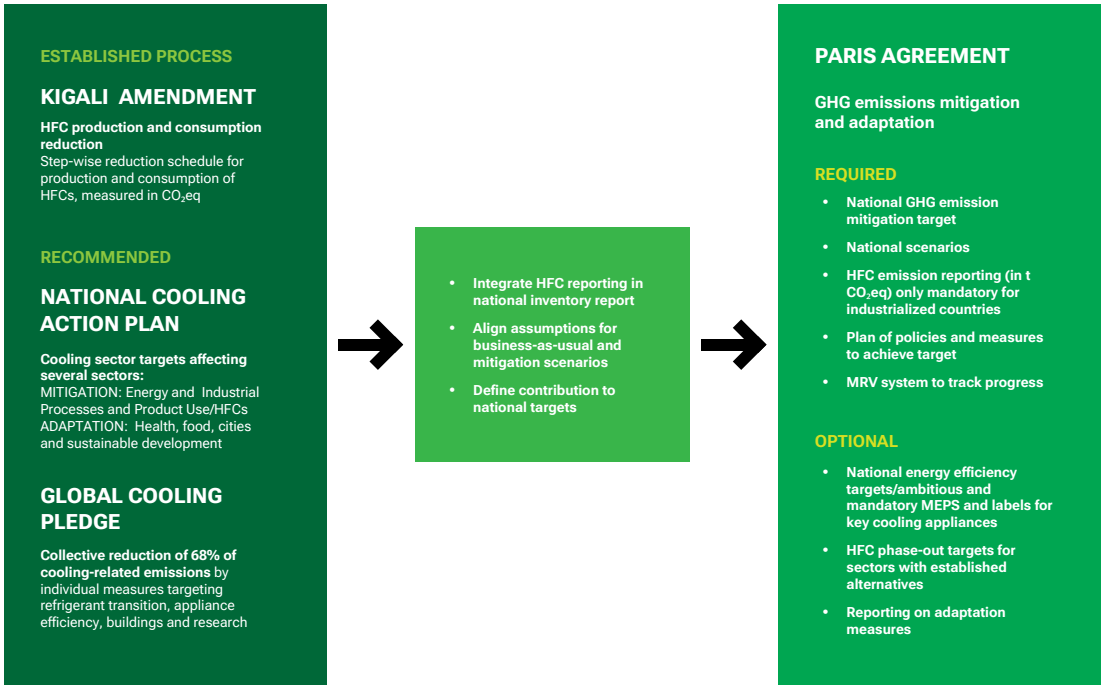
Figure 1: Staged approach to cooling sector integration into the NDC (mitigation and adaptation)



Source: Own elaboration

This guide provides a step-by-step on how to integrate cooling measures into the NDC through three phases as shown in Figure 1. The guide targets specifically the "translation" from cooling sector targets to mitigation and adaptation language that is relevant for the NDC as illustrated in Figure 2. Data available from established processes such HFC phase-down under the Montreal Protocol or comprehensive sector analysis on additional effects due to adaptation measures or buildings efficiency code implementation or energy efficiency improvements are looked at from the perspective of the Enhanced Transparency Framework (ETF) on NDC presentation and documentation. To this end, national mitigation scenarios need to align with sectoral scenarios to enable the quantification of the contribution of individual (cooling) measures to the national target.

Figure 2: Schematic translation from cooling sector targets to NDC-relevant mitigation and adaptation targets



2.1 Mitigation stage I: Baseline definition in alignment with NDC

2.1.1 Step 1: Taking stock of available data

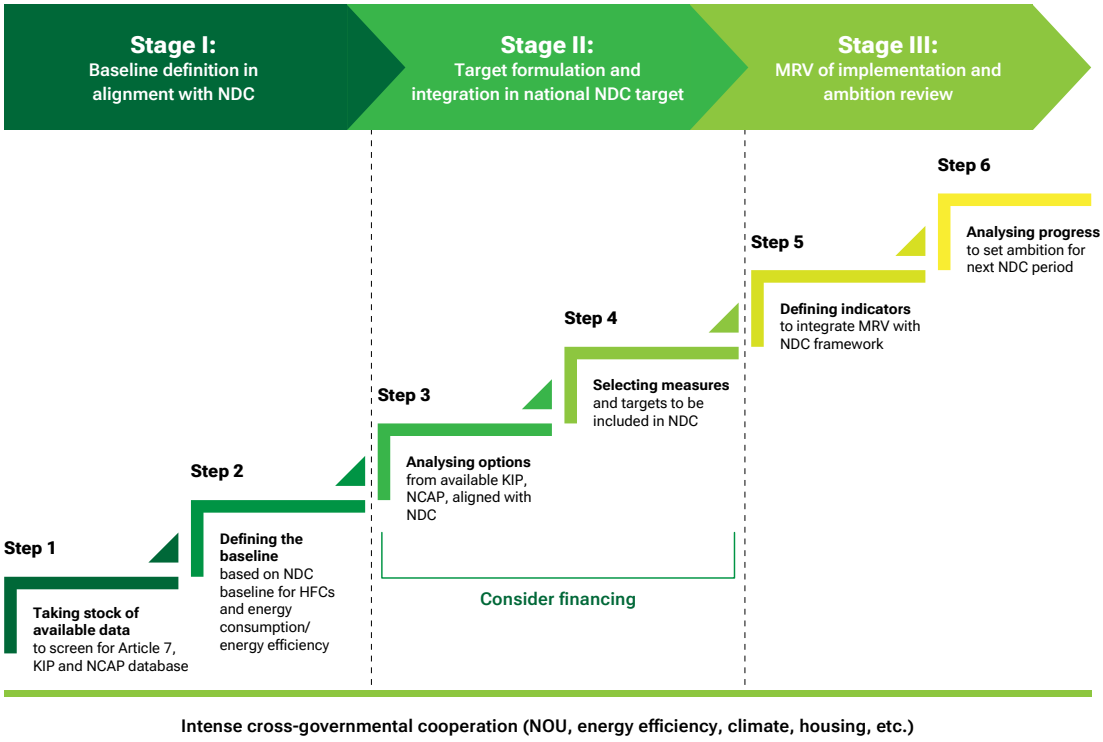
Several data sources are possibly available to serve as a basis for the cooling sector's integration into a country's NDC: A Kigali Implementation Plan (KIP) and/or a NCAP.

The KIP focuses on compliance with the Kigali Amendment, i.e. following a clear path towards the reduction of HFC consumption. The NCAP provides comprehensive coverage of cooling, addressing various sectors and end uses, while prioritizing equitable access to cooling. Countries that want to raise the ambition of mitigation and adaptation in the cooling sector will benefit from NCAP development, as it builds on a holistic methodology for the development of an integrated sector plan. Thus, an NCAP complements a KIP.

While there is no unique definition of a NCAP, this guide defines it as a comprehensive document, identifying a national path to sustainable cooling reducing emissions from both energy consumption (indirect GHG emissions) and F-gases from refrigeration and air-conditioning systems (direct GHG emissions). The NCAP can also consider adaptation measures, possibly with mitigation co-benefits.

The process of developing a sectoral baseline, stakeholder consultations and formulation of targets and action plans are described in detail in the Cool Coalitions' NCAP methodology guide (UNEP *et al*. 2021). Its staged approach is illustrated in Figure 3. The integration of the NCAP with the NDC process should be initiated early on, e.g. during steps 1 and 2, where overall energy efficiency targets could be analysed for their effect on cooling appliances and the entity responsible for the NDC process could be consulted. The results of this integration are expected to be reflected in the NCAP document, especially in the governance framework with defined progress reporting structures.

Figure 3: A holistic methodology for NCAP development



Source: National Cooling Action Plan Methodology, Cool Coalition (UNEP *et al.* 2021)

Countries that have not yet developed an NCAP can integrate cooling actions into their NDC based on considering the Kigali Amendment, the HFC consumption reduction schedule or preferably a more accelerated schedule along with synthesizing technical recommendations based on equipment efficiency labelling programs, building code or building efficiency policies and refrigeration and cold chain plans/policies.

Countries that have neither a NCAP nor a KIP are recommended to liaise with the NOU for available data and HFC reduction plans and with energy and buildings ministries for available data on cooling technologies and building energy demand data and agriculture ministries for cold chain data to develop improvement scenarios and mitigation targets. Based on this, an overall target for the cooling sector could be formulated. Further refinement is recommended for the next NDC update.

2.1.2 Step 2: Defining the baseline

Since the cooling sector affects two emission categories, baselines need to be set for both HFC emissions and emissions from energy consumption. Baselines can be defined in absolute terms or as intensity, e.g. as kWh/ installed cooling capacity.

2.1.2.1 HFC emissions

As not all countries report their HFC emissions, the starting point is assessing whether the national GHG emission baseline includes HFC emissions, and which data and methodology were used to determine these emissions. Countries that have ratified the Kigali Amendment are required to report HFC consumption data to the Ozone Secretariat. This so-called "Article 7 data" is reported annually in metric tonnes per substance, starting in 2020 for most Article 5 parties. Detailed clarification is provided in Box 2.

BOX 2: ARTICLE 7 REPORTING REQUIREMENTS FOR HFCS UNDER THE KIGALI AMENDMENT

In Article 7, each Party shall provide to the Ozone Secretariat statistical data on its production, imports and exports of each of the controlled substances. In Annex F, for the years 2011 to 2013, except that Parties operating under paragraph 1 of Article 5 shall provide such data for the years 2020 to 2022, but those Parties operating under paragraph 1 of Article 5 to which subparagraphs (d) and (f) of paragraph 8 qua of Article 5 applies shall provide such data for the years 2024 to 2026;

Each Party shall provide to the Secretariat statistical data on its annual production (as defined in paragraph 5 of Article 1) of each of the controlled substances listed in Annexes A, B, C, E and F and, separately, for each substance, as following:

- amounts used for feedstocks,
- amounts destroyed by technologies approved by the Parties, and
- imports from and exports to Parties and non-Parties respectively,
- for the year during which provisions concerning the substances in Annexes A, B, C, E and F respectively entered into force for that Party and for each year thereafter. Data shall be forwarded no later than nine months after the end of the year to which the data relate.

