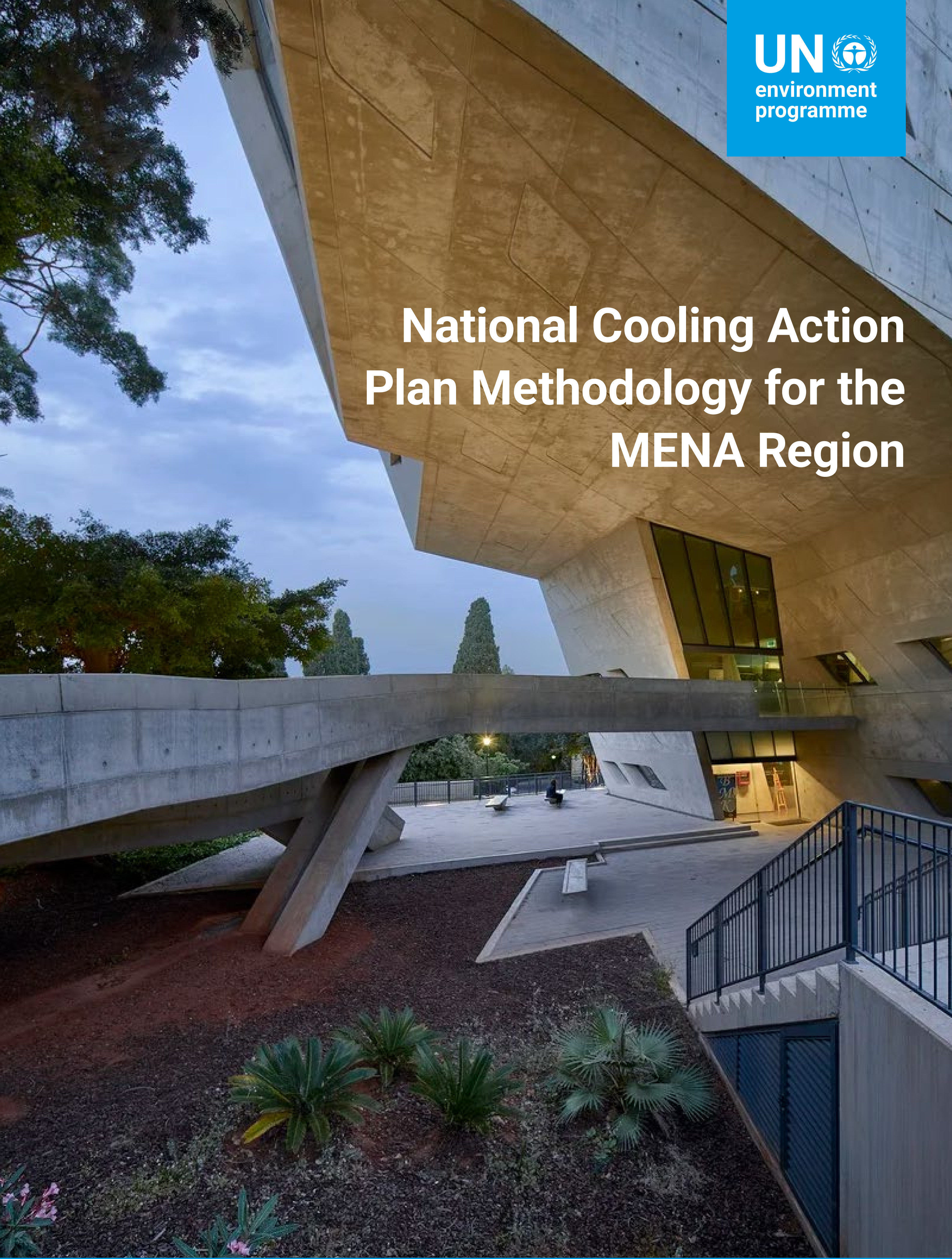
UN environment programme



National Cooling Action Plan Methodology for the MENA Region

A technical Report

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For feedback or comments on this Methodology, we welcome you to reach out at unep-coolcoalition@un.org. Your insights and suggestions are invaluable as we continue to develop this methodology.

Executive Summary

The urgency for sustainable cooling in Middle East & North Africa (MENA) is stark, given that most countries in the region are classified as high-ambient temperature (HAT) countries, with many experiencing additional thermal stress from high humidity. SEforALL's "Chilling Prospects" highlights that nearly all MENA countries face medium to high risks of inadequate access to cooling, underscoring the critical need for inclusive and equitable solutions as both a development imperative and a fundamental climate adaptation response. With 78% of the MENA population at risk from inadequate cooling access, equitable and sustainable strategies are crucial for climate resilience.

While several countries have introduced Minimum Energy Performance Standards (MEPS) and building energy codes, progress is slowed down by varying ambition, limited enforcement capacity, and fragmented market surveillance. Reliance on low-efficiency air conditioning systems, often using HCFCs or transitioning to HFCs, remains widespread. A shift toward super-efficient, climate-friendly solutions, including low-GWP refrigerants, passive cooling measures, and advanced technologies such as inverters, and scalable approaches like district cooling, is essential, yet uptake is slowed by high upfront costs and limited access to finance.

The cNCAP[1] MENA methodology offers a dynamic and adaptable framework for countries in the Middle East and North Africa to develop robust National Cooling Action Plans (NCAPs). This "living, green document" is designed to evolve with ongoing regional experiences and national implementation efforts, ensuring its continued relevance in the pursuit of sustainable cooling. It provides a flexible yet structured approach that helps MENA nations align their cooling strategies with global climate commitments, such as the Kigali Amendment, the Paris Agreement, and the ambitious Global Cooling Pledge, all while remaining grounded in local priorities. The methodology specifically addresses the unique regional challenges faced by MENA, including extreme heat, limited access to cooling, fragmented regulations, and the persistence of outdated technologies. It further emphasizes critical aspects like gender equality and social inclusion, facilitating access to climate finance and fostering technical partnerships, alongside promoting harmonized policy approaches.

Based on initial market analysis, residential cooling and cold chains are priority sectors given their high demand, direct impact on health, food security, and productivity, and strong potential for energy efficiency and emissions reduction. Over time, broader NCAPs can also address cooling in commercial and public buildings, industrial processes, data centres, and transport refrigeration, as data availability improves.

The cNCAP MENA methodology provides a structured approach, starting with a thorough assessment of the current cooling landscape, including demand patterns, existing technologies, policy frameworks, and market dynamics. This assessment phase, crucial for understanding country-specific challenges and opportunities, is followed by a strategic planning phase where countries can set ambitious, yet achievable, targets for sustainable cooling. The methodology guides the identification of key interventions, policy instruments, and financial mechanisms needed to achieve these targets. Finally, it outlines an implementation framework, emphasizing stakeholder engagement, capacity building, and robust monitoring and evaluation. By following this adaptive framework, countries can ensure their NCAPs are not only technically sound but also politically feasible and economically viable, fostering a just transition to sustainable cooling.

1 *cNCAP MENA Methodology – Contextualized NCAP MENA Methodology*

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List of Abbreviations

AC	Air Conditioning
AI	Artificial Intelligence
APF	Annual Performance Factor
AT&C	Aggregate Technical and Commercial
BAU	Business As Usual
BTR	Biennial Transparency Reports
CaaS	Cooling as a Service
CAPEX	Capital Expenditure
CBE	Central Bank of Egypt
CC	Cool Coalition
CCAC	Climate and Clean Air Coalition
CDD	Cooling Degree Days
cNCAP	contextualized National Cooling Action Plan
COP	Coefficient of Performance
COPH	Heating Coefficient of Performance
CSO	Civil Society Organization
CSPF	Cooling Season Performance Factor
EBRD	European Bank for Reconstruction and Development
EE	Energy Efficiency
EER	Energy Efficiency Ratio
EFT	Enhanced Transparency Framework
EOL	End of Life
FAO	Food and Agriculture Organization
FNMEERC	Fund for the Management of Energy and Renewable Energies and Cogeneration
GCF	Green Climate Fund
GCP	Global Cooling Pledge
GEFF	Green Economy Financing Facility
GFCCC	Global Food Cold Chain Council
GWP	Global Warming Potential
HAT	Extreme High Ambient Temperature
HCFC	Hydrochlorofluorocarbon
HEPS	High Energy Performance Standard
HFC	Hydrofluorocarbon
IEA	International Energy Agency
IEEHA	Italian Energy-Efficient Home Appliances Program
IFI	International Financial Institution
IMF	International Monetary Fund
IoT	Internet of Things
JREEEF	Jordanian Renewable Energy & Energy Efficiency Fund
KIP	Kigali Implementation Plan
LRM	Lifecycle Refrigerant Management
MDB	Multilateral Development Bank
MENA	Middle East and North Africa
MEPS	Minimum Energy Performance Standard
MLF	Multilateral Fund Secretariat
MRE	Monitoring, Reporting, and Evaluation
MVE	Monitoring Verification and Enforcement
NCAP	National Cooling Action Plan
NDB	National Development Bank
NDC	Nationally Determined Contributions
NEEAPs	National Energy Efficiency Action Plans
NEEREA	National Energy Efficiency and Renewable Energy Action
NGO	Non-Governmental Organization
NOU	National Ozone Unit
NPFC	National Policy Framework for Cooling
NREAPs	National Renewable Energy Action Plans
ODP	Ozone Depleting Potential
ODS	Ozone Depleting Substance
OPEX	Operating Expenditure
PNME	National Energy Efficiency Program
PPP	Public-Private Partnerships
PV	Solar Photovoltaic
PVT	Hybrid solar photovoltaic-thermal
RAC	Room Air Conditioning
RBF	Results-Based Financing
RCREEE	Regional Centre for Renewable Energy and Energy Efficiency
RH	Relative Humidity
SDGs	Sustainable Development Goals
SECAPs	Sustainable Energy and Climate Action Plans
SEER	Seasonal Energy Efficiency Ratio
SEforALL	Sustainable Energy for All
TEAP	Ozone Secretariat Technology and Economic Assessment Panel
TF	Task Force
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WHO	World Health Organization
YSDN	Youth Sustainable Development Network

01 Introduction

The Middle East and North Africa (MENA) region faces a distinctive set of cooling challenges shaped by its unique climatological, socioeconomic, and infrastructural conditions. Across *MENA countries*, several critical factors drive the urgent need for coordinated cooling action, including:

- Extreme High Ambient Temperature (HAT) environments that create substantial baseline cooling demands, with some areas experiencing over 50°C during the summer months[2]. This places extraordinary stress on cooling systems, making sustainable cooling a necessity.
- Profound disparities in cooling access disproportionately affect populations living below the poverty line in both rural and urban areas, leaving them highly vulnerable to heat-related risks. Moreover, heat risk and inadequate cooling access have gender differentiated health and livelihood impacts, especially for pregnant and older women, people with chronic illness, and low-income women working in informal outdoor and indoor settings.
- Underdeveloped food and medical cold chains that compromise food security, reduce agricultural income, and impair healthcare delivery, particularly for temperature-sensitive vaccines and medications.
- Limited technical capacity for effective refrigerant management during this critical transition period away from high-Global Warming Potential (GWP) refrigerants.
- Low market penetration of energy-efficient, climate-friendly cooling technologies and limited uptake of passive-first strategies due to economic barriers, policy gaps, and insufficient consumer and industry awareness.

These shared regional challenges present a compelling opportunity for collaborative approaches that transcend national boundaries while respecting individual country circumstances. The National Cooling Action Plan (NCAP) presents a strategic framework to proactively manage escalating cooling demand in a sustainable, equitable, and climate-friendly manner. NCAPs provide a structured approach for governments to align political will, establish clear and actionable targets, and coordinate efforts across diverse sectors to transition towards energy-efficient and low-emission cooling technologies.

Further, harmonizing these plans and policy settings across borders, i.e., for a region, coupled with the convergence of regulatory frameworks such as Minimum Energy Performance Standard (MEPS), product labelling, and refrigerant management protocols, creates a cohesive and predictable environment. This not only vastly simplifies the process of tracking collective progress and ensuring transparency but also, critically, fosters larger, integrated trade markets. Reduced trade barriers and standardized requirements encourage the flow of efficient, low-impact cooling technologies, driving economies of scale, stimulating regional innovation, and ultimately accelerating a sustainable cooling transition for the entire area.

Against this backdrop, tailoring the global NCAP methodology for the MENA region is important to ensure that we address the specific regional cooling challenges and mitigate the adverse environmental impacts of cooling while ensuring access to this essential service for all.

This document introduces the contextualized National Cooling Action Plan Methodology for MENA Countries (cNCAP MENA), a methodological framework that adapts global best practices to the region's specific cooling context. The cNCAP MENA framework serves as a strategic foundation for individual governments to develop tailored National Cooling Action Plans that include:

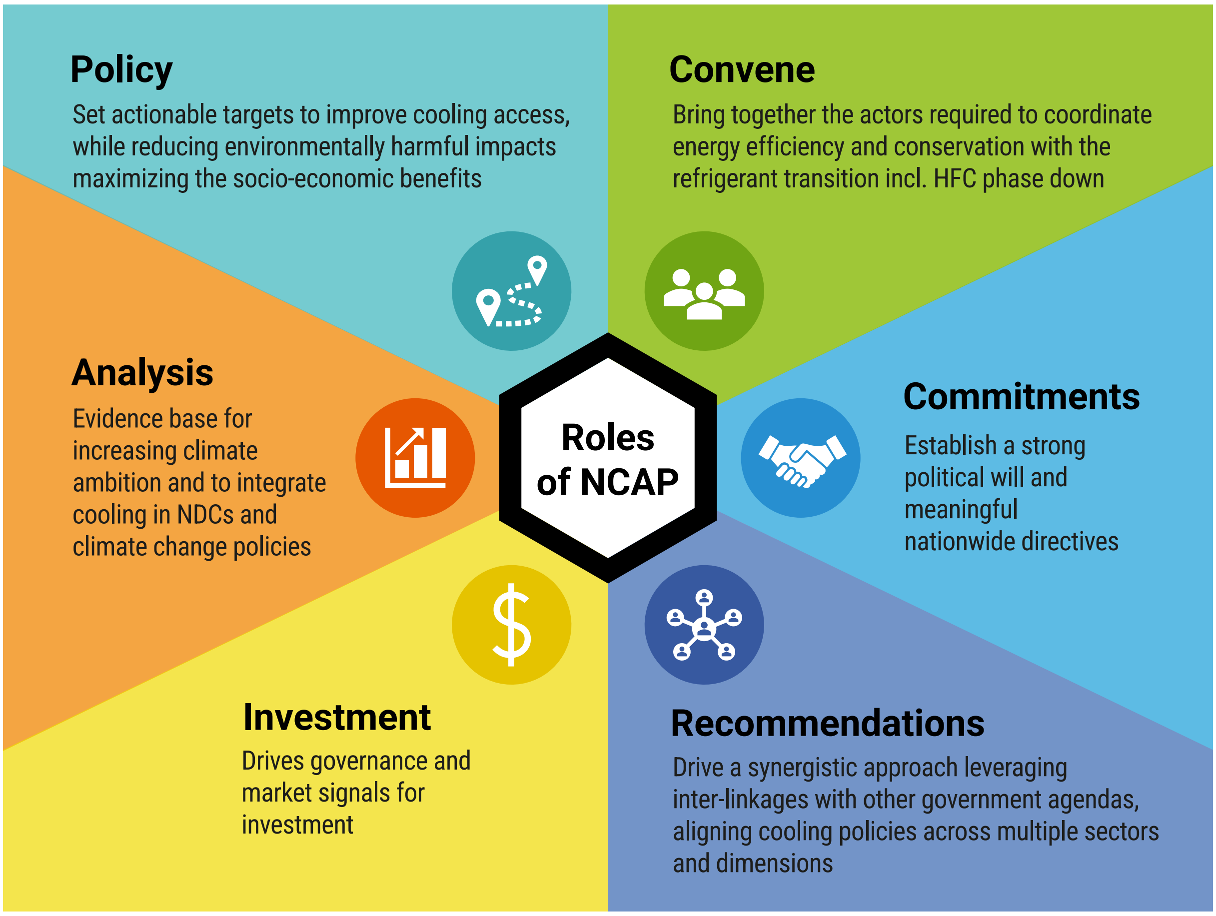
- Comprehensive, measurable targets for cooling action (e.g., energy efficiency improvements, emissions reduction, improved access, and/or HFC phase down) with clear implementation timelines
- Sector-specific strategies covering space cooling, refrigeration, cold chain, and mobile air conditioning
- Actionable measures for diverse stakeholders across government ministries, industry associations, and civil society
- Quantifiable objectives for energy efficiency improvements and sustainable refrigerant management
- Robust monitoring and evaluation mechanisms to ensure accountability and enable adaptive management

Experience demonstrates that developing a National Policy Framework for Cooling (NPFC) represents a valuable preliminary step before undertaking a full National Cooling Action Plan (NCAP) process. An effective NPFC articulates the government's strategic vision for sustainable cooling, establishes core principles, and defines the institutional architecture necessary for coordinated action. This foundation enables the detailed technical, financial, and operational elements within a comprehensive NCAP.

01.1 The Role of National Cooling Action Plans (NCAPs) for the MENA Region

In the MENA region, NCAP's role revolves around six thrust areas as shown in Figure 1.

Figure 1 NCAP roles and thrust areas



Lebanon has developed its NCAP[3], while Jordan[4] is at an advanced stage, and Egypt[5] is at the intermediate stage of its NCAP development process.

Within the framework of the Cool Coalition, United Nations Environment Programme (UNEP), RCREEE, Climate & Clean Air Coalition (CCAC), along with partners UNDP, SEforAll, African Development Bank and the Cool Up Programme jointly developed the regional contextualization of the Cool Coalition's global NCAP Methodology for the MENA region.

The development of the cNCAP MENA was guided by a Regional Cooling Advisory Group of experts from RCREEE member states. The contextualization was based on individual consultations with eight member countries (Algeria, Egypt, Kuwait, Iraq, Jordan, Lebanon, Morocco, and Sudan) representing MENA countries' diversity.

2 *Progress, Opportunities, and Insights, Issue 3 - Cool Up programme, accessed March 17, 2025, https://www.coolupprogramme.org/wp-content/uploads/2024/12/Cool-Up_MENA-Region-Cooling-Status-Report_Issue-3.pdf, page 7. Accessed March 18, 2025.*

3 *Guidance for Integrating Efficient Cooling in National Policies in Lebanon, https://www.undp.org/lebanon/publications/guidance-integrating-efficient-cooling-national-policies-lebanon, last accessed March 18th, 2025.*

4 *Jordan Finalizes National Cooling Action Plan to Drive Sustainable Cooling Transformation, https://www.coolupprogramme.org/knowledge-base/news/jordan-finalizes-national-cooling-action-plan-to-drive-sustainable-cooling-transformation/, last accessed March 18, 2025.*

5 *Kick-off of Egypt`s National Cooling Action Plan, https://www.coolupprogramme.org/knowledge-base/news/kick-off-of-egypts-national-cooling-action-plan/, last accessed March 18, 2025.*

1. Setting actionable targets to expand cooling access, minimize environmental harm, and maximize socio-economic benefits.

Thirteen of the seventeen RCREEE member states in the MENA region face significant cooling access deficits, as underscored by SEforALL's *Chilling Prospects* report[6]. Of these, nine are classified as 'high-impact countries,' meaning they are expected to experience sustained high temperatures and with large populations at high risk due to limited access to electricity and high poverty levels.

While three countries in the region have developed or are in the process of developing Kigali Implementation Plans (KIPs), many others have yet to do so and continue to rely on high-GWP and/or ozone-depleting (ODP) refrigerants, which pose serious environmental risks. Moreover, wide disparities in the adoption of MEPS for cooling appliances continue to hinder progress. While countries such as Morocco, Egypt, Algeria, and Bahrain have established robust programs, others remain in the early stages of planning or policy development.

To achieve sustainable and equitable cooling access, it is crucial to establish targets that: 1) expand cooling access, prioritizing populations at highest risk; 2) optimize cooling demand by leveraging passive cooling strategies in buildings; 3) accelerate the phase-down of high-GWP and ODP refrigerants; 4) promote energy-efficient cold chains to ensure robust food supply chain and 5) harmonize and strengthen MEPS and simultaneously maximize the socio-economic benefits of these transitions. Together, these actions can create socio-economic benefits for people and the planet.

Finally, NCAPs in the MENA region should also integrate climate change adaptation measures into cooling strategies, addressing the region's vulnerability to extreme heat. They should also address the affordability of sustainable cooling solutions for low-income households, ensuring equitable access and preventing a widening cooling gap.

2. Bringing together the actors required to coordinate energy efficiency with the HFC phase-down comprehensively

Achieving sustainable cooling requires a holistic strategy: ***protecting*** people with cooling solutions that are affordable and available, safe and reliable; ***reducing*** cooling demand via passive measures (e.g., nature based solutions, advanced building designs), ***improving*** efficiency through superior MEPS, ***transitioning*** to low-global warming potential (GWP) refrigerants, notably phasing down HFCs[7], using not-in-kind (NIK) technologies and District Cooling (DC) technologies as they have the potential to reduce energy consumption and reduce or eliminate the need for refrigerant, and using renewable-energy powered cooling, and ***leveraging*** the collective work of all actors involved rather than individual efforts. In the MENA region, the building, equipment, and refrigerant sectors have historically operated independently, hindering integrated progress. To effectively coordinate energy efficiency, conservation, and refrigerant transition, a robust collaborative framework is essential. Codes and Standards act as pivotal tools to facilitate this collaboration, uniting key actors to optimize synergies and accelerate the shift towards sustainable cooling practices.

There is no single government entity that is responsible for all activities related to sustainable cooling. Cooling is multi-sectoral and is typically covered under different directives among multiple government ministries and agencies, including energy, environment, water, urban planning, agriculture, health, finance, trade, manufacturing, tourism, higher education, among others.

A cooling task force should be created to promote interministerial collaboration among the relevant government ministries and organizations. NCAPs ensure consistency and coherence among policies related to energy efficiency, refrigerant transition, building codes, and urban development. It facilitates the pooling of resources and expertise from different sectors to achieve common cooling goals. NCAPs promote integrated implementation of cooling strategies across various sectors, maximizing synergies and avoiding duplication of efforts.

6 *Chilling Prospects: Tracking Sustainable Cooling for All 2025, https://www.seforall.org/data-stories/chilling-prospects-2025, accessed August 5, 2025.*

7 *MENA Region Cooling Status Report, https://www.coolupprogramme.org/wp-content/uploads/2023/12/Cool-Up_MENA-Region-Cooling-Status-Report_Issue-2.pdf, accessed March 18th, 2025.*

3. Producing the evidence base for increasing climate ambition and integrating cooling into NDCs, and climate change and energy policies

A comprehensive environmental stocktake of cooling is fundamental to increasing climate ambition. Currently, the MENA region struggles with a deficit of verifiable cooling data, hindering accurate assessments of both direct[8] and indirect[9] emissions. While some nations have successfully reported direct HFC emissions through Biennial Transparency Reports (BTRs)[10], the critical quantification of indirect emissions remains a significant gap. NCAPs are essential to bridge this gap. They establish robust baselines for cooling emissions and energy consumption and enable the development of future projections under diverse intervention scenarios. These projections provide the critical evidence base needed to demonstrably raise climate ambition. Furthermore, the strategic integration of quantified cooling impacts into Nationally Determined Contributions (NDCs) and broader climate change and energy policies is paramount. This integration should be harmonized with National Energy Efficiency Action Plans (NEEAPs) to maximize synergies between cooling efficiency measures and overall energy performance targets, while aligning with National Renewable Energy Action Plans (NREAPs) to accelerate the deployment of renewable-powered cooling systems. Additionally, embedding cooling strategies within Sustainable Energy and Climate Action Plans (SECAPs) will ensure comprehensive coordination across municipal and regional levels. This amalgamation will not only solidify cooling's role in national climate strategies but also unlock access to expanded financial resources, beyond traditional cooling sector investments, to support the necessary transitions.

4. Establishing strong political will and meaningful nationwide directives

NCAPs play a pivotal role in solidifying political commitment and translating it into concrete national directives[11]. The NCAP development process is inherently collaborative, requiring robust engagement from public, private, and civil sectors. This inclusive approach fosters a deeper understanding of the cooling sector's complexities, raising awareness of its environmental, economic, and social implications. The NCAP cultivates political will through:

- Facilitating broad stakeholder consultations, ensuring diverse perspectives are considered.
- Building consensus on strategic objectives and implementation pathways.
- Securing buy-in from relevant stakeholders, including line ministries, through active participation.
- Demonstrating the benefits of sustainable cooling, aligning with national development goals.

8 Direct emissions refer to the release of refrigerant gases directly into the atmosphere. These emissions occur during the manufacturing, operation (leaks), servicing, and disposal of RACHP equipment.

9 Indirect emissions refer to the release of GHG to the atmosphere due to the operation of the RACHP equipment; these are mainly associated with energy consumption.

10 A Biennial Transparency Report is the central instrument for reporting information established by Article 13 of the Paris Agreement, within the Enhanced Transparency Framework (ETF). It is a report that Parties to the Paris Agreement submit every two years, detailing their progress on climate action, including greenhouse gas emissions, efforts to achieve their NDCs, adaptation to climate change, and support provided and received. It's a key component of the ETF within the Paris Agreement, designed to track progress towards achieving the Agreement's goals.

11 Side Event – MENA National Cooling Action Plans - Cool Coalition, 2025, https://coolcoalition.org/side-event-mena-national-cooling-action-plans/, accessed March 18th, 2025.

5. Driving governance and market signals for investment

Governance. An NCAP is a powerful tool for strengthening governance in the cooling sector. The core strength of an NCAP lies in its ability to transcend sectoral silos and promote a holistic, integrated approach to sustainable cooling. In the MENA region, where various government agendas intersect, an NCAP serves as a crucial coordinating mechanism to align cooling with national development goals while fostering interministerial collaboration. In the MENA region, a well-structured NCAP can:

- Establish a Long-Term Policy Framework: NCAPs define national goals, objectives, and strategies for sustainable cooling, providing a cohesive policy direction and leading to policy certainty. NCAPs are also responsible for harmonizing these policies across different sectors (energy, environment, construction, etc.) and reducing regulatory inconsistencies.
- Enhance Regulatory Capacity: NCAPs identify gaps in existing regulations and recommend necessary updates or new legislation, such as strengthened MEPS, refrigerant phase-down schedules, improved building codes/passive cooling measures, and identify regulatory framework to enable district cooling. NCAPs also support capacity building for regulatory agencies, ensuring effective enforcement.
- Improve Coordination and Transparency: NCAPs establish a national coordination mechanism, facilitating collaboration among government agencies, industry, and other stakeholders for well-informed and coherent policies. They promote data collection and transparency, enabling informed decision-making and monitoring progress.
- Promote Accountability: NCAPs set measurable targets and indicators, allowing for regular monitoring and evaluation of progress and establish reporting mechanisms to track implementation and ensure accountability.