For Article 5, countries are a group of Parties to the Montreal Protocol whose annual consumption of controlled substances was less than 0.3 kilograms per capita at the time of entry into force of the Protocol or at any time thereafter up to 1 January 1999. There are currently 147 countries in this group. Parties operating under Article 5 have a grace period for ODS and HFC phase-down/out and typically receive support via the MLF.

Data reported may include HFC production, imports, exports, feedstock use and destroyed amounts. The Intergovernmental Panel on Climate Change (IPCC) provides a top-down (Tier 1) methodology, using Article 7 data to estimate emissions from the cooling sector. This is the simplest way to include HFC emissions in the National Inventory Report (NIR) and it is recommended if no sub-sector-specific data is available. A summary of this approach is provided in Box 3.

BOX 3: TRANSLATING HFC CONSUMPTION TO HFC EMISSIONS

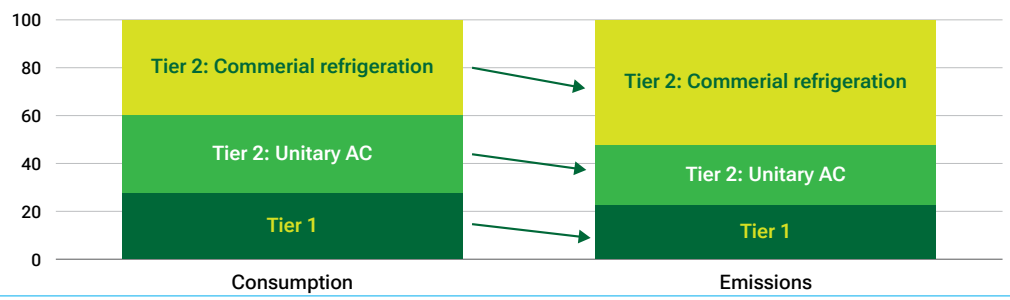
While the Montreal Protocol requires the reduction of production and consumption of HFCs, the UNFCCC and its Paris Agreement focus on emissions. In the cooling sector, there can be a considerable time lag between consumption and emissions, and efforts are undertaken to avoid their emissions altogether. Hence, the emissions that result from consumption depend on several factors that are specific to the application and the national circumstances.

IPCC Tier 1 methodology provides a top-down method to translate HFC consumption data (as reported under Article 7 of the Montreal Protocol) to HFC emissions and provides several default factors that can be adjusted depending on national realities. Estimates are done per refrigerant consumed in the cooling sector and require a little more input than is already required for Montreal Protocol reporting. Default factors are provided for the equipment lifetime, an average emission factor, the percentage of refrigerant destruction and the equipment lifetime. Based on the year of market introduction of the refrigerant, the consumption is interpolated, and emissions are estimated based on this consumption.

The IPCC used to provide an Excel tool for this calculation. However, it is no longer compatible with the inventory software tool, which has been updated providing options for Tier 1 and Tier 2 accounting. GIZ Proklima is working on an updated Excel tool for a better understanding on applying the methodologies that will be released in spring 2025.

A Tier 2 approach distinguishes between cooling applications, which all have their specific equipment. They differ in size, refrigerant use, equipment lifetime, maintenance practices and hence typical refrigerant leakage. In a Tier 2 approach, the emission per application is estimated based on the emissions of installed equipment (emission factor approach, Tier 2a) or the specific consumption of this application (mass balance approach, Tier 2b).

In case there is disaggregated data available for some applications, such as mobile air conditioning or domestic refrigeration, it is worthwhile to combine Tier 1 and Tier 2 approaches. This requires a careful assessment of refrigerant flows to avoid double counting. The portion of consumption that goes into the more detailed Tier 2 approach needs to be clearly delineated and taken out of the Tier 1 refrigerant consumption.



If a detailed cooling sector inventory and/or a NCAP is available, this database could be used for HFC emission reporting, possibly using a Tier 2 approach or a combination of Tier 1 and 2 (see definition in Box 3). As NIRs, which contain detailed descriptive and numerical information on a country's GHG emissions, need to be updated with each Biennial Transparency Report (BTR), it is necessary to ensure that RAC inventory/NCAP data is updated at the same interval. Under the ETF, Parties to the Paris Agreement are required to submit BTRs every two years. BTRs include information on NIRs, progress towards NDCs, policies and measures, climate change impacts and adaptation, levels of financial, technology development and transfer and capacity-building support, capacity-building needs and areas of improvement. Small island developing states and least developed countries may submit the information required for the BTR at their discretion.

Further information on IPCC methodologies and data management can be found here:

- IPCC guidance (IPCC 2006)
- Monitoring, reporting and verification (MRV) blueprint (GIZ 2020)
- RAC nationally appropriate mitigation actions (NAMA) inventory guidance (GIZ 2013)

Likely, HFC consumption and hence emission data may not be available before the year 2020. If the national NDC baseline specifies a reference year before that, HFC emissions can still be estimated based on the introduction year of the substance as per IPCC guidance. Some data could also be available from ODS alternative surveys that were undertaken by NOUs between 2015 and 2017 in most developing countries that benefit from the financial assistance of the Multilateral Fund (MLF). The MLF also currently provides financial support for compiling ODS/HFC banks inventories. ODS/HFC banks are the substances contained in products and appliances, e.g. within the refrigeration cycle. This can provide additional data, especially for sub-sectoral breakdown and end-of-life emissions. In any case, the NOU has the best overview of available data.

Baseline types

Once HFC emission data is determined, their inclusion in the national NDC baseline and its consequences for HFC emissions accounting should be assessed. Common types of NDC baselines are single base years and baseline scenarios.

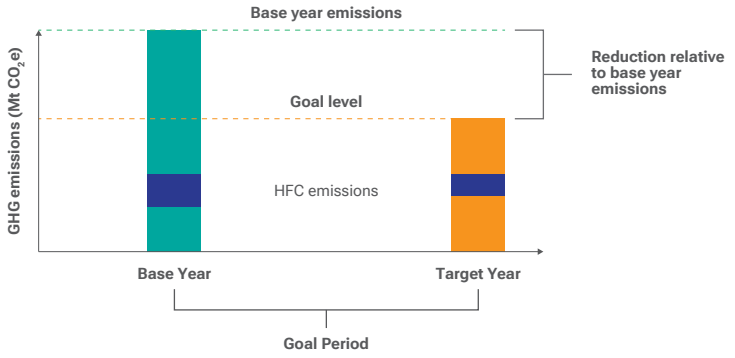
Single base years refer to a single year in the past, for which GHG emissions are determined. Depending on the national scope, HFC emissions can be either included or excluded. If the mitigation target includes HFC emissions, the base year GHG emissions need to include HFC emissions as well. Mitigation targets referring to a single base year are usually a single-year target in 2030 with a relative or absolute reduction target in reference to the base year (see Figure 4 section A).

Keeping the reduction target the same, while including HFC emissions, constitutes an ambition increase, as HFC emissions in the baseline are likely rather small compared to the projected increase.

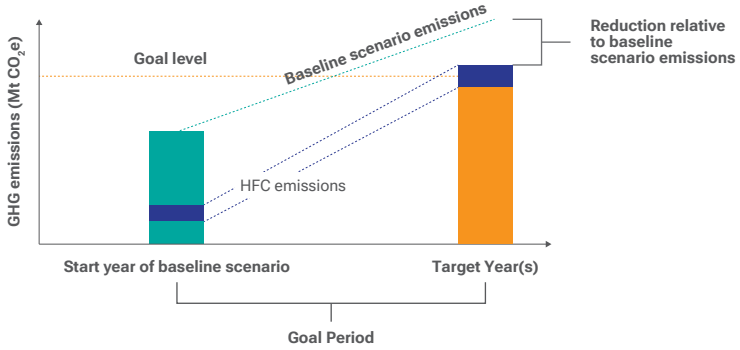
Baseline scenarios refer to GHG emissions resulting from a defined business-as-usual scenario. This is usually characterized by a policy cut-off date, hence only reflects policy impacts that were enacted before the cut-off date. Therefore, it is important to understand if the Kigali Amendment and its resulting national policies are part of the baseline scenario or not (see Figure 4 sections B to C). This differentiation might be important for the attribution to either baseline, unconditional or conditional targets. Emission reduction resulting from the implementation of the Kigali Amendment in Article 5 countries, which is funded by the MLF, is often regarded as an unconditional target. An accelerated HFC phase-down and measures to reduce the energy consumption of cooling equipment might be treated as conditional to additional financial support. The classification depends on the national definitions of the scenarios.

Figure 4: Typical baseline types and their consequences for the description of HFC emission targets

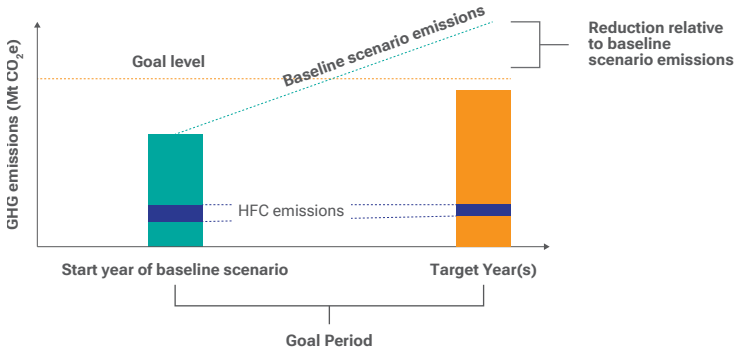
A: Single base year as the basis for a single year reduction target



B: Baseline scenario with policy cutoff date before the ratification of the Kigali Amendment



C: Baseline scenario with policy cutoff date after the ratification of the Kigali Amendment



Source: World Resources Institute 2014

Where NCAP scenarios are used for cooling baseline and target setting, those scenarios need to be aligned with national baseline and target scenarios. This enables the quantification of the cooling sector target as a share of the national target for both HFC and energy emissions.