Investment. It provides the necessary governance framework and market signals to attract private sector participation, unlock financial resources, and accelerate the transition to a climate-friendly cooling sector. This creates market readiness and strengthens the sustainable cooling ecosystem by building the capacity of technicians, creating improved market awareness, and utilizing the efficient technology available in the market. In the MENA region, where investment in the cooling sector is often limited, an NCAP can:

- Enable the development of bankable sustainable cooling projects: NCAPs provide a long-term vision and clear policy direction, reducing investment uncertainty, and signal governments' commitment to sustainable cooling, encouraging private sector participation.
- Stimulate demand for sustainable cooling technologies: NCAPs promote the adoption of energy-efficient and low-GWP cooling technologies through MEPS, high energy performance standard or sustainable procurement guidance, labelling schemes, and public awareness campaigns, and encourage the development of local manufacturing and service capabilities for sustainable cooling solutions. Awareness campaigns should effectively target both women and men to ensure household decision makers, based on needs and preferences, are well educated when it comes to energy-efficient cooling solutions.
- Unlock Financial Incentives: NCAPs identify opportunities for financial incentives, such as subsidies, tax breaks, and green bonds, to support investment in sustainable cooling and facilitate access to international climate finance and development assistance.
- Promote Public-Private Partnerships (PPPs): NCAPs identify opportunities for PPPs in areas such as district cooling, building retrofits, and refrigerant recovery and recycling, and reduce the risks of private investment by providing governmental backing.
- Unlock Innovative Financial Mechanisms: NCAPs can leverage climate finance, blended finance, Results-Based Financing (RBF), and models like Cooling as a Service (CaaS) to attract private investment, reduce upfront costs, and accelerate the adoption of sustainable cooling technologies

By establishing a comprehensive policy framework, the NCAP guides regulatory measures, incentive mechanisms, and investment strategies. It provides a clear roadmap for achieving national cooling targets, ensuring accountability and effective coordination. This is achieved through:

- Defining clear, measurable targets and timelines for implementation.
- Developing regulatory frameworks for MEPS, refrigerant transition, and building codes.
- Creating a national coordination mechanism.
- Providing a long-term vision, which ensures the cooling projects' bankability and allows for stable investment.
- Outlining investment priorities for infrastructure and capacity building.
- Identifying and promoting financial incentives for sustainable cooling technologies.

6. Driving a synergistic approach leveraging inter-linkages with other government agendas, aligning cooling policies across multiple sectors and dimensions

The core strength of an NCAP lies in its ability to transcend sectoral silos and promote a holistic, integrated approach to sustainable cooling. In the MENA region, where various government agendas intersect, an NCAP serves as a crucial coordinating mechanism to align cooling with national development goals while fostering interministerial collaboration.

NCAPs align cooling with national development goals, including:

- **Health and wellbeing:** promoting access to sustainable cooling is especially critical to the region, which is increasingly exposed to extreme heat. An integrated approach, which combines passive cooling to reduce demand, optimized mechanical systems, and phasedown of high-GWP refrigerants, is particularly important for vulnerable populations – and for high-impact countries where large segments of the population face heightened health risks.[12]
- **Energy security:** promoting energy efficiency and integrating renewable energy-powered cooling technologies reduces MENA's reliance on fossil fuels.
- **Water security:** promoting passive cooling strategies and integrating water-efficient cooling technologies, such as district cooling technology, addresses the region's water scarcity while improving cooling access. This is also relevant for data centres, where traditional evaporative cooling towers can consume large volumes of water, up to 80% of which evaporates, making efficient cooling solutions critical.[13]
- **Food security:** promoting reliable, sustainable cold chains reduces food loss.
- **Refrigerant Supply:** promoting lifecycle refrigerant management (LRM), reducing refrigerant leakage and promoting refrigerant recovery, recycling, and reclamation to reduce refrigerant wastage. LRM also offers a secondary, important benefit of enhancing operational energy efficiency as it reduces system leakage and ensures optimum lifetime operation.
- **Urban planning:** promoting sustainable urban development by ensuring urban planning effectively integrates sustainable cooling features.
- **Economic growth:** stimulating local manufacturing and service industries by mobilizing government and private sector investment in sustainable cooling technologies. These technologies contribute to economic diversification and job creation and reduce heat-related productivity losses, aligning with national economic strategies.[14]

A unique opportunity for the region is the potential for NCAPs to serve as a catalyst for regional cooperation on sustainable cooling, build policy & standards harmonization to bring scale, promoting knowledge sharing, technology transfer and innovative financial mechanisms. Convergence of regulatory frameworks, and monitoring and verification mechanisms, as well as the wider trade markets, would unlock a larger potential for the wide-scale adoption of sustainable cooling technologies.

12 High-impact countries are those expected to experience sustained high temperatures which also have significant populations at high risk from a lack of access to cooling due to poverty and electricity access gaps.

13 https://www.nasuca.org/wp-content/uploads/2025/02/2025-06-10-NASUCA-Data-Centers-Final-Schneider.pdf

14 https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@dgreports/@dcomm/@publ/documents/publication/wcms_711919.pd

02 The Cooling Context in the MENA Region

This section outlines the cooling context in the MENA region, framing four core elements essential to the cNCAP: equitable access, passive cooling, energy efficiency, sustainable cooling technologies, and alignment with climate and development goals.

02.1 Equitable Cooling Access

According to *SEforALL*, thirteen out of the *seventeen RCREEE member states* have significant populations at high risk (see Table 1. Cooling access risk definition:19 for definition) due to a lack of access to cooling, exposing them to health risks from heatwaves, food spoilage, risks from inadequate cold chains for medicine and agriculture, and reduced productivity. Extreme heat events, exacerbated by climate change, are becoming more frequent and severe, making access to cooling technologies essential for survival and well-being. High-impact countries[15] include Algeria, Djibouti, Egypt, Iraq, Mauritania, Morocco, Somalia, Sudan, and Yemen. Non-high-impact countries include Jordan, Lebanon, the West Bank and Gaza, Syrian Arab Republic. SEforALL highlights Sudan as one of the nine critical countries[16] worldwide.

Access to cooling is a vital component of sustainable development, with far-reaching implications for health, food security, and economic growth. Chilling Prospects 2023 suggests that 78% of the MENA population is at various degrees of risk. Addressing cooling gaps and ensuring that no one is left behind in the transition to a sustainable cooling future is essential. As countries develop their NCAPs, prioritizing equitable access to cooling and protection of vulnerable groups from the impacts of extreme heat must be a cornerstone of their strategies. By doing so, MENA countries can enhance resilience, reduce emissions, and improve the quality of life for more than 335 million people without access to cooling in the MENA region. The lack of access to these solutions disproportionately affects women and men differently, including low-income households, rural and peri-urban communities, female-headed households, elderly women and men, persons with disabilities, forcibly displaced people, and workers in informal sectors. NCAPs should therefore diagnose gender differentiated needs and constraints and ensure targeted measures for equitable access. It is important to highlight that the proper food cold chains help avoid food loss and waste, which can lead to significant methane emissions when dumped[17] and PM2.5[18] when burnt in open fire. Addressing these disparities is critical to achieving the Sustainable Development Goals (SDGs), including Zero Hunger (SDG2), Good Health and Well-Being (SDG 3), Gender Equality (SDG5), Energy Access (SDG 7), and Climate Action (SDG 13).

15 *High-impact countries face prolonged high temperatures and have large populations at risk due to poverty and limited access to electricity for cooling.*

16 *Countries with largest population at risk worldwide.*

17 *https://unfccc.int/sites/default/files/resource/UNEP%20-%20Webinar%20on%20Food%20Security%20in%20the%20NDCs%203.0%20of%20the%20MENA%20Region%20.pdf*

18 *When plastics are mixed with food waste.*

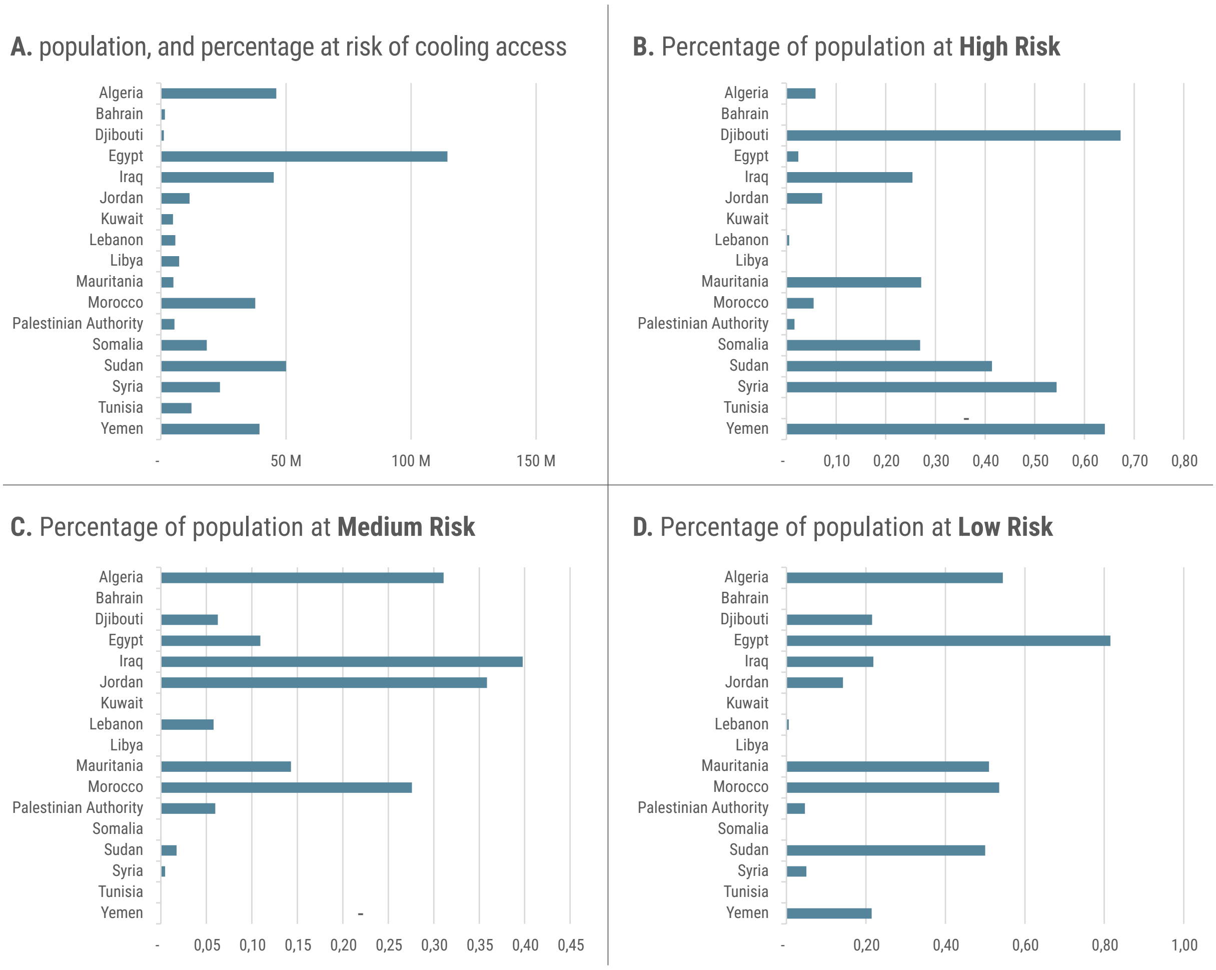
According to the SEforALL definition of the cooling access risk, as summarized in Table 1. Cooling access risk definition:19, we can see that there is a huge variability in risk between MENA countries. Some countries have more than 50% of the population percentage in high-risk category such as Djibouti, Yemen, and Syria, between 25 and 50% of the population percentage in high-risk category such as Iraq, Mauritania, Somalia, and Sudan; others have more than 50% of the percentage of their population in the medium-risk category including Egypt, Algeria, Sudan, Morocco, and Mauritania; and many have more than 30% of the population in the low-risk categories such as Iraq, Jordan, and Algeria. Figure 1 (a) shows a pictorial map with the RCREEE member countries' population, Figures 1 (b-d) illustrate the corresponding percentage of population at high-, medium- and low-cooling access risk, respectively.

Table 1 Cooling access risk definition:[19]

	High Risk		Medium Risk	Low Risk
Risk Spectrum	- No access to electricity - Income below poverty line - Poor ventilation and construction - No access to refrigeration for food - Farmers lack access to cold chains - Vaccines exposed to high temperatures		- Access to electricity - Lower income levels - Ability to run a fan, buildings constructed to older standards - Food is refrigerated - Farmers only have access to intermittently reliable cold chains - Vaccines may have exposure to occasional high temperatures	- Full and reliable electricity - Middle income and higher - Well-built homes can include insulation, passive design, air conditioning - Food is refrigerated reliably - Farmers' goods and vaccines have well-controlled cold chains
Risk Populations	Rural Poor	Urban Poor	Lower-middle income	Middle income
Risk Indicators	- Lack of access to energy - Population living in rural areas on < $1.90/day	- Lack of access to energy - Population living in urban slums on < $1.90/day	- Population living on <$10.01/day outside of rural or urban poverty	- Population living on $10.01 to $20/day

19 https://www.seforall.org/chilling-prospects-2022/global-access-to-cooling-gaps

Figure 2 **RCREEE Member countries. population, and percentage at risk of cooling access [2023]**



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Source: SEforALL Chilling Prospects: Global Access to Cooling Gaps 2023.[20]

02.2 Passive Cooling

Consultations through online one-to-one meetings with eight RCREEE member countries' key focal points and/or National Ozone Units followed a structured questionnaire. During these interviews, the focal points were asked a set of questions related to the countries' cooling ambitions, priorities, and status.

Through consultations and complementary desk research, it was found that nine of the 17 RCREEE member countries have adopted building energy codes; however, several countries still lack such codes, enforcement mechanisms are often weak, and passive cooling measures are not adequately incorporated.

Case Study 4
Building codes

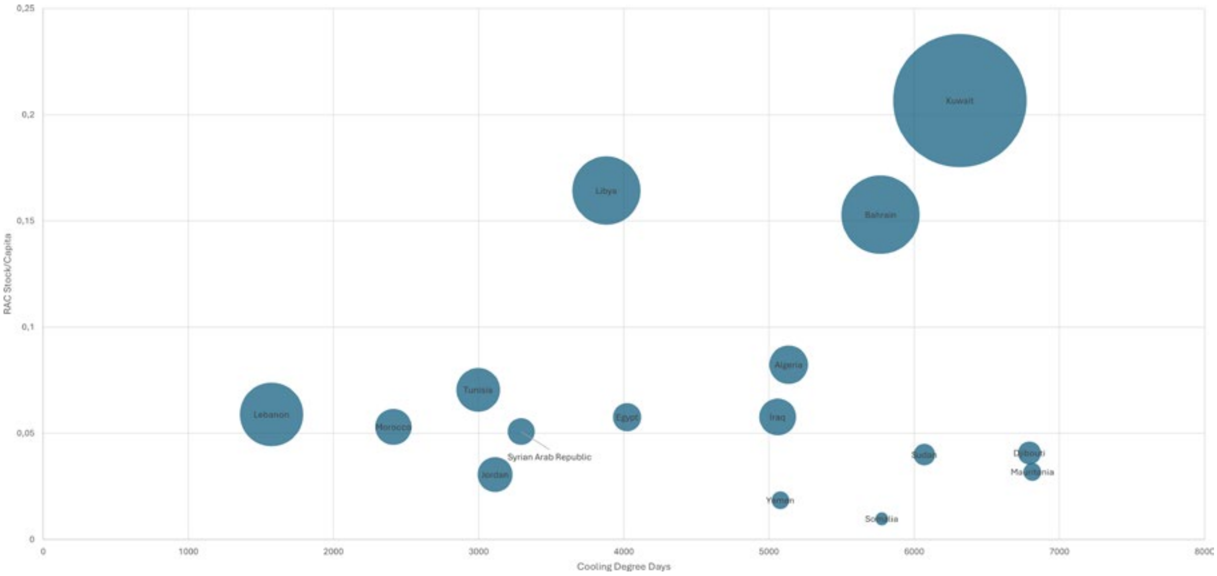
20 https://www.seforall.org/our-work/research-analysis/chilling-prospects-series/chilling-prospects-global-access-to-cooling-gaps-2023

02.3 Equipment Energy Efficiency

According to the *Green Cooling Initiative*, the MENA region cooling sector is responsible for a total of 132.14 Mt CO2eq of emissions (of which 37.38 direct and 94.76 indirect). The Green Cooling Initiative estimates that space cooling unitary equipment is responsible for direct and indirect emissions with 36% and 43% of total cooling emissions, respectively.

The estimated number of unitary cooling equipment in use in the MENA region is currently 23.3 million units operating in a region with *Cooling Degree Days (CDD)*[21] *varying from 1573 to 6814*. Figure 3 shows that RAC stock in use per capita is highest in countries with high CDD and high GDP per capita. However, it also highlights the access disparity in high ambient temperature countries, as shown in the available RAC stock in use per capita in Kuwait and Bahrain versus Mauritania, Sudan, Djibouti, and Somalia. This is an example for room AC alone; other cooling technologies have similar trends as shown in Figure 3, which is based on information available on the Green Cooling Initiative country data.[22]

Figure 3 RAC Stock per capita versus cooling degree days for seventeen MENA countries



Bubble size is indicative of the per capita GDP.

Consultations and a subsequent desk review revealed significant gaps in cooling efficiency standards across the region. Of the 17 RCREEE member countries, ten have implemented mandatory MEPS for room air conditioners, three have such standards for refrigerators, and one is actively developing MEPS for one or more categories of cooling equipment. However, consultations with eight countries showed that only four have enacted mandatory MEPS for certain cooling products, and two are currently developing such standards. This underscores the need for additional technical and financial support to expand MEPS coverage and enforcement. The U4E country savings assessments[23] provide preliminary overview of potential additional savings countries may achieve if they adopt or align their MEPS to the U4E model regulations.[24]

Case Study 3
MEPS in Lebanon

21 *A cooling degree day (CDD) is a measurement designed to track energy use. It is the number of degrees that a day's average temperature is above 18°C. Daily degree days are accumulated to obtain annual values.*

22 https://www.green-cooling-initiative.org/country-data#!total-emissions/all-sectors/absolute

02.4 Sustainable Cooling Technologies

The key elements are a holistic lifecycle environmental impact, with a focus on refrigerants and energy consumption, and affordability and accessibility, resilience, and meeting human and societal needs. In this section, we focus on the cold chain as an emerging area of need for the MENA region, refrigerant circularity through lifecycle refrigerant management, renewable energy integration, and energy efficiency metrics to meet sustainable cooling.

02.4.1 Cold Chains (*UNEP Cold Chain Report*, *Cold Chain Initiative*)

Access to cooling is also critical for food security. The Chilling Prospects report estimates that nearly 500 million smallholder farmers and food vendors in developing countries lack access to cold storage, leading to significant post-harvest losses. Inefficient or non-existent cold chains result in food spoilage, reduced incomes for farmers, and higher food prices for consumers. By addressing cooling gaps, countries can reduce food waste, improve food security, and boost agricultural productivity.

Cold Chain can be defined as: "The series of actions and equipment applied to maintain a product within a specified low temperature range from harvest/production to consumption, including farming/fishing, food processing, cold storage, transportation, food services, display, and domestic uses, as well as special products like medicinal products and vaccines."[25]

The cold chain is a complex sector resulting in greenhouse gas (GHG) emissions from direct refrigerant emissions, indirect energy consumption, and other direct emissions related to food loss and indirect emissions related to the processes involved. As such, the NCAP development process should recognize the importance of the cold-chain sector and properly define the scopes that should be covered as they ultimately impact emissions, but also access to affordable and sustainable food supply (SDG2, 3, 9, 12, and 13).

The methodology developed by GFCCC-UNEP OzonAction is based on a questionnaire that subdivides the cold-chain sector into primary production, food and drink processing, bulk storage, refrigerated transport, food and drink retail, food service, and residential sectors. Some of these sectors are applicable in all MENA countries, while others have limited applicability, as shown in Figure 4.

23 *https://united4efficiency.org/countries/country-assessments/*

24 *https://united4efficiency.org/resources/model-regulation-guidelines/.*

25 *A GFCCC – UNEP OzonAction Initiative towards a Sustainable Cold Chain: Cold Chain Database, the Concept & Methodology, http://www.foodcoldchain.org/wp-content/uploads/2021/07/GFCCC-UNEP-Cold-Chain-Database-Methodology-Final.pdf*

Figure 4 Cold-chains sub-sectors, MENA needs, and current access rates (indicative).

	Primary Production	Food and Drink Processing	Bulk Cold Storage	Refrigerated Transport	Food and Drink Retail	Food Service	Residential
Applicable in all MENA	Some	Most	All	All	All	All	All
Access in MENA	Medium	Medium/High	Medium/High	Medium/High	Medium	Medium	Medium/low
Comments	Most relevant for countries producing food (agriculture and/or fisheries)		More important in HAT and requires special attention		Prevailing technology varies	Varying levels from one country to another	Access might be an issue in some countries

Sustainable cold chain technology options vary by sector, focusing on the largest sectors of interest in the MENA region. In general, low-GWP refrigerants are widely available for large industrial refrigeration systems used in primary production, food and drink processing, and bulk cold storage, as well as for residential applications. There are some low-GWP refrigerants solutions available for food and drink retail, the food service sector and limited low-GWP refrigerants options for refrigerated transport. While lower GWP refrigerants are widely available for all sectors, it is important to differentiate between the availability and accessibility[26] of sustainable cold chain technologies in the MENA region. Some of the available technologies are not readily accessible and would only become so through effective implementation of the cNCAP MENA.

With regards to energy efficiency options in the cold chains, it is important to first consider reducing the cooling load (passive cooling) and then improving the efficiency of the cooling equipment.

The cooling load may be reduced through:

- Improving thermal insulation (e.g., increasing insulation thickness, using lower thermal conductivity foam, or using vacuum insulation panels),
- Adding doors to display cases,
- Reducing heat and moisture leaks, or
- Reducing heat sources, etc.

The efficiency of the cooling equipment may be improved by a combination of:

- Using higher efficiency compressors (up to 15% efficiency improvement over baseline compressors)[27],
- Improved heat exchangers,
- Optimized component sizing,
- Improved controls,
- Higher efficiency balance of system components, and
- Variable speed compressor technology that has shown the promise to provide 25 to 30% efficiency improvement over baseline compressors.[24]
- Advanced digital technologies, such as smart sensors, predictive maintenance systems and AI-driven optimization, to monitor performance and adjust operations in real time.

26 *Available technology primarily signifies that a particular technology exists, can be acquired, and is potentially usable. Accessible technology, on the other hand, refers to technology that is designed, developed, or modified to be widely usable by individuals with diverse economic and technical capacities.*

27 *UNEP 2021, TEAP 2021: Decision XXXI/7 - Continued provision of information on energy-efficient and low-global-warming-potential technologies (Volume 4), https://ozone.unep.org/system/files/documents/TEAP-EETF-report-may2021.pdf*

Finally, improving access to reliable and sustainable cold chains in the MENA region is crucial for enhancing food security and the safe storage of medical supplies. cNCAP MENA can play a vital role in this by supporting national governments in setting strategic frameworks and identifying cold chain development as a key intervention area. Initiatives like the Fair Cooling Fund[28] demonstrate how targeted financial support can drive innovation in sustainable cold chain solutions. Finally, innovative solutions such as cooling-as-a-service (CaaS) have shown effectiveness in improving access;[29] this approach may be leveraged in the MENA region – especially in the agri-food cold chain to reduce post-harvest food loss.

Case Study 9 **Nigeria – The CoolCycle Project**

02.4.2 Lifecycle Refrigerant Management (*TEAP TF report*)

Life Cycle Refrigerant Management (LRM) is an integrated policy framework that aims at minimizing the direct refrigerant emissions from refrigeration, air-conditioning, and heat pump appliances, while reducing the need for producing new refrigerants, and eventually making sure that the refrigerant is responsibly disposed of. LRM is particularly important for servicing-only parties which account for about 75% of refrigerant consumption in the MENA region.

The key stages of LRM are:

1. Preventing refrigerant leakage during design, manufacturing, installation, and operation,
2. Recovering refrigerant during servicing and at end-of-life (EOL), and
3. Reusing (through either recycling or reclaiming), or
4. Destroying recovered refrigerant that does not meet the standard quality requirements.

The HVAC&R technical workforce in the MENA region faces distinctive operational challenges that directly impact the quality and sustainability of cooling sector outcomes. Technicians often work in harsh, high-temperature environments, especially during peak cooling seasons, while facing intense pressure to meet surging service demand. This seasonal workload imbalance incentivizes rapid job completion at the expense of adhering to proper installation, servicing, and refrigerant handling procedures. As a result, common practices such as inadequate leak testing, improper refrigerant recovery, and rushed system commissioning contribute to elevated refrigerant emissions and reduced equipment efficiency.

Integrating LRM into MENA NCAP is important to ensure that each country considers LRM as an integrated policy early on and understands its primary impact on direct and secondary impact on indirect emissions. Implementing LRM effectively will require technical, policy, and behavioural shifts.

28 https://www.seforall.org/data-stories/ashden-fair-cooling-fund

29 https://www.seforall.org/data-stories/using-data-science-for-agricultural-cold-chains

To address these gaps, MENA region countries are working on upskilling the workforce and avoiding leakage during installation and operation – mostly through funding from the Montreal Protocol Multilateral Fund (MLF). However, there is still limited availability of refrigerant recovery equipment – especially for fast operation in high ambient temperature environments. In addition, MLF is working through the international implementing agencies to develop some pilot projects in the MENA region related to refrigerant reuse – especially more structured reclaim facilities. Finally, refrigerant destruction is limited in the MENA region and the available funding remains insufficient to develop a pilot project in this area.

LRM can increase available refrigerant supply, especially for servicing-only parties – like many within the MENA region – that have less flexibility in their approach to phasing out or phasing down refrigerant consumption. Effective leakage prevention and refrigerant reuse provide additional tools to reduce production and consumption for countries, which can assist with Montreal Protocol compliance. In addition, LRM can contribute to countries' NDCs. Currently, 89 A5 countries are being supported by the MLF to develop inventories of ODS/HFC banks and national action plans. Data from these inventories should be integrated into the NCAPs and NDCs and any potential future destruction can be accounted for in the NDC. Countries may also review the applicability of carbon markets under Article 6 of the Paris Agreement for the refrigerant reuse and destruction applications. There was limited information on refrigerant management in the region. Establishing a proper understanding of baseline refrigerant leakage rates, refrigerant recovery, recycling, and reuse, as well as destruction facilities in the region is an important precursor to starting any effective LRM policies or capacity building activities.

In absence of a detailed LRM accounting countries may use the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 3, chapter 7,[30] to estimate their inventory and leakage of refrigerants. Countries that lack available first-hand-information for some end-uses may elect to use the IPCC worst-case scenario estimates as shown in Table XXY (next page).

30 Intergovernmental Panel on Climate Change (IPCC). (2019). 2019 refinement to the 2006 IPCC guidelines for national greenhouse gas inventories. Agriculture, forestry and other land use, 4, 824, Volume 3, Chapter 7. https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/3_Volume3/19R_V3_Ch03_Chemical_Industry.pdf

Table XXY Charge, lifetime recovery efficiency, initial charge remaining and Worst-case estimates for charge emission factors at time of charge and annual operating leakage.[30]

Sub-application	Charge, kg	Lifetime, years	Emission Factors, % of initial charge		End-of life emissions, %	
			At time of charge	Annual loss, Operating life	Recovery efficiency	Initial charge remaining
Domestic refrigeration	0.05 to 0.5	12 to 20	1%	0.5%	0 to 70%	0 to 80%
Self-contained commercial refrigeration	0.2 to 6	10 to 15	3%	15%	0 to 70%	0 to 80%
Medium to large commercial refrigeration	50 to 2,000	7 to 15	3%	35%	0 to 70%	0 to 100%
Transport refrigeration	3 to 8	6 to 9	1%	50%	0 to 70%	0 to 50%
Industrial refrigeration including food processing and cold storage	10 to 10,000	15 to 30	3%	25%	0 to 70%	0 to 100%
Chillers	10 to 2,000	15 to 30	1%	15%	0 to 70%	0 to 100%
Residential and commercial air conditioners, including heat pumps	0.5 to 100	10 to 20	1%	10%	0 to 70%	0 to 80%
Mobile air conditioners	Maritime: 5 to 6500 Railway: 10 to 30 Busses: 4 to 18 Other: 0.5 to 2	9 to 16	0.5%	Maritime: 40% Other: 20%	0 to 70%	0 to 50%

Case Study 8 Energy Efficiency, LRM, and refrigerant transition

02.4.3 Renewable Energy Integration

Integrated renewable cooling refers to systems that strategically combine one or more renewable energy sources – such as solar (photovoltaic and thermal), geothermal, biomass, and wind – often coupled with energy storage (thermal and electrical) and intelligent control systems, to deliver cooling services. System integration is key to emphasizing the holistic design approach that optimizes energy flows, maximizes renewable energy utilization, and enhances overall system efficiency and cost-effectiveness. The use of renewable energy significantly reduces indirect emissions, and when deployed in a decentralized manner, it can also expand access to cooling in areas with limited or no grid connectivity.