BOX 4: SCENARIO ALIGNMENT

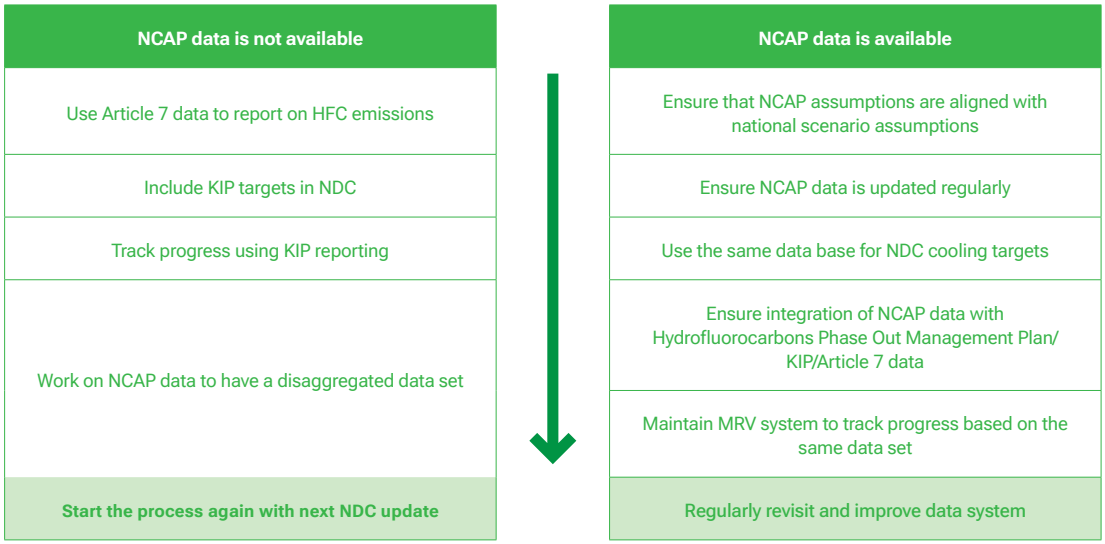
NCAP scenarios need to be aligned with national scenarios. This means they should use the same set of socioeconomic drivers such as population and household growth, urbanization and electrification rate as well as household income trends and gross domestic product development. More specific are the effects of the increasing number of hot days on cooling equipment and increased cooling capacity that is driven by economic growth.

Ideally, the share of the total energy that is consumed by households and commercial/industrial entities is identified in the national scenarios and congruent with the calculated share for cooling applications as calculated in NCAP scenarios.

Encountered differences need to be well justified and embedded in the narrative on attributing emission reduction targets to the cooling sector.

Note that HFCs can have other sources apart from the cooling sector: firefighting, foam, metered dose inhalers, aerosols and solvents. It is important to ensure separate reporting of these emissions. Some of these uses might be covered under the KIP (or elsewhere) and hence mitigation measures could be included in the NDCs. Figure 5 illustrates the flow of data processing with and without available NCAP data.

Figure 5: Data processing for HFC reporting



2.1.2.2 Emissions from energy use

Cooling is responsible for a sizable share of electrical energy consumption and summer peak electricity, thus proper attribution is important. This share is higher in hot and hot-humid countries and projected to increase with rising income and electricity access, as well as rising temperatures. Figure 6 shows how data can be processed for reporting emissions from the cooling sector's energy consumption.

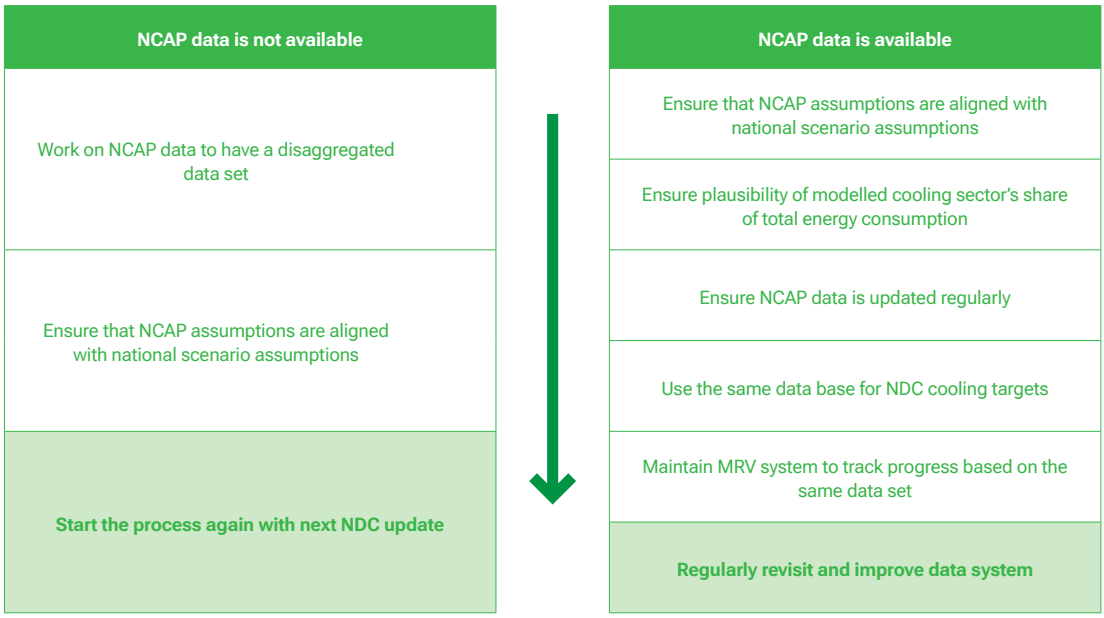
The NIR covers emissions from electricity use from the top-down modelling approach depending on the energy sources of the national electricity grid. Similarly, targets are often defined as economy-wide targets of emission reduction or efficiency increase.

Nevertheless, a cooling sector baseline that is aligned with national electricity consumption and trends provides a robust starting point for attributing the contribution of mitigation achievements in the cooling sector to the overall target. The ease of this endeavor largely depends on the set-up of national NDC target formulation in the energy sector.

For countries that have undertaken a detailed analysis of energy demand, down to specific uses such as lighting, space heating, space cooling, refrigeration, etc., and modelled mitigation potential bottom-up per specific use, attributing the contribution of specific measures in the cooling sector will be rather straightforward. United for Efficiency's Country Savings Assessments offer baseline information and highlight projected impacts in terms of GHG mitigation, electricity savings (avoided powerplants) and lower utility bills for refrigerators, air conditioners and other key energy end uses thanks to improvements in energy efficiency alongside refrigerant GWP reductions.

Countries that have formulated national mitigation targets in a top-down manner still have to undertake this exercise. Where detailed NCAP data is available, alignment with national energy use data needs to be ensured and thus can be used to attribute the share of cooling sector targets to the national energy-related targets.

Figure 6: Data processing for reporting emissions from the cooling sector's energy consumption

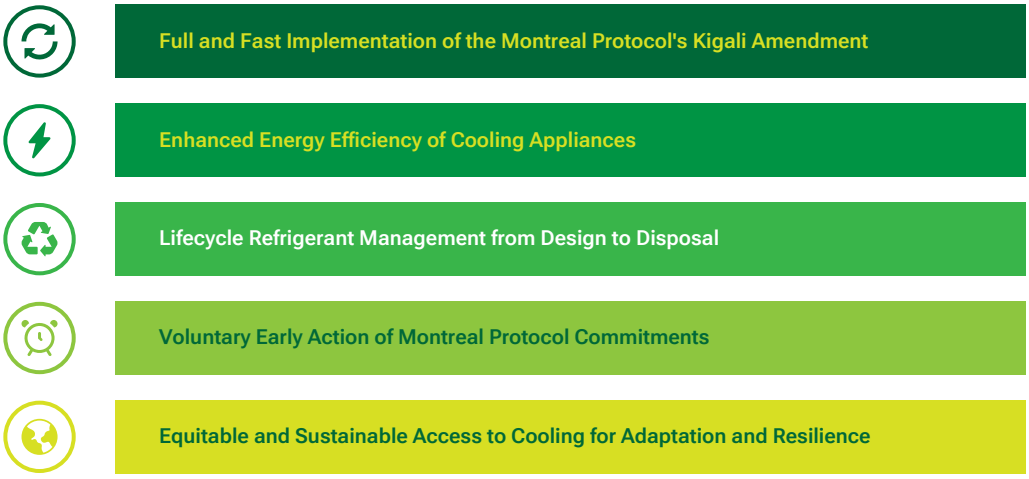


2.2 Mitigation stage II: Target formulation and integration in national NDC target

2.2.1 Step 3: Analysing options

Mitigation scenarios are ideally based on specific measures as defined under the KIP or NCAP. A thoughtful selection of measures and the means for implementing them are the focus of several guidelines. It is imperative to prioritize highly emitting applications, which are often stationary air conditioners and commercial refrigeration. The list of options for policy interventions is long and is elaborated in detail for example in the Climate and Clear Air Coalition (CCAC) Guidance on Sustainable Cooling Approaches for Enhanced NDCs (UNEP -Convened Climate and Clean Air Coalition Secretariat 2024) and GIZ's guidance for policymakers titled Raising ambition in NDCs through holistic mitigation approaches in the cooling sector (2022). The GIZ guide also provides an ambition benchmark for each policy option, based on country categories as illustrated in Table 2 for selected policy instruments. CCAC's guide offers a menu of policy options organized into five categories as shown in Figure 7.

Figure 7: Categories of policy options as presented by CCAC



Source: UNEP-Convened Climate and Clean Air Coalition Secretariat 2024, adjusted for style

Table 2: Regulatory instruments to control HFC consumption and ambition per country category

Policy instrument	Ambition level		
	Category A	Category B	Category C
No regulation to reduce HFC use	Low	Low	Low
Introduction of GWP limit of HFCs for certain appliances/ technologies based on thresholds as defined in current EU F-gas regulation	High	Medium	Medium
Ban of synthetic refrigerants for specific sub-sectors/ appliances, e.g., refrigerators, freezers, plug-in commercial equipment	High	High	High
Green public procurement with GWP limits for refrigerants based on current EU F-gas regulation	Medium	Medium	Medium
Green public procurement to promote the availability of highly efficient equipment using low-GWP refrigerants	High	High	High
Refrigerant assessment on its recyclability, with possible restrictions on blends that are difficult to recycle/reclaim	N/A	High	High
Commitment of local manufacturers to change to low-GWP refrigerants	N/A	N/A	Medium
Regulation/ requirement for local manufacturers to change to low-GWP refrigerants	N/A	N/A	High

Source: GIZ 2022, EU=European Union, adjusted for style

In addition, countries can consider addressing other high-impact areas, such as passive cooling measures, to reduce cooling energy demand in buildings. This often intersects with adaptation-related measures, and more links to existing guidance are provided in section 2.5.1.

2.2.2 Step 4: Selecting measures

Modelling the effects of individual measures is considered a sound basis for the tracking of implementation but requires detailed data and analysis. For countries with an advanced NCAP, this should be possible. It is recommended to carefully choose the mitigation measures to be included in the NDC. This decision can be based on mitigation potential, feasibility, adaptation co-benefits, required financial or technical assistance, and the necessary MRV system to track implementation.

For HFC emission reduction, the simplest approach is to translate the KIP consumption reduction schedule to emission reductions (Box 5).

Common fields of activities undertaken during KIPs are training, awareness raising and technician qualification and certification schemes. As the gender perspective is an integral part of KIP activities, those activities could be an opportunity to build the technical capacity of vulnerable groups and create employment and livelihood streams. It is very difficult for such measures to estimate their effect on emission reduction, although their effect on leakage factors should be noticeable. KIP measures are thoroughly drafted, scrutinized and negotiated with the Executive Committee of the MLF, and require regular reporting on progress. It is recommended to utilize those plans and report their results to the NDC in an aggregated form. The achieved consumption reductions should be translated to emission reductions as described in Box 5.

Measures can target both HFC emissions and energy emissions at the same time, such as eco-design requirements that specify energy efficiency and refrigerant requirements. Some energy efficiency measures could also be supported by the MLF. However, there is no clear reporting requirement on emission reduction achieved by such activities within the MLF reporting framework. To determine the emission targets for such interventions, a detailed database and detailed modelling of market uptake of that efficient equipment are required.

Similarly, the modelling of measures that only target energy efficiency requires comparable effort.

CLASP's Mepsy tool can help model the effect of energy efficiency policies for a range of appliances including cooling appliances. Mepsy also has bottom-up estimates of current, past and future energy demand and resulting emissions from air conditioners and refrigerators. Similarly, the LEAP model offers the functionality to model increased energy efficiency as part of an energy model.

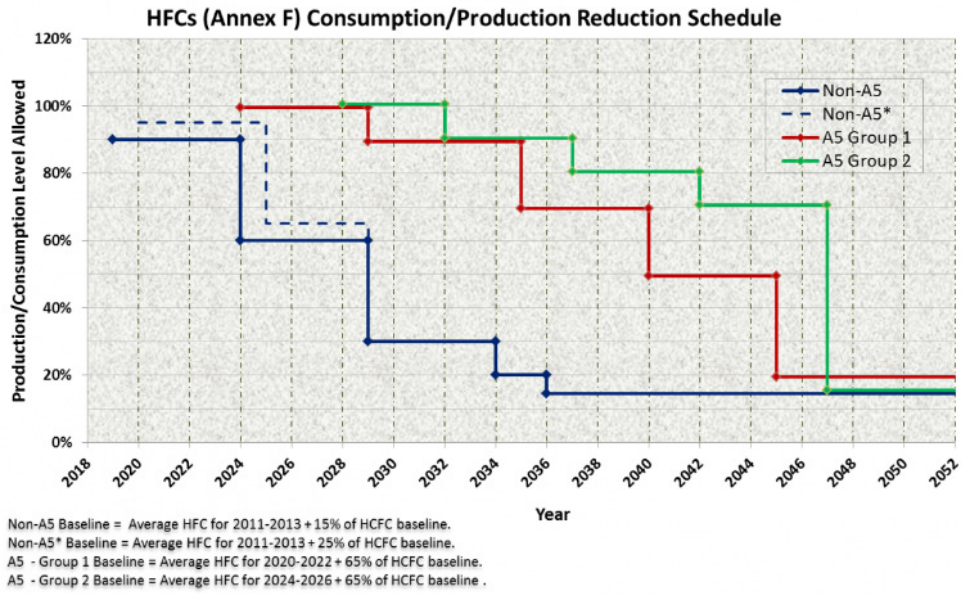
BOX 5: INCLUDING KIP REDUCTION SCHEDULES IN EMISSION SCENARIOS

The step-wise reduction schedule – for Article 5 countries until 2045 or 2047 – should be reflected in the national scenarios.

The reduction schedule is defined in CO_2eq relative to an established baseline. It is the decision of the national government how the schedule shall be achieved, i.e. which substance in which sector is phased down first. Where detailed KIPs are already developed, this information can be used for Tier 2 models to estimate emission reduction on a measure-per-measure calculation. Where this is not the case, a Tier 1 approach can be used to estimate emission reductions. Instead of calculating emissions per substance in metric tonnes, the input parameter is the baseline consumption and the intended reduction schedule in t CO_2eq. To take care of the time lag between consumption and emission, the time series should start in 2010, when a 10-year average lifetime is used. This provides complete results from 2020 onwards. Data from 2010 onwards can be deducted from the consumption in those years, calculating the t CO_2eq of metric consumption across all substances.

The results are emission estimates per year, again not disaggregated by substance, using the same (default) assumptions as with current emission Tier 1 emission calculations. Those can be used as emission targets achieved through KIP implementation.

A tool developed by GIZ Proklima aids this calculation (access the tool here).



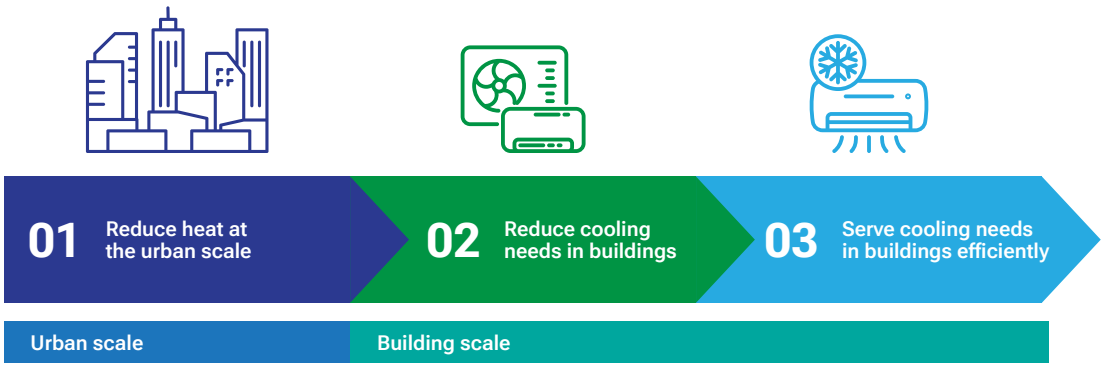
Source of graph: Ozone Secretariat 2007

Other mitigation measures formulated in a NCAP might overlap with KIP measures. A sound database with a defined baseline and target per measure enables quantitative inclusion in the NDC and transparent reporting of progress as part of the BTR.

Guidance to the selection of measures targeting the energy efficiency of buildings and design for passive cooling is provided in the UNEP report *Beating the Heat: A Sustainable Cooling Handbook for Cities* (2021). It is specifically addressed to cities, however its principles are applicable to all buildings. The handbook offers a comprehensive overview of sustainable urban cooling approaches within an integrated "whole-system" approach. It includes actionable guidance to support cities in organizing and prioritizing action towards sustainable and equitable urban cooling tailored to their unique context, contributing to increased city resilience and reduced emissions. Because multiple factors contribute to increasing warming in cities, often with interrelated effects, the whole-system approach suggests multi-pronged strategies to effectively address urban cooling. This includes three core steps: reduce heat at the urban scale, reduce cooling needs in buildings and serve cooling needs in buildings efficiently – as summarized in Figure 8.

Figure 8: Key intervention pathways for sustainable urban cooling

WHOLE-SYSTEM FRAMEWORK FOR SUSTAINABLE URBAN COOLING



Source: UNEP 2021

2.3 Mitigation stage III: MRV of implementation and ambition review

2.3.1 Step 5: Defining indicators

MRV systems on NDCs are being set up in many countries and usually follow the ETF and its provisions laid out in several COP decisions (no. 4 and 1/CMA1), outlining information requirements for clarity, transparency, understanding and tracking of progress.

The basis for reporting mitigation progress is the definition of suitable indicators that reflect the pledged target. While economy-wide targets are usually in focus, cooling sector indicators or even project-related indicators may be relevant. In principle, each party can decide on the definition of the indicators as long as they are suitable to track progress and a description is provided. Those indicators should be defined in the NDC to allow the BTR to refer to them. As NDCs are getting more detailed with each iteration, indicators need to be carefully selected and structured to keep the reporting effort manageable. Indicators on the project level might not be reported as part of the NDC but rather use a second level of progress monitoring by national institutions. However, signatory countries of the Cooling Pledge might want to report at least on their overall progress towards their pledged target of 68 per cent reduction of cooling-related emissions. Table 3 proposes a set of indicators to track the progress of items contained in the Cooling Pledge.