Some of the key renewable energy integrated cooling technologies include:

- Geothermal-powered cooling technologies: using geothermal heat to run absorption or adsorption cooling technologies
- Geothermal cool reservoirs and thermal storage may be used as a sink for cooling if adequate temperature is available or as sink for air conditioning systems to improve their energy efficiency
- Solar thermal cooling technologies: using solar thermal heat to run absorption or adsorption cooling technologies
- Solar photovoltaic (PV) integrated technologies: using solar PV to either assist or run vapor compression systems completely off-grid. Off-grid operation requires the use of electric batteries and/or thermal energy storage
- Hybrid solar photovoltaic-thermal (PVT) technologies: using solar PV to power the electrical components (e.g., fans and pumps) and solar thermal to power the absorption/adsorption cycle

In the MENA region, Renewable Energy (RE) cooling technologies have gained traction as countries seek solutions tailored to their climate, energy resources, and development priorities. The UAE has pioneered a geothermal absorption cooling pilot[31] and large-scale cooling[32] projects. Solar thermal cooling technologies have been tested in Gulf countries to reduce peak electricity demand during the hottest months, while solar PV-powered systems are increasingly being adopted for both urban and rural settings. Off-grid solar PV refrigeration is helping close the access gap and improve food and vaccine cold-chain in remote areas in North Africa and the Levant. Hybrid approaches that use solar PV-thermal systems (PVT) are under exploration to integrate electricity and heat generation for most optimal performance using separate sensible and latent cooling technologies.

It is important to align renewable cooling targets with NDCs. This can further reduce the cooling sector emissions; however, it requires smart integration into urban planning and smart city initiatives and phasing out subsidies for fossil fuels to create a level playing field.

The widespread use of renewable cooling technologies can be attained through technological advancements, especially in smart controls, including the use of artificial intelligence (AI), and the Internet of Things (IoT). These technologies can be used to optimize the system operations and extend their economic viability.

Despite significant progress, several challenges hinder the widespread adoption of integrated renewable cooling:

- Renewable energy intermittency requires effective integration of energy storage and smart management systems.
- Initial investment remains a barrier, particularly in price-sensitive markets.
- A knowledge gap exists among end-users, policymakers, and even some industry professionals.
- Inconsistent or absent supportive policies and complex permitting processes can slow deployment.

It is important that cNCAP considers renewable energy integration for cooling as a means for reducing indirect emissions and improving access to cooling. Balanced cNCAP policy recommendations should promote these technologies and suggest relevant interventions to increase their market penetration.

02.4.4 Energy Conservation and Efficiency

Improving energy efficiency is key to reducing cooling-related indirect emissions. This can be achieved through reducing the cooling demand (building/load energy efficiency) or equipment energy efficiency.

Passive Cooling Strategies

Passive cooling and nature-based solutions reduce the demand for mechanical cooling and can significantly lower the associated electrical energy consumption. They can be applied at the building scale through building energy codes or the urban scale through city planning and sustainable cities codes.

Some of the building-scale passive cooling techniques include the integration of architectural features that minimize solar heat gain and the inclusion of natural ventilation and shading solutions. It also features the implementation of advanced building envelope designs to minimize heat gain, such as increased thermal envelope resistance and mass, and the use of insulating glazing. It also may refer to cool roofs to minimize solar heat gain. In addition, passive cooling encompasses the reduction of cold chain thermal load (e.g., increased insulation, reduced infiltration, adding doors on display cases, etc.).

Urban planning measures, such as green spaces and cool pavements are critical to an integrated passive cooling approach. Nature-based cooling solutions (e.g., tree shading, evapotranspiration or cool corridors, or green roofs/facades, vertical greenery systems at building scale).

It was found through desk research on 21 MENA countries[33] it was found out that 10 have established building energy codes, and seven have partial/subnational/draft/limited implementation of building energy codes, while 4 countries have no building energy codes or regulations. It was found that passive measures are well integrated with these building energy codes and that requirements for building envelope specific values are widespread. Finally, 13 countries showed the use of either a national green building certification scheme or strong uptake of international schemes (e.g., LEED or BREEAM), while 2 countries have partial efforts in green building certification and 6 countries with no green building certification efforts.

Most GCC countries (UAE, Qatar, Saudi Arabia, Kuwait, Bahrain, Oman) have formal building energy codes and/or green building regulations that employ explicit envelope & passive requirements. However, enforcement and stringency vary by country, and emirate/authority. For North African countries (Algeria, Egypt, Libya, Morocco, and Tunisia) there is a clear mix in implementation and approach to building energy codes, Egypt, Morocco and Tunisia have clearer national codes or labelling schemes; while Algeria & Libya are more uneven. In the Levant & smaller states (Jordan, Lebanon, and Palestine) it was found that Jordan have clearer standards and national rating initiatives; Lebanon/Palestine have national/municipal guidelines and growing local rating schemes, but national enforcement is mixed. Low-capacity states (Mauritania, Somalia, Sudan, Djibouti, and Yemen) lack national, enforceable building energy codes and rely instead on donor projects, national energy strategies, or adopt foreign standards Finally, in conflict-affected countries (Iraq, Libya, Syria, and Yemen) typically have partial or paper regulations but implementation and enforcement are the limiting factors; several have nascent green rating efforts.

Case Study 5 **Passive cooling in buildings**

Case Study 6 **Cooling access through passive cooling**

Case Study 9 **India and Nigeria examples on passive cooling**

33 *These countries represent 17 RCREEE Member states and Oman, Qatar, Saudi Arabia, and United Arab Emirates. The desk research involved reviews for the following public literature papers and UN resource: Gaum, T., & Laubscher , J. . (2021). Building Energy Codes: Reviewing the Status of Implementation Strategies in the Global South. International Journal of Built Environment and Sustainability, 9(1), 39–53. https://doi.org/10.11113/ijbes.v9.n1.871, Analytics | Regulatory Indicators for Sustainable Energy, https://rise.esmap.org/countries, Building Green - Home*

Energy-efficient Equipment

Some cooling sectors combine the cooling energy efficiency components (load and equipment), such as refrigerators and self-contained commercial refrigeration equipment, while others aggregate into building load and equipment energy efficiency, such as room and commercial air conditioning systems.

For domestic refrigeration systems, a typical combined energy efficiency metric is kWh/year[34]. This value is typically estimated as a function of the adjusted gross volume (measured in litre) of the refrigerated compartment and allowed to increase linearly with the size of the refrigerated compartment. The lower the kWh/year, the more efficient the refrigerator is.

Similarly, for self-contained commercial refrigerators, the typical combined energy efficiency metric is typically measured in kWh/year[35]. However, depending on the type of equipment, this value may be normalized by the vending volume, litres, or vending area, m2. Higher energy efficiency is indicated by lower kWh/year for the same size of the equipment.

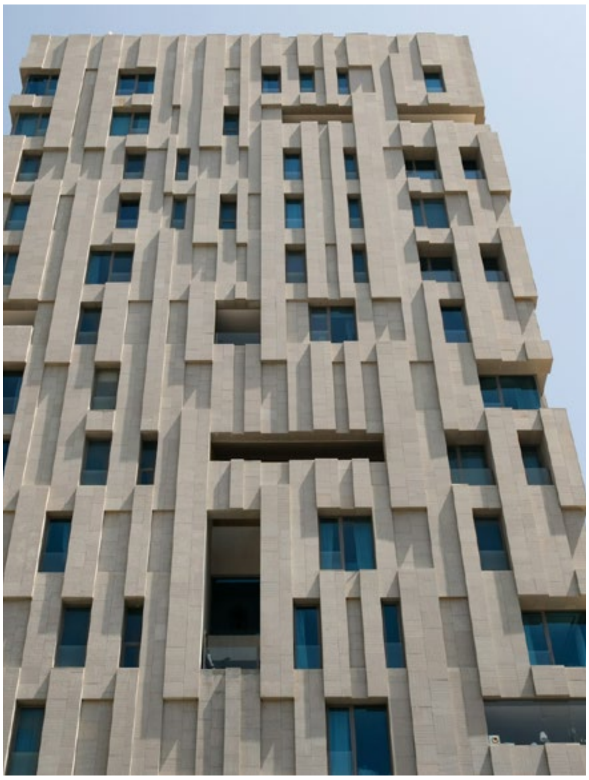
For air conditioning equipment, it is first important to reduce the building load to reduce the size of the air conditioning equipment. The building load reduction may be achieved through passive cooling measures, building energy code compliance or higher building energy rating systems, such as *LEED*, *Estidamah*, *GPRS*, etc. The building energy efficiency is typically measured in W/m2, where lower values are desired.

Residential air conditioning equipment efficiency is typically rated using seasonal performance energy efficiency ratio (SEER, BTU/W) or cooling season performance factor (CSPF, W/W) and annual performance factor (APF, W/W), to account for heat pump operation. In addition, the rated energy efficiency ratio (EER, BTU/W), coefficient of performance (COP, W/W) and heating coefficient of performance (COPH, W/W) can be used to evaluate the performance of the unit at standard rated conditions. Higher values for SEER, CSPF, APF, COP, and COPH indicate higher energy efficiency and correspondingly lower energy consumption.[36]

Countries strategically implement MEPS and energy efficiency labels in tandem to foster a dynamic and evolving market for energy-efficient products. MEPS act as a "market push" mechanism by legally prohibiting the sale of the least efficient appliances, thereby compelling manufacturers to innovate and improve the baseline energy performance of their offerings. Concurrently, energy labels provide clear, comparable information on product efficiency, creating a "market pull" effect as informed consumers are empowered to choose more efficient models, rewarding manufacturers who exceed the minimum standards. This dual approach not only transforms the market by removing inefficient products and encouraging the uptake of better ones but also lays the groundwork for the progressive introduction of stricter MEPS over time, ensuring continuous improvement in overall energy efficiency.

Alternative Technologies

Apart from conventional technologies, there are alternative options to deliver cooling efficiently in the HAT countries. Prominently these include District Cooling Systems (DCS) and other Not-in-Kind technologies. This section highlights DCS overview and benefits briefly.



34 *U4E Model Regulation Guidelines for Energy-Efficient and Climate-Friendly Refrigerating Appliances, https://united4efficiency.org/resources/model-regulation-guidelines-for-energy-efficient-and-climate-friendly-refrigerating-appliances/, accessed June 2, 2025.*

35 *U4E Model Regulation Guidelines for Energy-Efficient and Climate-Friendly Commercial Refrigeration Equipment, https://united4efficiency.org/resources/model-regulation-guidelines-for-energy-efficient-and-climate-friendly-commercial-refrigeration-equipment/, accessed June 2, 2025.*

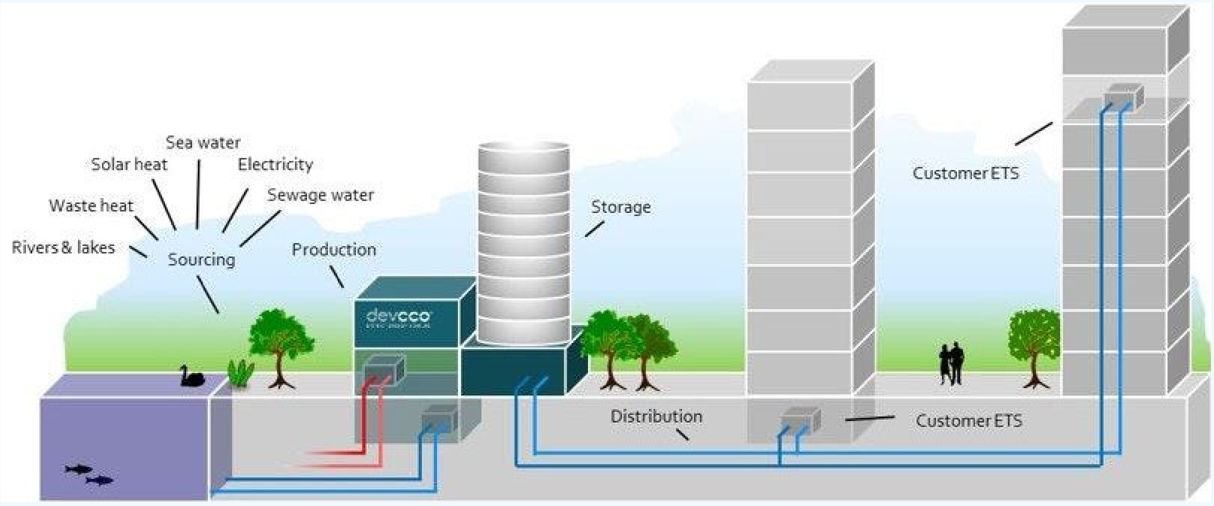
36 *U4E Model Regulation Guidelines for Energy-Efficient and Climate-Friendly Air Conditioners, https://united4efficiency.org/resources/model-regulation-guidelines-for-energy-efficient-and-climate-friendly-air-conditioners/, accessed June 2, 2025.*

Box -XX: District Cooling Systems:

While The implementation of alternative delivery mechanisms such as District Cooling Systems could be promoted at the accelerated pace. There are several countries in the Global south are progressing to adopt the district cooling systems including UAE, Tunisia, India, Philippines, Malaysia, Singapore, China etc. The efficiency and refrigerant consumption of on-site cooling equipment vary significantly depending on the product, building and cooling system design, operation and maintenance, and even the building's ownership structure. In general, in dense urban areas, energy and refrigerant use for air conditioning is far lower if clusters of buildings and even whole townships are connected to a District Cooling System (DCS).