A detailed guideline for cooling sector MRV on a Tier 2 level is provided in GIZ's MRV blueprint (2020), where the focus lies on using and organizing already existing data and establishing an institutionalized reporting system.

For overall HFC emissions, the Ozone Secretariat established an MRV system for HFC consumption, which can be used as the basis for HFC emission reporting as explained in Box 5.

Table 3: Cooling Pledge targets and possible indicators

Target area	Indicators / status
Cooling related emissions	National methodology to determine cooling emissions is defined, baseline is set, and reporting has started
Early reduction of HFCs	• Yes/in progress/not started • State policy target and timeframe • % of progress
KA ratification	Yes/no
NCAP set up	• Yes/in progress/not started • % of progress

Action on buildings: • Building energy codes • Passive cooling • Energy efficiency strategies	• Yes/in progress/not started • State policy target and timeframe • % of buildings that follow codes • % of buildings that comply with passive cooling
Market penetration of highly efficient AC equipment	• Yes/in progress/not started • State policy target and timeframe • % of market uptake
Minimum energy performance standards (MEPS) established	• Yes/in progress/not started • State policy target and timeframe • % of the equipment that is tested for conformity
Public procurement includes policy for low-GWP and high efficiency cooling technologies	• Yes/in progress/not started • State policy target and timeframe • % of procurement that followed the criteria
Research and deployment of innovative technology, including remote, off-grid solutions are promoted	• Yes/in progress/not started • State policy target and timeframe
Life cycle management of fluorocarbons in particular addressing HFCs banks is pursued	• Yes/in progress/not started • State policy target and timeframe • % of progress
Review progress annually	Yes/no
Maintain up-to-date information on policies and commitments that is transparent, and publicly available	Yes/no

On the measure level, each indicator requires an MRV system to collect the required information. This MRV system is best set up along with the implementation of the mitigation activity and optimally placed within the KIP or the NCAP. For KIP implementation, the MLF Executive Committee requires regular progress reports, which should be used for this purpose.

Depending on the measure, the MRV system can also be a means of implementation, such as product registration systems that provide the basis for MEPS implementation and tracking. United for Efficiency provides extensive guidance on such systems. There are numerous systems on how to establish useful indicators. A commonly used concept is SMART indicators, specifying five features that indicators should fulfill: specific, measurable, achievable, relevant and time bound.

Cooling sector MRV systems are complex and are not likely to be perfect from the start. They might begin with capturing only a few basic parameters, such as overall HFC emissions and a rough estimate of overall energy emissions. But they can evolve and improve over time when experience grows, and effort is put into analysing specific applications in more detail. Ideally, the groundwork is done while preparing the NCAP, feeding into a continuous improvement process.

2.3.2 Step 6: Analysing progress

As with the MRV system, an ambitious sector plan requires several iterations and needs to follow technological improvement. To raise ambition in NDCs for future iterations, it is important to recognize that this does not solely involve increasing the emissions reduction target itself.

Instead, ambition can be enhanced in several ways that strengthen the quality, specificity and effectiveness of the NDC. The most suitable steps in the national context will mainly depend on the country's starting point.

One important step is improving the overall data situation, such as integrating a comprehensive HFC emission inventory into the NIR. This allows for a more detailed understanding of the country's emissions profile, facilitating more targeted mitigation efforts.

Additionally, raising ambition involves defining clear and precise targets by setting SMART indicators. These ensure that the goals are not only well-defined but also trackable and realistic. Equally crucial is specifying the measures required to achieve these targets, detailing the concrete actions that need to be implemented. This clarity provides a clear roadmap for execution, making it easier to align national efforts with global climate objectives.

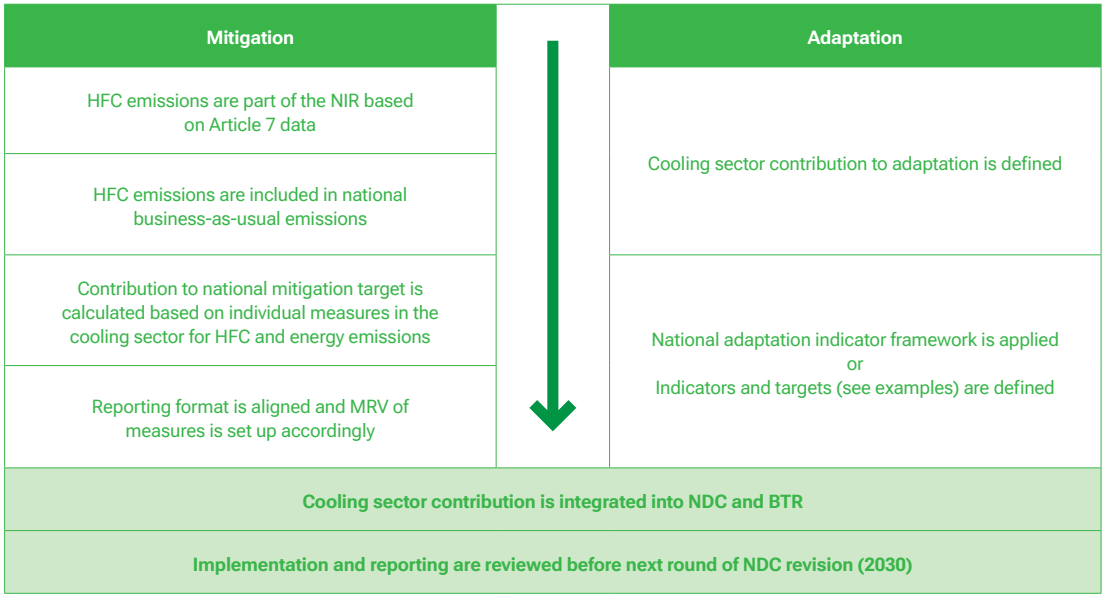
Another way to raise ambition is by ensuring that these specific targets and their corresponding measures are fully incorporated into the NDC document itself. By embedding these elements within the official NDC, the country demonstrates a stronger commitment and provides greater clarity to all stakeholders involved in the process.

Lastly, a robust system for MRV is essential. Establishing an MRV system, aligned with the ETF under the UNFCCC, ensures that the implementation of measures is rigorously tracked and that progress can be transparently assessed. This enhances both accountability and transparency, critical elements for driving effective climate action.

In this context, a Product Registration System (PRS) can play a key role, which is used to capture specific information on products to underpin policies or programmes and to provide an initial compliance gateway for products entering the market. PRS can capture information such as on energy efficiency baselines, but also on current refrigerants circulating in the market. United for Efficiency has developed a prototype PRS that can be used for free by countries and that also includes refrigerant tracking.

Figure 9 provides a suggested process flow on integrating cooling measures equally into adaptation and mitigation into the NDCs. By focusing on these elements, a country can significantly raise the ambition of its NDC in ways that go beyond just setting higher emissions reduction targets and driving meaningful progress toward achieving national and global climate goals.

Figure 9: Cooling sector integration into NDCs: Suggested process flow



2.4 Adaptation stage I: Baseline definition in alignment with NDC

While mitigation actions in the cooling sector are already getting mainstreamed in national policymaking, adaptation is only recently gaining increased attention. Access to cooling services, protection from extreme heat for living and office spaces as well as for food and medicine, are strongly connected to adaptation. Especially given the increased days of extreme heat, access to cooling is a matter of physical well-being and productivity, and can be a life-or-death challenge. NCAPs or NDCs so far rarely consider adaptation related to cooling sector targets.

"Access to cooling" refers to the ability of individuals and communities to obtain cooling solutions that are essential for health, productivity and well-being. This includes access to technologies and services that provide cooling for comfort, food preservation and medical needs, especially in the context of rising global temperatures (SEforAll 2022).

Adaptation is a broad concept that is driven by a community's need to adapt to changing climate conditions. Often, a risk assessment is carried out to prioritize areas of action. As heat stress is one aggravating factor driven by climate change, the need for cooling is implicitly – or explicitly – part of adaptation. Therefore, the first aim could be to make the relevance of cooling for adaptation visible and identify better cooling infrastructure as a

means for adaptation. In addition, many actions to address sustainable cooling support both mitigation and adaptation. These include for example:

- passive and nature-based solutions that can protect people during heatwaves while lowering overall energy demand for cooling
- efforts to expand access to sustainable energy in rural areas, providing sufficient energy to power a fan or refrigerator while reducing reliance on diesel or kerosene.

It is highly recommended to formulate adaptation (co-)benefits of cooling and recognize the cross-cutting nature of the cooling sector and their contribution to the SDGs. Adaptation targets, such as access to cooling, tend to be less quantitative than mitigation targets. Nevertheless, the formulation of indicators is a common tool to track the progress of adaptation measures.

2.4.1 Step 1: Taking stock of available data

Adaptation issues are (still) less data driven than mitigation targets. Adaptation metrics are often based on indicators aimed at quantifying how many people that are exposed to a certain risk have access to risk alleviation. In the case of cooling, this is often access to space cooling and cold chain infrastructure for food and medicine, but also urban planning to reduce heat island effects can be part of adaptation.

The initiative by SEforALL with its Chilling Prospects reports on the global state of populations' access to cooling provides a methodology to identify populations at risk. This analysis is mainly based on internationally available data and can guide interventions that support regional development while addressing climate goals.

To measure cooling access risks, SEforALL Chilling Prospects considers three primary indicators that can be adapted for adaptation metrics in NDCs: heat stress, energy access and poverty. In rural areas, those at high risk due to a lack of access to cooling are exposed to heat stress, lack access to electricity and are likely to live in extreme poverty. In urban areas, those at high risk are exposed to heat stress, have marginal or no access to electricity, and live in extreme poverty (Figure 10). To define metrics for improving adaptative capacity to climate change, the overlap between these three indicators within a given country would provide a baseline. The specific data sources, however, would need to be defined on a national basis. Nominally, if a country or sub-national unit within it experiences heat stress, that country may utilize poverty metrics or electrification metrics to determine the baseline, with preference given to the higher figure.

Figure 10: Indicators for cooling access risk

	Heat stress	Energy access	Poverty exposure
Indicators for cooling access risks	• Number of people exposed to temperature- and humidity-based heat at or above 35°C (meteorological statistics) • Compound heat risk (World Bank Climate Change Knowledge Portal)	• National electrification statistics (rural and urban) • Access to reliable, sustainable energy supply (SDG 7.1.1) (rural and urban)	• National poverty statistics • Proportion of the population living under the international poverty line (SDG 1.1.1) • Poverty threshold (World Development Indicators)

Cooling metrics can be integrated across sectors like agriculture, health, nutrition, thermal comfort and urban planning to support climate targets in support of key cooling needs. In agriculture, cold chains reduce food loss and improve food security. In health, they ensure the safe preservation of vaccines and medicines. For nutrition, cooling helps maintain food quality and reduces spoilage. In buildings and urban planning, thermal comfort metrics guide the use of energy-efficient cooling systems, lowering energy demand and mitigating heat stress.

Primary and secondary indicators across these cooling needs are provided below and serve as exemplary data sets that can support discrete topic or sector-based improvements of adaptive capacity in NDCs. . Additionally, it is essential to collect and analyze sex and gender-disaggregated data to understand the different cooling needs and impacts on men and women. This data will help in designing targeted interventions that address the specific vulnerabilities and requirements of both genders. The *Cooling for All Needs Assessment Scorecard* (SEforALL 2019) provides additional indicators and metrics, as well as their links to the SDGs.

Figure 11: Need-based indicators to measure improved adaptive capacity

Need-based indicators to measure improved adaptive capacity	Human comfort and safety	Food, nutrition and agriculture	Health services
Primary need-based indicators	• Proportion of the number of buildings supported by passive cooling measures • Morbidity and mortality related to heat stress • Cooling system ownership rates (% of households owning fans, air conditioners or other)	• Proportion of households with access to refrigeration • Proportion of food loss as a result of a lack of access to a cold chain	• Proportion (and total number) of vaccines, medicines and medical products lost each year due to cold chain failures • Number of health centres not served by cold storage facilities
Secondary need-based indicators	• Workdays or GDP lost annually due to heat stress • Proportion of the urban population with access to public green spaces • Proportion of learners and workers exposed to heat stress	• Volume and proportion of food loss and waste in the value chain • Prevalence of undernourishment, or moderate or severe food insecurity	• Proportion of the target population covered by all vaccines included in the national program

As indicated below in more detail, some of these indicators are monitored within international statistics that can be used for an initial assessment.

2.4.2 Step 2: Defining the baseline

Adaptation baselines are often described in a broader sense, combining information from general climate data, vulnerability assessments, socioeconomic and environmental indicators, institutional capacity and stakeholder engagement.

Depending on the level of detail of the national adaptation baseline and the focus areas, links to cooling can be apparent or not. Cooling is often relevant for:

- agriculture and nutrition (cold chain to reduce food loss)
- health (cool storage for medicine)
- thermal comfort, including urban planning (access to air conditioning during heat stress for safety, wellbeing and productivity).

To define the national adaptation baseline aspects where cooling can contribute to risk alleviation, the starting point can be the quantification of the number of people exposed and vulnerable to heat stress. The definition of heat stress and vulnerability may be determined by national governments based on local and national circumstances, but in principle the goal should be to quantify the number of people exposed and vulnerable to the effects of extreme heat. Possible indicators and potential data sources include:

- Number of people exposed to temperature and humidity-based heat at or above 35°C. Data available through national or international meteorological statistics.
- Number of people living in areas with a Compound Heat Risk factor of three or higher for temperature-based or temperature- and humidity-based heat and population risk categorization within a given climate scenario for the period of 2020–2039. Data available through the World Bank Climate Change Knowledge Portal
- Number of people could be disaggregated by gender. Sex-, age- and disability-disaggregated data would be beneficial to understand the different needs of various households and to design interventions with a leave-no-one-behind approach.

The second step is to account for reduced adaptive capacity. Vulnerabilities to heat stress will increase for those without adaptive capacity, and as a result countries may choose to designate those without such capacity at higher risk from extreme heat and heat stress. Indicators that imply reduced adaptive capacity to the effects of extreme heat include a lack of energy access to power a mechanical cooling solution and poverty exposure that prevents cooling solutions from being affordable. Possible indicators and potential data sources include:

- Number of people lacking access to electricity (rural and urban), as defined by the national authority. Data available through national electrification statistics or through *Tracking SDG7: The Energy Progress Report* (IEA *et al.* 2024)
- Number of people exposed to poverty, as defined by the national authority. Data available through national poverty statistics or the World Development Indicators.

As described above, countries may apply one or both of these indicators to the number of people exposed to heat stress to refine the baseline and/or delineate those at highest risk due to a lack of access to cooling. Countries may also elect to account for social factors affecting risk such as age, gender and people with underlying medical conditions.

Primary and secondary needs-based indicators can also be tailored to national adaptation priority areas, for example to assess the importance of cooling when working on urban planning. This would allow a country to track its progress against a discrete target where progress implies improved access to cooling.

2.5 Adaptation stage II: Target formulation and integration in national NDC target

2.5.1 Step 3: Analysing options

Assuming a national risk assessment has been undertaken, the identified risks should be reviewed with the question: Can cooling play a role for risk mitigation? And, how can cooling aspects be part of broader measures, such as urban planning and building codes? For a start, highlighting cooling-relevant measures increases their visibility and paves the way to specific measures in following NDC updates. If a NCAP exists, it may have addressed adaptation and could provide guidance for this analysis.

It might also help to categorize measures as either adaptation measures with mitigation co-benefits, or mitigation measures with adaptation co-benefits, especially to create a common understanding between stakeholders and NDC developers.

How to reduce the exposure to extreme heat in urban areas should be a stakeholder driven process. Technology choice should take mitigation co-benefits into account, e.g. the use of highly efficient equipment. Passive cooling measures such as green roofs, insulation and shading have found increasing attention in this context as they reduce the need for mechanical cooling.

Further information on cooling-related adaptation measures can be found here:

- World Bank: Primer for Cool Cities
- World Bank and SEforALL: Rural Cooling and Energy Access Nexus
- Climate Resilience Centre: Create a Heat Action Plan
- Efficiency for Access Library in General
  - Uses and Impacts of Off-Grid Refrigerators
  - Walk in Cold Room Practitioners Guide
  - 2021 Solar Technology Briefs
- Community cooling hubs
- Passive solutions to reduce the need for cooling in buildings
- Beating the Heat
- PARIS à 50`C (in French)

2.5.2 Step 4: Selecting measures

As stated in Step 3, there may not be a formal selection process at this stage, as specific measures have not yet been defined, instead the focus is on highlighting the cooling aspects within relevant measures.

In case a selection process is required, criteria could involve the magnitude of population being affected and mitigation co-benefits.

Adaptation measures can target both improved adaptive capacity as well as emissions reductions at the same time, and indeed many adaptation measures are likely to contribute to mitigation goals. These include enhancing passive cooling in buildings through updated building codes or retrofitting existing public buildings. The expansion of green spaces, water bodies, trees and vegetation in urban areas is another such measure. In health and agricultural cold chains, the creation of sectoral strategies to increase the use of sustainable cooling solutions in off-grid settings can contribute to increased adaptive capacity for rural farming communities and healthcare providers, while reducing sectoral emissions.

Measures that contribute only to adaptation are typically associated with reducing the impacts of extreme heat. These include the development of heat action plans and strengthening of disaster risk reduction efforts by

developing early warning systems, preparedness measures and response protocols for heatwaves, including for the health care sector.

2.6 Adaptation stage III: MRV of implementation and ambition review

2.6.1 Step 5: Defining indicators

Overall indicators were already identified when the baseline was established. For measures that specifically integrate cooling as an adaptation component, additional, more targeted indicators can be introduced to track progress. In particular, the primary and secondary indicators outlined in Figure 11 may prove useful. Developing gender-specific indicators is also useful to track the progress of gender-responsive cooling measures. For instance, indicators could include the number of women benefiting from energy-efficient cooling technologies or the reduction in heat-related health issues among women. Ultimately, the selected indicators should be integrated into the national adaptation monitoring.

2.6.2 Step 6: Analysing progress

As climatic conditions become more extreme, it is critical to respond promptly to minimize risks and protect communities. For example, as the risk of extreme heat increases, so too should efforts to ensure access to cooler spaces for the vulnerable population. Monitoring the outcomes of these measures using suitable indicators – and utilizing the regular cycle of NDC updates to evaluate past performance – is considered best practice. The MRV systems should also involve stakeholder engagement which contributes to accountability and transparency in adaptation and mitigation efforts.

Primary and secondary indicators across these cooling needs are provided in Figure 11 and serve as exemplary data sets that can support measuring adaptive capacity improvements in NDCs. For additional indicators and metrics, as well as their links to the SDGs, please see the *Cooling for All Needs Assessment Scorecard* (SEforALL 2019).

2.7 Country examples for NDC integration of mitigation and adaptation measures

The integration of cooling-related measures into the NDCs should be treated as a long-term process with continuous improvement over NDC cycles. The cross-cutting nature of cooling enables impacts in several mitigation and adaptation sectors. However, this can also be a barrier to implementation as it requires intense coordination between these sectors. The following country examples are meant to showcase different approaches and inspire countries to find their own way.