A District Cooling System (DCS) distributes (supplies and collects back) cooling energy in the form of chilled water from a central district cooling plant to multiple buildings through a distribution network of insulated, underground pipes for space and process cooling. Individual users purchase chilled water for their own building from the operator of the DCS and do not need to install their own chillers or cooling towers. The supply sources for the central source can include free cooling from rivers, lakes or seas; large high efficiency electric chillers; absorption chillers connected to waste heat sources such as industry, data centres, sewage systems and waste incinerators; absorption chillers connected to renewables such as solar thermal, geothermal and biofuel boilers; and tri-generation plants using gas, biomass or biogas . Globally, DCS vary significantly in size from serving two buildings to serving an entire city. A DCS can serve a wide variety of loads inter alia commercial offices, hotels, residential, industry units, data centres, cold chain, sports arenas, malls, schools, institutional buildings and hospitals.

Figure: A schematic of a typical district cooling system (Devcco District Energy Venture, 2018)



The above mentioned highly efficient and/or renewable sources produce chilled water at a district cooling plant which is then distributed to energy transfer stations at the base of each building, where the cooling is used in the building's centralized air conditioning system. A typical DCS comprises the following components :

- Central Chiller Plant - generate chilled water for cooling purposes.
- Distribution Network - distribute chilled water to buildings
- Consumer Substation - interface with buildings' own air-conditioning circuits.

Benefits: The DCS provides wide range of benefits in comparison to conventional on-site cooling systems, which includes energy efficiency, refrigerant consumption, optimal operations etc. According to reports, it consumes 35% and 20% less electricity as compared with conventional air-cooled air-conditioning systems and individual water-cooled air-conditioning systems using cooling towers respectively . The demand aggregation through combining many diverse load profiles provides the economies of scale that allows district cooling systems to cost-effectively utilise high-efficiency and sustainable technologies, such as trigeneration, that are less economically and technically feasible for an individual building. Aggregated cooling loads makes creative alternative technologies such as free cooling from lake, river or ocean water, grey water recovery and reuse, thermal energy storage, industrial waste heat capture etc., more feasible in application as they reduce cost and environmental impact associated with space cooling technologies. Additionally, district cooling offers huge benefit to building owners of not procuring, installing, operating, and maintaining air conditioning plants, which consumes large portions of annual budgets . Finally, the centralised approach of district cooling allows the safe and controlled use of environmentally friendly refrigerants that are not appropriate or available at the individual building level.

02.4 Integration with Climate and Development Goals

In cooling energy demand-dominated regions like MENA – where cooling demand is estimated to more than triple over the next decades[37], it is important to align cooling strategies with Kigali Implementation Plans, NDCs, Net Zero Climate Change Strategies, and Global Cooling Pledge (GCP). The integration of NCAPs with broader climate development goals is an opportunity for countries to simultaneously address rising cooling demand and improve cooling access while advancing their climate commitments. In cooling energy demand-dominated regions like MENA – where cooling demand is estimated to more than triple over the next decades[38], it is important to align cooling strategies with Kigali Implementation Plans, NDCs, Net Zero Climate Change Strategies, and Global Cooling Pledge (GCP). For MENA countries confronting both rising temperatures and growing cooling demands, embedding cooling considerations within climate planning processes ensures that development pathways remain both climate-compatible and human-centred, avoiding the lock-in of inefficient, high-emission cooling infrastructure that would undermine long-term climate goals.

When NCAPs are explicitly linked to NDC frameworks, countries can unlock greater financial resources, technical assistance, and implementation support for cooling initiatives through climate finance mechanisms.

Tools such as the UNEP Cool Coalition's *NDC Cooling Guide* and the Climate and Clean Air Coalition's (CCAC) *NDC Guide on Short-Lived Climate Pollutants* provide structured approaches to embed cooling into national climate policies, addressing both mitigation (e.g., low-GWP refrigerants, high-efficiency systems) and adaptation (e.g., heat resilience, equitable access).

Further, Kigali Implementation Plans can connect refrigerant phase-down strategies with efficiency upgrades to maximize climate benefits. Similarly, embedding cooling in National Adaptation Plans (NAPs) secures adaptation co-benefits, including urban heat action plans, passive cooling in public infrastructure, equitable cooling access for vulnerable groups, and climate-resilient urban design.

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37 *UNEP 2023, Global Cooling Watch 2023, Keeping it Chill – How to meet cooling demands while cutting emissions, https://www.unep.org/resources/global-cooling-watch-2023*

38 *!!!!!! Foonote is missing*

Within MENA, cooling is beginning to emerge in NDCs, though coverage is uneven. Egypt, Jordan, Lebanon, Somalia, and the UAE explicitly reference cooling in different forms, from solar and district cooling to HFC phase-down, energy efficiency measures, and national cooling plans, while most other countries remain at early stages. This indicates both a growing recognition of cooling as a mitigation and resilience priority, and a need for systematic mainstreaming across the region. UNEP Cool Coalition's NDC Cooling Guide provides detailed *guidance for integrating the cooling sector into NDCs*. This guidance includes a methodology and blueprint to effectively integrate the cooling sector into the NDC. The Cool Coalition guide provides a step-by-step approach for different cooling sectors, including but not limited to passive cooling in buildings and energy efficiency in cooling technologies, to raise national ambitions on emissions. The guide also has a key focus on adaptation to extreme heat in cities and lays out the steps to include adaptation strategies to promote cooling access through NDCs. Furthermore, the Guide ensures NDC implementation feasibility by providing a monitoring, reporting and verification framework to track cooling NDC measures. Further, the Climate and Clean Air Coalition's (CCAC) NDC Guide on SLCP *provides sustainable cooling approaches for enhanced NDCs* and a comprehensive framework for this integration, and how cooling interventions, including low GWP refrigerant technologies, can deliver substantial reductions in both greenhouse gas emissions and short-lived climate pollutants including HFCs while advancing multiple Sustainable Development Goals.

For MENA countries confronting both rising temperatures and growing cooling demands, embedding cooling considerations within climate planning processes ensures that development pathways remain both climate-compatible and human-centred, avoiding the lock-in of inefficient, high-emission cooling infrastructure that would undermine long-term climate goals. CCAC has highlighted climate policy opportunities and corresponding risks of not taking action in them with a focus on the cooling sector as shown in Table 2.

As per Cool Coalition's NDC Guide, NCAP is the first step towards integrating cooling into NDCs, and when NCAPs are explicitly linked to NDC frameworks, countries can unlock greater financial resources, technical assistance, and implementation support for cooling initiatives through climate finance mechanisms.

The CCAC guidance suggests that National Ozone Units (NOUs) are heavily involved in information gatherings to estimate the f-gas emissions based on their international requirement (Montreal Protocol reporting). Other energy and building divisions within the government can provide crucial data related to the reduced energy consumption in the cooling sector due to the implementation of new measures. These data can support the Biennial Transparency Reports (BTRs) and other reporting under the Enhanced Transparency Framework (EFT).

Table 2 Key climate policy related to cooling showing the opportunities versus the risks of inaction.

Category	Opportunity	Risk of Inaction
Comfort Cooling Applications		
Mitigation	Transition to low-GWP refrigerants, LRM, DC, and Not-in-kind cooling technologies.	Fluorinated(f-) gas emissions increase due to consumption, production, and leakage.
Energy Security	The implementation of passive cooling technologies and energy efficiency measures yield dual benefits: decreased energy consumption and associated costs, as well as a reduced load on the energy grid, thereby improving energy security.	Higher indirect CO2eq emissions related to electricity consumption; higher electrical peak load on the grid; increased utility costs; larger access disparity.
Heat risk Adaptation	Supporting improved access to sustainable cooling; including for the most vulnerable population.	Unaffordable sustainable cooling to vulnerable population, continued use of inefficient, climate polluting cooling technologies.
Socio-economic and gender inequalities	Passive cooling can extend thermal comfort to vulnerable and disadvantaged communities, improving socio-economic and gender equality, while the adoption of higher efficiency cooling appliances can increase disposable income and enhance overall well-being.	Failure to address socio-economic and gender inequalities in the comfort cooling sector will deepen existing disparities, leaving vulnerable populations increasingly exposed to extreme heat and excluding them from the benefits of sustainable and resilient cooling solutions.
Cold Chains		
Food Security related Adaption	Reliable sustainable cold chains sustain food security and strength economic growth.	Persistent food waste in the agricultural and fisheries; resulting in inadequate access to food and loss of profit throughout the food production chain.
Health related Adaptation	Ensuring safe operation in health facilities and maintaining viable medicines and vaccines.	Exposing patients and health workers to heat stress, wastage of medicines and vaccines, and poor access to health benefits. Increased health risks for all: exacerbating health conditions (cardiovascular disease, respiratory illnesses, etc.), increased risk of heat stroke and heat exhaustion.
Economic Development	Strengthening local economies through job creation in sustainable cooling sectors, improved productivity, and enhanced resilience of businesses.	Economic losses due to productivity declines, increased costs of business interruptions during heatwaves, and missed opportunities for job creation.
socio-economic and gender inequalities	Strengthening pharmaceutical and agricultural cold chains creates a vital opportunity to reduce post-harvest losses and ensure equitable access to vaccines and medicines, while also empowering women, who play key roles in agriculture, health care, and informal markets, through improved livelihoods.	Neglecting to invest in equitable cold chain infrastructure risks perpetuating food insecurity, health disparities, and economic marginalization, especially for women.

Another important element within international climate and environmental architecture addressing cooling is the Global Cooling Pledge (GCP).[39] In MENA, **Djibouti, Lebanon, Morocco, Somalia, Tunisia, Syria, and the UAE** have joined the GCP. Through this pledge, signatory governments (Signatories) commit to collaborative global action to reduce cooling-related emissions by at least 68% by 2050 relative to 2022 levels. This supports the global initiative of the 1.5°C goal and net-zero through integrated mitigation and adaptation measures. Signatories commit to ratifying the Kigali Amendment by 2024, leveraging the Montreal Protocol Multilateral Fund to phase down HFCs and boost efficiency during HCFC and HFC transitions. Furthermore, they commit to raising the global average efficiency rating of new air conditioners by 50% compared to 2022 levels by 2030, while implementing MEPS, national or sub-national building energy codes (with passive cooling), and low-GWP refrigerant procurement policies. Signatories also commit to publishing their NCAPs by 2026, as they can be used to drive the national cooling actions to support the GCP commitments. Additionally, Signatories support fluorocarbon lifecycle management, international research collaborations (e.g., renewables-based cooling), and public procurement strategies to drive low-carbon cooling deployment.

39 *Djibouti, Lebanon, Morocco, Tunisia, Somalia, and Syrian Arab Republic are the 6 RCREEE member states that are currently signatory to the GCP, United Arab Emirates is an additional MENA region who is a GCP sigantory.*

03 cNCAP MENA Development Process

The cNCAP MENA provides a framework for addressing cooling challenges in a holistic and sustainable manner. cNCAP MENA shall prioritize access to cooling – especially in high-impact countries11 as a core objective, ensuring that cooling solutions are affordable, efficient, and environmentally friendly. Key elements of cNCAP MENA shall include:

- Equitable Access: Policies must focus on reaching underserved populations (including women and children), including rural and low-income communities.
- Energy Efficiency: Promoting energy-efficient cooling technologies and improving equipment efficiency (e.g., through MEPS and labelling programs). In parallel, promoting passive cooling strategies to reduce the cooling load.
- Sustainable Cooling Technologies: shifting towards lower global warming potential refrigerant solutions, reducing the direct refrigerant emissions through a comprehensive LRM approach, and adopting alternative cooling technologies, including non-refrigerant-based solutions such as NIK solutions and district cooling.
- Integration with Climate and Development Goals: cNCAP MENA should align with national climate commitments, such as Nationally Determined Contributions (NDCs), the Global Cooling Pledge and broader development agendas to maximize co-benefits.

The cNCAP MENA methodology approach should ensure an integrated approach where all relevant government stakeholders are represented to improve synergy.

The development of a comprehensive NCAP is a complex task that requires significant time and resources. To streamline this process for the MENA region, the holistic methodology[40] has been contextualized in this document to better suit the MENA region countries based on a detailed study. The cNCAP MENA methodology aims to provide a flexible framework that can be adapted to the specific needs and priorities of different countries.

The key principles of this methodology are:

- **Holistic Approach:** Consider the interconnectedness of various cooling sectors and end-uses (e.g., comfort cooling with impact of passive cooling, cold chains, and LRM, and the impact of comfort cooling on urban heat island effect).
- **Strategic Planning:** Balance immediate priorities with long-term goals.
- **Modular Framework:** Allow for a phased approach to cNCAP MENA development.
- **Equitable Access:** Ensure that cooling solutions are accessible to all.

The cNCAP MENA contextualized Methodology acknowledges that a "one-size-fits-all" approach does not work for national cooling plans. Instead, it emphasizes:

- **Adaptability:** Countries can customize the contextualized methodology based on their unique context (priorities, resources, data availability). This allows flexibility for both comprehensive plans and phased development.
- **Simplification and Prioritization:** The contextualized methodology aims to be user-friendly and guide countries to prioritize manageable data collection and focus on their immediate needs and resources.

40 *UNEP 2021; "National cooling action plan methodology: Holistic Methodology for Developing a National Cooling Action Plan", Cool Coalition, AEEE, UNEP, UNESCAP, World Bank Group, UNDP, K-CEP, SEforALL, GiZ, U4E, OzonAction, Clasp, Energy China Foundation, University of Birmingham, https://coolcoalition.org/national-cooling-action-plan-methodology/*

The methodology development aims to provide a process for most MENA countries to prioritize climate-friendly cooling, focusing on quantifying the met cooling demand with minimum resource use within their reach. The proposed data analytics incorporates Sustainable Energy for All (SEforALL) Needs Assessment parameters to encourage access to cooling and low climate impact. This growth is linked to SDGs Zero Hunger (SDG2), Good Health and Well-being (SDG3), Decent Work and Economic Growth (SDG8), and Reducing Inequality (SDG10).