2.7.1 Bangladesh

Bangladesh has progressively included cooling targets in its NDC 2.0 under F-gases, which accounted for an estimated 2.9 million tonnes of emission reductions. The government was motivated by a desire to increase its climate ambition, supported by a structured assessment process to further refine the targets in the country's NDC 3.0. The integration process was led by the NOU, with input from investment projects and a NCAP, first developed in 2021. The NCAP provided scenario analyses of current and future cooling demand and was a key reference for embedding cooling in the NDC. A multi-sectoral technical committee was established and consultations with national stakeholders and international partners such as GIZ and the United Nations Development Programme (UNDP) played a crucial role. In addition, the BTR helped to refine sectoral data, particularly in the RAC sector.

Bangladesh approached the integration of cooling through both energy efficiency and refrigerant replacement, using the NCAP analysis, MLF projects and green building strategies under the HFC Phase-out Management Plan. Training and upskilling of technicians have also been included, and adaptation components will be introduced for its NDC 3.0 to ensure a more comprehensive approach. The inclusion of cooling targets has influenced sectoral planning, aligning energy efficiency measures with market transformation strategies. Governance structures mirror the NCAP model, with the Climate Change Unit overseeing the broader NDC integration, while the NOU and the Ministry of Energy lead implementation.

Bangladesh's Climate Change and Gender Action Plan integrates gender considerations into climate actions, including cooling strategies. The plan emphasizes the importance of gender-disaggregated data and includes specific measures to address the cooling needs of women, particularly in rural areas (Bangladesh Climate Change Trust and United Nations Women Bangladesh 2024). For instance, the plan promotes the use of energy-efficient cooling technologies in women-led agricultural businesses to reduce post-harvest losses and improve food security.

Challenges included defining conditional versus unconditional targets due to dependence on international assistance, accurately modelling cooling-related emissions and ensuring effective inter-agency coordination. Strengthening institutional collaboration across ministries helped to overcome these barriers.

2.7.2 Cambodia

Cambodia identified the relevance of cooling for adaptation already in 2020. Their first NDC references the following adaptation actions:

- Implementation of "passive cooling" measures in cities (addressing the urban heat island effect [UHIE]), public buildings and commercial buildings.
- Cities (Phnom Penh and Siem Reap) are analysed for mitigating UHIE and projects are implemented: two per cent of the existing public and commercial buildings are retrofitted with passive cooling measures Inclusion of performance requirements of Passive Cooling Systems in the Building Energy Code of Cambodia (20 per cent of the newly constructed buildings will comply with the Building Energy Code)

Emission reduction estimates as co-benefits are provided for each activity along with the lead ministry. For example, the inclusion of performance requirements of Passive Cooling Systems in the Building Energy Code of Cambodia is led by the Ministry of Mines and Energy with the criteria being developed by the Ministry of Land Management, Urban Planning and Construction, and the estimated emission reduction is 140.9 kilotonnes of CO_2eq.

Cambodia's National Cooling Action Plan includes gender-responsive measures by ensuring that women are actively involved in the planning and implementation of cooling strategies. The plan highlights the need for gender-disaggregated data and promotes the inclusion of women in training programs for sustainable cooling technologies (Cambodia, Ministry of Environment 2023). Additionally, Cambodia's NDC actions reported gender equality results, with women engagement rates varying between 10–64 per cent (Cambodia, National Council for Sustainable Development 2023).

2.7.3 Colombia

In Colombia, the process of integrating cooling targets into their NDC was significantly shaped by the work surrounding the KIP. The NOU, within the Ministry of Environment, played a crucial technical support role, facilitating the inclusion of specific cooling-related projects. As highlighted in interviews with NOU representatives, the development of a domestic refrigeration Nationally Appropriate Mitigation Action (NAMA) project, concurrently with the NDC updating process, offered a readily available, fundable initiative to demonstrate the country's commitment. This strategic alignment of NAMA development with the NDC timeline is a valuable lesson for other countries seeking to effectively integrate cooling. The already existing proposal for the NAMA project, focusing on the manufacturing sector, enabled its seamless integration into the NDC, showcasing a practical approach to incorporating concrete, actionable cooling measures.

Colombia's Gender and Climate Change Submission to the UNFCCC outlines the integration of gender considerations into climate policies, including cooling strategies (Colombia 2024). The submission highlights the importance of gender-responsive capacity building and technology transfer, ensuring that women have access to training and resources in the cooling sector.

Interviews with Colombian officials revealed that the primary challenge for cooling integration lies in the complexity of climate change-focused projects. The requirement for detailed indicators, implementation plans, MRV frameworks and near funding-ready status makes it difficult to include nascent or less developed measures. Colombia overcame this hurdle by focusing on projects with secured funding and detailed plans, such as the domestic refrigeration NAMA and a thermal district project. This highlights a best practice: prioritizing "shovel-ready" projects for NDC inclusion. However, Colombia also noted the substantial financial burden and technical complexities associated with developing new cooling measures for subsequent NDC updates. This underscores the need for simplified inclusion processes and accessible funding mechanisms specifically targeted at cooling projects, which could be a crucial element for the broader adoption of cooling targets in NDCs by other countries. They also emphasized the inherent conflict between the Montreal Protocol's focus on ODS and HFC consumption reduction and the NDC's requirement for emissions reduction projects with MRV, highlighting the need for greater alignment between these frameworks.

2.7.4 Ghana

Ghana has been proactive in integrating cooling targets into its NDC, building on its early regulatory efforts in the RAC sectors. The integration process was initiated by the NDC Department, using data from the NCAP. The Energy Commission and the NOU played a central role in coordinating the efforts. The establishment of the National Committee for Cooling provided governance oversight to ensure effective implementation and alignment

with climate and energy policies. The country took a holistic approach to cooling, balancing energy efficiency improvements with the transition to low-GWP refrigerants.

Governance of the cooling targets within the NDC framework is structured around the Climate Change Unit, which leads implementation and reporting, while the Energy Commission enforces policy and collects data. The NOU ensures alignment with international obligations under the Montreal Protocol. This coordinated approach has enabled efficient data sharing and the integration of NCAP targets into the NDC. The inclusion of cooling targets in the NDC has had a transformative effect on Ghana's appliance market, moving it from a reliance on used, inefficient appliances to a more energy-efficient product landscape.

Ghana's National Adaptation Plan process includes a strategy for integrating gender considerations into climate actions, including cooling. The plan recognizes the different climate vulnerabilities of men and women and includes measures to address these disparities (Ghana, Environmental Protection Agency 2020).

Ghana faced several challenges in including cooling targets in its NDC. Institutional coordination was an initial hurdle due to a lack of clear synergies between government agencies, which was later addressed through formal collaboration frameworks. Data availability was another key issue, with limited baseline information on cooling equipment and imports prior to the development of the NDC. The Energy Commission addressed this by establishing an inventory database to track imported equipment, while the NOU established a refrigerant consumption database to improve monitoring and compliance.

2.7.5 Grenada

The transformative journey toward incorporating cooling considerations into NDCs began with Grenada's bold and visionary aspiration to become the world's first HFC-free island nation. This ambitious initiative catalysed a paradigm shift by actively promoting energy-efficient, HFC-free alternatives, which successfully raised awareness and persuaded numerous equipment importers to introduce fluorinated gas-free refrigerators and split air conditioning units to the Grenadian market.

A comprehensive RAC sector inventory, published in 2019, established the critical foundation for quantifying cooling's impact on national energy consumption – revealing the startling figure that over 60 per cent of electricity usage was attributable to cooling applications. Building upon this insight, Grenada developed a strategic NCAP that outlined multifaceted measures to enhance building envelope performance and boost appliance efficiency standards, while simultaneously accelerating HFC emission reductions through targeted technician training programs and the establishment of a sophisticated refrigerant recycling infrastructure. Also, this NCAP includes gender-responsive measures by advancing gender mainstreaming in the RAC sector. The plan supports the training of female RAC technicians and promotes the inclusion of women in decision-making processes (GIZ 2021).

The considerable mitigation potential identified through these initiatives captured the attention of Grenada's National Climate Change Committee, whose substantive endorsement and support proved instrumental in seamlessly integrating these cooling-focused interventions into the country's updated NDC submission.

Commercial establishments, residential dwellings and tourism-related facilities constitute the primary locations for cooling applications across the island. The unwavering determination of the NOU, coupled with its synergistic collaboration with the Department of Energy, represents a cornerstone of Grenada's remarkable progress in this domain.

Currently, Grenada is diligently enhancing its MRV framework to effectively track and evaluate the implementation progress of these transformative policies, ensuring accountability and continuous improvement in its climate action initiatives.

2.7.6 Nigeria

Nigeria chose to integrate cooling into its NDCs due to a confluence of factors, including increased heatwaves, the recognized impact of HFCs on climate change and the ozone layer, and the understanding of cooling's importance for adaptation. Unlike many countries that prioritize cooling for mitigation purposes, Nigeria recognized its significance in adapting to rising temperatures, particularly given the impact of heatwaves on vulnerable populations like schoolchildren. This focus allowed them to increase the ambition of their NDC by addressing a critical climate vulnerability. The integration of cooling was further facilitated by the development of a NCAP, which provided a readily available framework for incorporating cooling considerations into the NDC.

The process of integrating cooling into Nigeria's NDC involved close collaboration between several ministries and agencies. The Ministry of Housing played a key role in addressing building codes and appliance efficiency, while

the NOU focused on HFC phasedown. The renewable energy agency expressed interest in exploring solutions for powering cooling appliances with off-grid renewable energy, particularly for vulnerable and rural communities. This distribution of responsibilities ensured a comprehensive approach to cooling, encompassing both energy efficiency and refrigerant transition. Despite initial challenges related to inter-agency coordination and data collection, Nigeria successfully streamlined the process by clarifying roles and responsibilities and establishing clear data collection procedures across agencies. The country also benefited from international partnerships and support from organizations like UNDP and the United Nations Industrial Development Organization (UNIDO).

It is worth noting that Nigeria has implemented gender-responsive measures such as training programs for women in the RAC sector, ensuring that women have the skills and opportunities to participate in the cooling industry (UNIDO 2023). This approach not only addresses gender disparities but also enhances the overall effectiveness of cooling strategies.

2.7.7 United Arab Emirates

The United Arab Emirates' drive to include cooling targets in its NDC originated from a national demand-side management program focused on reducing consumption-based emissions, particularly within the building sector. This emphasis on cooling efficiency and technology, coupled with the United Arab Emirates' recognition as a global leader in district cooling, positioned them well to incorporate Global Cooling Pledge targets. Their existing National Cooling Efficiency Program, with targets extending to 2050, and the development of a dedicated NCAP were instrumental in aligning cooling with broader national objectives. Specifically, the NCAP, originating from the 2021 demand-side management strategy, provided a framework for integrating local and national cooling targets, a best practice other countries could replicate.

A key takeaway from the United Arab Emirates' experience is the emphasis on stakeholder engagement and a whole-government approach. The Ministry of Energy, Ministry of Climate Change (driving the Net Zero Strategy) and Ministry of Industry and Technology (setting standards) collaborated with private sector district cooling leaders. This multi-stakeholder engagement ensured buy-in and addressed data collection challenges through quarterly data updates, training and a dedicated data portal. Another valuable lesson for other countries is the United Arab Emirates' focus on raising awareness and promoting energy efficiency through initiatives like "Save to Sustain" and utility-led programs targeting diverse communities, showcasing impactful implementation beyond policy setting. They also stressed the importance of research and development, collaborating with universities for technological advancements, a crucial aspect for optimizing cooling solutions and achieving ambitious targets.

2.7.8 Singapore

Singapore's approach to cooling in its NDC stands apart from many countries, as it follows an absolute emissions cap rather than a sector-specific baseline. While Singapore does not set explicit cooling targets, cooling is embedded within broader climate mitigation and adaptation strategies under the Singapore Green Plan 2030, which aims to cut emissions to 45–50 $MtCO_2e$ by 2035. This plan guides national climate strategies by focusing on reducing the UHIE and advancing sustainable cooling systems. Key measures include the Resource Efficiency Grant for Energy, MEPS for appliances and green procurement requirements for public agencies. Cooling is also incorporated into green building policies, with mandates for energy audits, environmental sustainability standards and HFC regulation under the Kigali Amendment. Governance follows a whole-of-government approach, with responsibilities distributed across ministries. Also, the plan promotes the use of sustainable cooling solutions that account for gender-informed needs, such as thermal comfort at home and in the workplace. Singapore's policies also leverage synergies with electricity, water and healthcare policies to ensure equitable access to cooling for women.

Singapore faced key challenges in integrating cooling into its climate strategy. Balancing economic growth with energy efficiency was a major hurdle, given the country's tropical climate, which drives high cooling demand in buildings and industries. Stakeholder alignment, from building owners to businesses and consumers, also posed challenges, addressed through financial incentives like the Green Mark Incentive Scheme and the Climate-Friendly Household Programme. In the RAC sector, phasing out high-GWP refrigerants in line with the Kigali Amendment required regulatory and financial support to drive industry transition. While prioritizing sustainable cooling has helped transform Singapore's built environment to reduce energy use and emissions, retrofitting older buildings remains costly and disruptive, presenting an ongoing challenge.

2.7.9 Viet Nam

Viet Nam's inclusion of the cooling sector in its 2022 NDC update stemmed from recognizing cooling emissions as a significant source during the NDC development process. The ozone cooling sector played a crucial role by providing initial data, prompting further analysis and identifying concrete mitigation measures. This process involved extensive consultations with various ministries and stakeholders, leading to the selection of

four specific measures – three focused on energy efficiency and one on industrial processes – for integration into the NDC. A key challenge was the difficulty in collecting consistent and comprehensive data from various sources, necessitating capacity building and the development of a more structured approach to data gathering. The process also included a cost-benefit analysis to identify the most feasible and cost-effective measures for implementation, considering both domestic resources and potential international support. Their National Adaptation Plan process includes mainstreaming gender considerations into climate actions, including cooling. The plan analyses the gender-differentiated impacts of climate change and includes measures to address these disparities. Viet Nam's National Adaptation Plan promotes the recognition of women as agents of change and includes activities to enhance women's resilience and participation in climate actions (UNDP 2023).

While the initial NDC primarily focused on cooling as a mitigation target, subsequent updates, aided by UNEP experts, have incorporated adaptation co-benefits. A roadmap with activities to analyse mitigation actions was developed, emphasizing a comprehensive process beginning with sector identification, followed by in-depth analysis leading to concrete measures with clear methodologies and realistic assumptions. This process also considered the alignment of measures with available funding and costs, particularly for cost-benefit/cheap measures. Although a systematic tracking framework for NDC implementation is still desired, assumptions about air conditioning availability and urban-rural disparities were considered, along with initiatives like the UNEP Cool Coalition's work on city planning for heating and cooling. Future NDC updates will further reflect on these lessons learned and incorporate more robust tracking mechanisms.

3 Blueprint for NDC section on cooling

The following blueprint offers an example of a NDC section on cooling for the new phase of NDCs (2025–2035). It is based on a similar blueprint that was developed for buildings (Global Alliance for Buildings and Construction et al. 2024). It captures the most relevant information on cooling that will effectively enhance the NDC on the subject. The following can be used by countries as a template and adapted as well as expanded with national information. It is purely illustrative.

Items highlighted in green are to be filled with national information.

-- Start by dedicating a section or chapter in the NDC to the cooling sector --

The cooling sector comprises refrigeration for domestic, commercial and industrial needs, as well air-conditioning of buildings and vehicles. It has been growing at a rate of xx% annually, with the largest growth witnessed in the [residential/commercial/industrial] subsector. Drivers for this growth are [increasing household income and higher extreme temperatures/urbanization/etc.] and the development is expected to continue, with equipment numbers reaching xxx units in the xxx subsector by 2035.

The cooling sector is crosscutting over adaptation, energy and Industrial Processes and Product Use (IPPU) emissions. Relevant aspects include buildings, efficient appliance use, industrial efficiency, refrigerant shift and urban planning, as well as access to cooling... [as identified in the NCAP]. Refrigerant consumption leading to HFC emissions is controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer.

-- Give general introduction to state of the cooling sector in country and outline overall targets for sector --

In [20XX], the cooling sector in [country name] emitted [XX MtCO2eq] (including HFC emissions and indirect emissions from electricity consumption), mostly originating from ... [sectors with highest share]. By 2035, emissions will be reduced by [XX%], achieving a target of [XX MtCO2eq] in cooling-related emissions. This ambitious target recognizes the growth of cooling demand but emphasizes the country's commitment to transitioning to a low-carbon economy.

As of [20XX], approximately [XX million people of which xx million are women], or [XX% of the population of which xx% are women], lack access to reliable cooling systems for health, food preservation and productivity. This has led to a high vulnerability to extreme heat, with [XX million people] at significant risk. By 2035, the country aims to reduce the number of individuals at high risk from extreme heat by [XX%], through expanded access to energy-efficient cooling systems, enhanced building designs and integrated nature-based solutions.

-- Outline current policy landscape of climate change mitigation and adaptation in buildings --

Existing policies (expand and adapt as required)
[Country name]'s regulatory and policy frameworks currently support efforts to mitigate and adapt to the challenges posed by growing cooling demand, with several initiatives already in place.

Kigali Amendment compliance:

- [Country name] ratified the Kigali Amendment in [month, year], committing to phase down HFCs and adopt low-GWP alternatives. The National Ozone Unit (NOU) coordinates HFC phase-down efforts, overseeing licensing systems, capacity building to enhance the capability to handle low-GWP refrigerants, and refrigerant recovery programs.

Minimum Energy Performance Standards (MEPS):

- Mandatory MEPS for air conditioners (≤ [XX kW]), refrigerators and freezers, revised last in [year], are enforced through a combination of regulations and oversight by the [ministry/agency] in collaboration with customs and enforcement authorities.

Building codes and urban planning:

- National building codes mandate insulation, passive cooling and energy-efficient designs for public buildings and major commercial structures, aiming to reduce overall cooling demand. Urban planning strategies, like "cool city" programs include green space development, reflective surfaces and ventilation corridors to address urban heat island effects.

[Space to provide examples on national initiatives]

-- Describe the mitigation effect of the implementation of the Kigali Amendment --

Mitigation effect of the implementation of the Kigali Amendment (expand and adapt as required)
The Kigali Implementation Plan (KIP) was approved in [20xx]. [Country name] committed to restrict HFC consumption to [xxx Mt CO_2eq] in 2029. This is an xx% reduction relative to the baseline consumption (average HFC consumption of 2020–2022). Further consumption reduction compliant with the Kigali Amendment will lead to a further reduction of 30% relative to the baseline. It is project that this will lead to HFC emission of [xx Mt CO_2eq] in 2030 and [yy Mt CO_2eq] in 2035. This is a reduction of [x%] and [y%] relative to [20xx].

-- Outline planned policy for increased ambition --

New policy options (measures) to close the gap towards the more ambitious 2035 target
The NCAP was set up in [20xx] and has set out a comprehensive roadmap that will reduce emissions of [xx t CO_2eq] by [20xx] and improves adaptation by [improving access to refrigeration by x%, reduces food loss by y%, ...] Sub-targets on emission reduction include ... [as identified in the NCAP].

In addition to the HFC emission reduction, measures implemented under the Kigali Amendment (KA) on energy efficiency will mitigate [x t CO2] in 2035. [specify measures, i.e. building energy codes, MEPS introduction, finance support for market uptake...]

Other measures outside the KA include ... [as identified in the NCAP].

The first NDC did not identify a specific GHG mitigation target for the cooling sector. This NDC reinforces the targets identified in the NCAP and captures its crucial linkage for the national GHG inventory.

The following table presents the actions named above, focusing on both mitigating emissions from the cooling sector and enhancing resilience to extreme heat.

	Measure	Target 2030	Target 2035	Responsible institution	Reporting mode	Estimated finance needed
1						
2						
...						

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