The methodology advocates an integrated approach to address cooling needs, focusing on four key strategies:

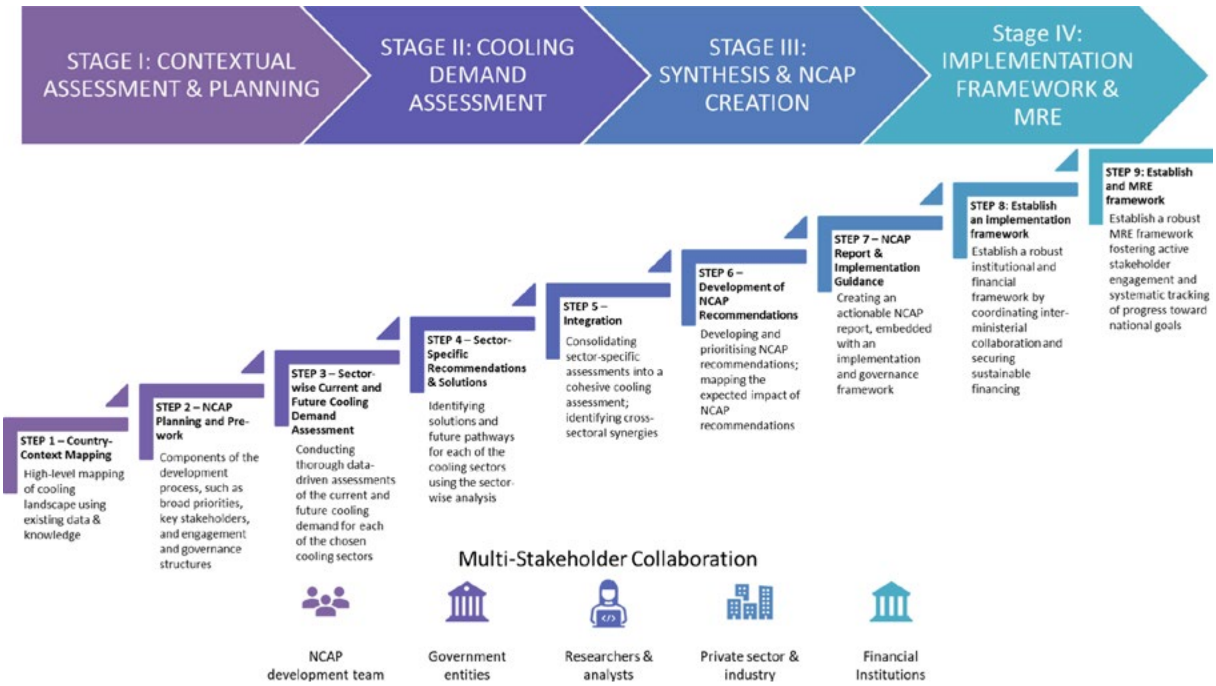
1. **Reducing Cooling Load:** Minimizing the energy demand for cooling through efficient building design and passive cooling techniques.
2. **Efficient Cooling Solutions:** Employing energy-efficient cooling equipment and technologies to deliver the required cooling with minimal energy and potable water consumption and reduced emissions.
3. **Optimizing Cooling Operations:** Implementing best practices for operation and maintenance, as well as encouraging user behaviour changes to ensure efficient cooling delivery.
4. **Effective Phase-down of HFCs:** relying on low-GWP refrigerant technologies and implementing LRM to effectively phase down HFCs.

By combining these strategies with a transition to renewable energy sources, countries can significantly reduce the greenhouse gas emissions associated with cooling, approaching near-zero cooling emissions.

03.1 NCAP Development Overview

The NCAP methodology typically consists of three sequential stages: Contextual Assessment and Planning, Cooling Demand Assessment, and Synthesis and NCAP Creation. The NCAP development process requires effective stakeholder collaboration as depicted in Figure 5.

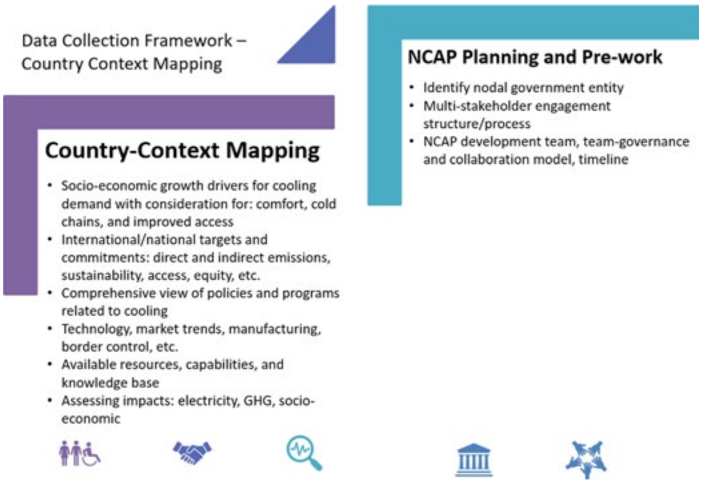
Figure 5 NCAP development stages – an overview.30



03.2 Stage I: Contextual Assessment and Planning

This foundational stage involves 1) country context mapping to assess baseline conditions for cooling, identify core elements and priorities, and 2) the NCAP planning and pre-work process as shown in Figure 6.

Figure 6 Steps involved in Stage I of the typical NCAP development process.



03.2.1 Step 1: Country Context Mapping

The NCAP should begin with the formation of a core team, including development agencies and consultants. This team should involve the government entity that owns the NCAP from the beginning. A comprehensive assessment of a country's cooling landscape should include understanding its cooling needs, socio-economic factors, national priorities, and growth drivers such as population growth, income growth, urbanization, and construction trends. Other relevant factors, such as technology trends, manufacturing base for cooling equipment, and market purchase behaviours, should also be considered.

Both quantitative and qualitative information are essential components for country context mapping. Countries should leverage existing research, such as government databases, market research, and knowledge base from multilateral organizations. Data gaps can be closed with input from subject-matter experts. The Data Assessment Framework aims to facilitate comprehensive national cooling mapping by gathering high-level contextual data during the initial phase of NCAP development. This framework helps determine the NCAP's scope, identify country-specific cooling priorities, and direct targeted data collection efforts across various cooling consumption sectors.[41] Table 3. Data considerations for high-level MENA country mapping. captures the various high-level country-wide data considerations with their intended objectives. While this is a suggested list, countries may wish to further select/add what is most relevant to them. In addition, it is important to note that data may be quantitative or qualitative.

41 *The Data Assessment Frameworks can be accessed online (https://bit.ly/DataCollectionFrameworksNCAP).*

Table 3 Data considerations for high-level MENA country mapping.

Category	Objective	Typical Collected Data	Typical Resources
Socio-economic growth drivers for cooling demand	Map overarching growth drivers and macro-trends for cooling demand.	- Population growth - GDP growth - Per-capita GDP - Urbanization rate - Energy access rates - High-level country targets around electrification, food security, and enhanced healthcare access - Demographics of vulnerable populations (elderly, children, low-income groups) particularly exposed to extreme heat Note: This data should include contextual disaggregation by sex, age, socioeconomic status, geographic location, and other relevant factors – when relevant and available. This disaggregation will help uncover specific gender and social vulnerabilities to support more targeted and tailored cooling interventions.	Primary: - National Census Data - Energy and environment Ministries - Urban planning and construction, agriculture, hydraulic/irrigation, and welfare Ministries Secondary: international organizations such as the UN, IMF, The World Bank, WHO, FAO.
Climate mapping	Assess prevailing and changing climatic conditions and the impact on population.	- Climate types - Temperature & RH characteristics - Seasonal variations - Cooling Degree Days (CDD) - Maximum peak temperature relative to average; Maximum annual temperature relative to average - Heatwave events - Heat-stressed regions and % of at-risk population due to heat stress - Morbidity and mortality related to heat stress - Impact on agri-food cold-chain not adequately serviced by mechanically cooled equipment	Focus on broad climatic impact: use National weather service – if not available, use publicly available data/models.
Power grid parameters	Determine power grid parameters and future changes impacting cooling energy and emissions.	- Primary energy conversion efficiency - AT&C losses - Grid carbon intensity/factor (& future trends) - Power supply reliability - Grid resilience to heatwaves and extreme weather events	Energy Ministry Secondary data sources may include reputable international organizations such as IEA.
International commitments	Establish motivation framework for NCAP based on global agreements which influences the NCAP objectives and priorities.	- Potential sectoral contributions to NDCs - Kigali Amendment (HFC phase-down, LRM, etc.) - Sustainable Development Goals 2030 - Global Cooling Pledge - Priorities under National Adaptation Plans (NAPs) - Mission Innovation	This information can be sourced from government departments.
National targets/ learning and their adoption	Map internal directives and targets related to cooling and their implementation.	- Energy efficiency targets - Refrigerant conservation measures (LRM) related policies - Carbon emission reduction - High-level cooling related regulatory and policy landscape - Renewable energy, energy poverty, and energy security related targets - National or subnational heat-health action plans	General policy roadmaps that apply to more than one cooling consumption sectors (e.g., Ministries of Energy, Environment, Agriculture, Buildings and Urban development, etc.).
Cooling consumption and associated sectors	Priorities key cooling consumption sectors.	- Cooling consumption sectors & high-level relative size - Associated sectors (refrigerant, service, etc.) - Population with cooling access (active and passive) - analysis of the agri-food cold chain (including access issues)	This should be sourced from credible secondary literature from international and national organizations.

Category	Objective	Typical Collected Data	Typical Resources
Financial resources	Identify financial instruments supporting/impacting sustainable cooling transition (e.g. subsidies, incentives, soft credit line, grants for access to cooling, energy efficiency and renewable energy use in cooling sectors).	- Energy costs subsidies - Efficiency Equipment and appliance purchase support (subsidies, grants, vouchers) - Tax rebates, credit - Funding sources (public/private, NDBs, MDBs, IFIs) - Public procurement policies - Technical assistance and training - Financing mechanisms for adaptation-oriented cooling solutions in vulnerable communities, if any	While MDBs report on energy efficiency investment – there is minimum reporting on cooling activities, for NDBs, data can be sourced – but not sufficient.
Key stakeholder mapping	Map stakeholders across public, private, and civil society for NCAP development.	- Public sector: central-level line ministries & associated agencies, state-level departments, etc. - Private sector: industry associations, equipment/refrigerant manufacturers, service sector representation - Civil society & academia: NGO/non-profits, educational institutes, etc.	
Data resources & country capabilities	Scope core data resources and in-house expertise.	- Existing government databases/research - Credible non-govt sources - In-house cooling/industry experts - Data analysis and modelling capabilities	
Others	Map additional factors impacting the NCAP development process	- Import vs. domestic production - Investment barriers/risks - Key economic activities (tourism, agriculture)	

The objectives of the Country Context Mapping include assessing the political landscape as it relates to cooling, mapping existing policies and programs related to cooling, presenting data-backed context to a country's cooling profile, and mapping the existing knowledge base and resources. Each sector has unique characteristics, reflecting the relative size and importance of different cooling sectors. The Context Mapping provides a qualitative and quantitative view into a country's cooling sectors, highlighting nuances and priorities. It also allows for an investigation of the country's existing resources and capabilities. A summary of qualitative guidance for step 1 is shown in Table 4. Qualitative guidance for step 1 of the cNCAP MENA.

Interviews conducted during the cNCAP MENA's initial phase identified room air conditioning and cold chains as the largest market segments. Although manufacturing capabilities differ significantly among the MENA countries, a consistently high demand for servicing indicates that Lifecycle Refrigerant Management (LRM) is a crucial component of the cooling sector's industry landscape.

While detailed market statistics are often lacking, countries can utilize existing data from Montreal Protocol reporting on refrigerant consumption as a proxy to estimate equipment banks, particularly for manufacturing nations. For service-only countries, HS codes can help estimate annual equipment imports. Further insights can be gained from secondary data sources like the Green Cooling Initiative, which include predictions for equipment stock and future growth by sector. In the absence of specific electricity consumption data for cooling appliances, national energy balance data can be disaggregated, and proxies such as population growth, urbanization rates, GDP per capita, and climate data (heating/cooling degree days) can model future cooling demand.

Table 4 Qualitative guidance for step 1 of the cNCAP MENA

Focus Area	Question/Objective	Aspects to Explore (MENA context)
Cooling Sector Composition & Industry Landscape	Where is cooling most used/needed in the country?	Sector Mapping (preliminary/high-level): - Space cooling (buildings) - Mobile/transport AC - Cold chain & refrigeration (agri/food, healthcare) - Industrial process cooling (textiles, data centres, etc.) - Critical facilities requiring adaptive cooling (e.g., hospitals, emergency shelters)
	What are the important cooling-related (indirect/second order) services/industries?	Related Industries/Services: - Equipment servicing/maintenance - Refrigerant recovery, recycle, and reclaim - Cooling research and development - Climate-resilient building design and retrofitting services
Current Cooling Practices & Market Dynamics	What are the sociocultural and market characteristics related to cooling practices?	Practices & Characteristics: - Cooling behaviours across sectors - Typical equipment used - Market efficiency levels - User/stakeholder awareness - Purchasing behaviours and decision-making dynamics - User satisfaction - Manufacturing capacities - Cultural adaptation strategies for coping with heat (e.g., passive cooling traditions, shaded public spaces)
	What are the underlying factors/barriers for climate-friendly cooling demand?	Barriers: - Financing access - Consumer information availability - Professional/servicing capacities - Legislative barriers (safety codes, standards)
	What are the enablers to stimulate the demand for climate-friendly cooling?	Enablers: - Financial instruments (subsidies, incentives) - Capacity building (professional/servicing) - Policy development (MEPS, building codes, safety standards)
Drivers of Cooling Demand Growth	What is driving the demand for cooling in the country?	Demand Drivers: - Demographic/Socio-economic: Population growth, Urban/rural distribution, Urbanization rate, economic/purchasing power growth, and electrification growth - Climate/Environmental: Climatic conditions (high-heat days, seasonal variations), heatwave events, and urban heat islands - Access: Unmet cooling needs and heat-vulnerable populations - Other: Grid decarbonization plans and unique sector-specific drivers Note: This data should include contextual disaggregation by sex, age, socioeconomic status, geographic location, and other relevant factors – when relevant and available. This disaggregation will help uncover specific gender and social vulnerabilities to support more targeted and tailored cooling interventions.
	What is the current and expected rate of growth of cooling demand?	Growth Rate: - Preliminary intelligence (research, experts, associations, agencies) - Estimated/projected growth (equipment, energy consumption, under climate adaptation scenarios, if available)

Focus Area	Question/Objective	Aspects to Explore (MENA context)
Current & Future Impacts of Cooling	What are the broad impacts – current and future – of BAU cooling and its projected growth?	Impacts (BAU): - Socio-economic: Health/productivity loss, social inequity, generation capacity additions, and power cuts/grid impacts - Environmental: Direct/indirect carbon emissions and aggravated urban heat islands
	What are the power grid parameters?	Power Grid: - Grid carbon intensity - Transmission losses - Grid decarbonization plans - Grid resilience under extreme heat stress (Grid capacity limitations)
Cooling-Related Policy Landscape	What are the country's international and internal commitments/ targets intersecting with cooling?	Commitments/Targets: - Global: NDCs (Paris Agreement), refrigerant management (Kigali Amendment), SDGs 2030 and National Adaptation Plans (NAPs) and heat-health action frameworks - National: Carbon emission reduction, energy efficiency mandates, thermal comfort, food security, and health/safety
	What is the current policy landscape to address growing cooling demand?	Policy Landscape: - Programs/initiatives (federal/state) - Inter-linkages between policies
Cooling Stakeholder Mapping	What are the key government stakeholders (line ministries) intersecting with cooling?	Government Stakeholders: - Environment/climate change - Energy/power (New and renewable energy) - Housing/urban/rural development - Science/technology - Agriculture - industries and micro, small, and medium-sized enterprises - Transport - Energy efficiency, finance, or other government entity that work with cooling supply chain - Ministries of health, disaster management and social protection for heat resilience
	What are the key non-governmental stakeholders in the country's cooling discourse?	Non-Governmental Stakeholders: - Equipment/refrigerant manufacturers - Industry associations - Academia/research - Civil society - Harmonization/alignment on cooling action between different sectors - Humanitarian and health NGOs working on heat stress adaptation
Available Information & Resources	What is the level of availability of data in the country?	Data Availability: - Pre-intelligence on data types - Key sources (ozone units, energy ministry, census, weather services, associations) - Data accessibility, quality, and value (how recent)
	Who will develop the NCAP?	NCAP Development: - In-country expertise/capacities - Leverageable resources

Case Study 2 **Country context mapping in Egypt**

This step aims to identify critical cooling needs and challenges and develop a case for sustainable cooling to meet national and global climate commitments. It highlights potential gaps and opportunities for immediate and longer-term interventions and their corresponding level of readiness. It ensures alignment between the different stakeholders in the cooling sector and guides the next steps by providing contextual assessment to help inform the broad contours and key elements for the country's NCAP development.

03.2.2 Step 2: NCAP Planning and Pre-Work

A National Cooling Action Plan (NCAP) should be tailored to a country's specific context, priorities, resources, and urgency for action. It should also ensure that environmental and gender analyses are integrated into the planning and policy development process to assess the differentiated impacts of cooling policies and to adjust measures that promote environmental sustainability and gender equality.

The planning and pre-work stage involves establishing the NCAP's scope and contours, drawing on country context mapping. Identifying a nodal government entity, such as the National Ozone Unit, is crucial for effective collaboration and buy-in from various government bodies. Establishing a mechanism for effective multi-stakeholder engagement is essential for cross-functional synergies. This could involve cross-functional teams, a team-governance structure, and a stakeholder engagement process that aligns diverse interests, ensuring broad buy-in for proposed policies and solutions. It is important to establish the cNCAP MENA inter-ministerial steering committee by this stage. This steering committee is the nucleus for guiding the NCAP development process. It should have clear roles and responsibilities for the different participants to ensure the timely development and future implementation of the NCAP.

A qualitative guidance for step 2 is summarized in Table 5, highlighting some of the key considerations for the MENA region.

Table 5 Qualitative guidance for step 2 of the cNCAP MENA

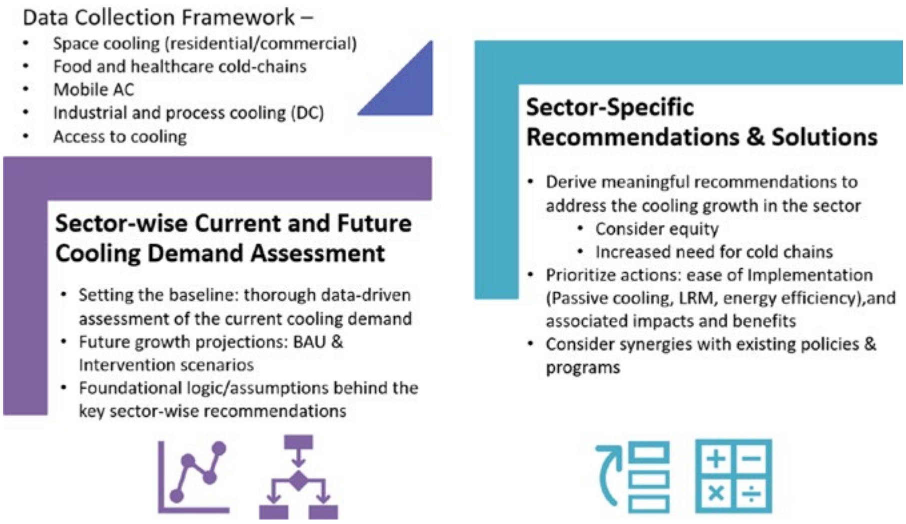
Areas to Explore	Associated Aspects (MENA Context)
NCAP Core Team & Resources	- Lead Entity: Identify the most effective government body (Ministry of Environment (Ozone Unit) or Ministry of Energy based on regional dynamics. *Consider potential for inter-ministerial coordination*. - Team Composition: Ensure balanced representation, including: • Technical experts (climate, energy, engineering, disaster risk reduction, health) • Policy specialists (regulations, finance) • Private sector representatives (industry associations, manufacturers) • Civil society/academia (CSOs, NGOs, research institutions) • Ensure gender-balanced representation in NCAP core teams and working groups. Promote the inclusion of women experts, practitioners, and community leaders in decision-making and technical roles. - Resources: Leverage existing national databases, regional research centres (e.g., RCREEE), and international partnerships (UNEP, UNDP, World Bank). Consider data sharing agreements.
NCAP Priorities & Objectives	- Broad Targets: Prioritize objectives aligned with national development plans and regional challenges: • Energy efficiency in cooling • Carbon emissions reduction (Paris agreement) • HFC phase-down (Kigali Amendment) • Climate resilience (heat stress mitigation) • Sustainable cold chain development (food security) • Job creation in sustainable cooling sectors • Emphasize water-energy nexus in cooling • Address desert climate challenges.
Nodal Ministry/ Government Entity	- Ownership: Determine if a single ministry will lead or if a collaborative approach is needed. Consider political sensitivities and existing inter-ministerial coordination mechanisms. - Adoption Process: • Clarify the pathway to official adoption, including potential legislative changes and stakeholder consultations. • Consider the influence of national development visions and leadership on adoption.
NCAP Scope & Timelines	- Sector Focus: Prioritize sectors with the highest impact and feasibility (e.g., residential buildings, and cold chain). - Quantification and Unmet Needs Assessment: Employ a phased approach, starting with available data and progressively refining methodologies. Consider regional data gaps and capacity building for data collection. - Outlook and Milestones: Align with national development plans (e.g., Vision 2030) and set realistic milestones. Consider potential political transitions and their impact on timelines. - Development Timeframe: Establish a realistic timeline, considering potential bureaucratic delays and the need for thorough stakeholder engagement. *Adapt timelines to regional political and economic uncertainties.*
Multistakeholder Engagement Structure	- Working Groups: Establish sector-specific working groups with diverse representation of relevant sectors, gender and expertise. Consider the role of regional experts and international organizations. Facilitate inclusive participation, timely access to information, considering language barriers, gender and cultural sensitivities. Leverage existing regional networks. - Input Integration: Develop a clear process for collecting, analysing, and incorporating working group inputs. Ensure transparency, accountability, and feedback loops.
NCAP Governance Structure	- Oversight & Collaboration: Establish an inter-ministerial steering committee with clear roles and responsibilities. Ensure regular communication and coordination between working groups. Ensure alignment with existing national coordination mechanisms and address potential bureaucratic silos. - Cross-Sectoral Alignment: Develop a mechanism for integrating sector-specific recommendations into a cohesive NCAP. Consider the role of a technical secretariat to support coordination.

The board parameters, focus areas, scope, depth, and key stakeholders for the country's NCAP development are established in this step.

03.3 Stage II: Cooling Demand Assessment

At the NCAP methodology's core is a data-driven cooling demand assessment. Stage II examines current and future demand across sectors, energy consumption, refrigerant usage, and greenhouse gas emissions. The two steps involved in this stage are summarized in Figure 7.

Figure 7 Steps involved in Stage II of the NCAP development process.



03.3.1 Step 3: Sectoral Current and Future Cooling Demand Assessment

This step involves quantifying current and future cooling demand for all relevant sectors. It involves establishing a baseline, which includes met and unmet cooling demand (see Box X) and associated impacts like energy consumption, peak loads (and corresponding impact on grid stability), greenhouse gas emissions, and refrigerant demand. The future growth of cooling-related emissions should be projected at different levels of intervention, including a Business-As-Usual (BAU) growth scenario and an intervention growth scenario. This comparative assessment helps inform sector-specific recommendations to sustainably address cooling growth. Data collection is crucial, and countries should leverage resources from credible and multilateral organizations. The Data Assessment Frameworks33 provide guidance on data inputs, calculations, and outcomes. A summary of the qualitative guidance for step 3 is shown in Table 6; more information is available in Table 5 of the *Holistic Methodology for Developing a National Cooling Action Plan*.32

Box 1: Met and Unmet Cooling Needs

Understanding Cooling Needs:

The document differentiates between "met" and "unmet" cooling needs:

- **Met Cooling Demand:** This is the existing demand, and its growth, currently served by mechanical cooling solutions, reflected in energy and refrigerant consumption.
- **Unmet Cooling Demand:** This represents the proportion of the population that lacks access to sustainable and affordable cooling services to meet essential needs. These populations are identified by assessing factors such as extreme heat exposure, electricity access, and poverty levels.

While quantifying both types of cooling demand is essential for NCAP development, accurately measuring unmet needs remains a challenge due to a lack of established models.

The building of the CIB Bank Development in Egypt

The Data Assessment Frameworks aim to provide guidance rather than strict rules, allowing the NCAP development team to adapt them for their countries' specific needs, capacities, and available resources. They include flexible features to support cooling demand assessments in various contexts and prioritize essential data to avoid overwhelming first-time developers. Additionally, the frameworks are user-friendly, with ample guiding notes. They identify key data inputs for estimating current and future cooling demand, offering different pathways for analysis and calculation. Though not intended as a comprehensive modelling exercise, the frameworks can facilitate prioritized actions for climate-friendly cooling and may be used as inputs for modelling if desired. The frameworks for space cooling in buildings, food cold-chain, and healthcare cold-chain specifically provide high-level guidance for the NCAP development team to consider the unmet cooling demand and evaluate the extent of lack of access to cooling in the country. The Data Assessment Frameworks are implemented through a series of activities, as shown in Figure 8 and discussed in the following sections.

Table 6 Qualitative guidance for step 3 of the cNCAP MENA

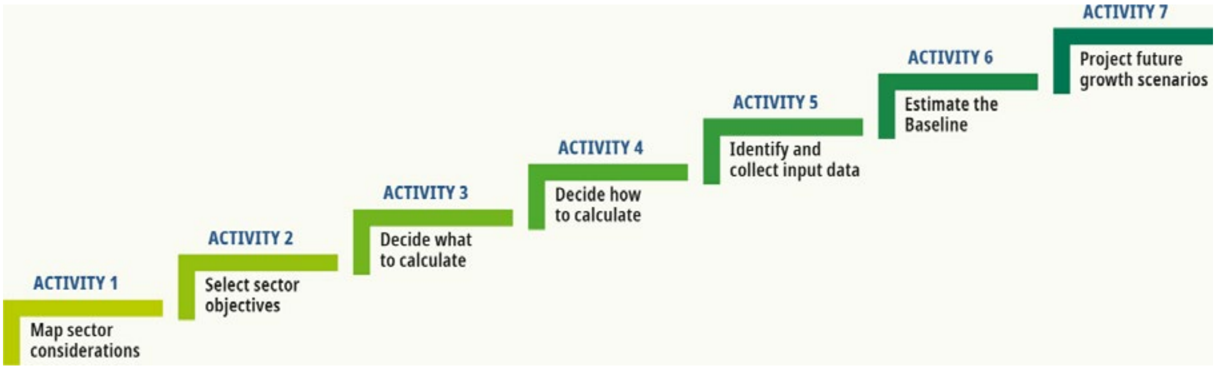
Areas to Explore	Associated Aspects (MENA Context)

Sector-Specific Cooling Data Points	- Granular Data Needs for key sectors: buildings (residential, commercial), cold chain (agriculture, healthcare), industrial cooling, and transport. This data should include contextual disaggregation by sex, age, socioeconomic status, geographic location, and other relevant factors – when relevant and available. This disaggregation will help uncover specific gender and social vulnerabilities to support more targeted and tailored cooling interventions.
	- Met Demand (Vapor Compression):
	  • Technology Mapping: Focus on prevalent AC technologies (split units, central AC), refrigeration systems, and their market penetration. *Consider data on water-cooled vs. air-cooled systems, performance in high ambient temperatures, and impact of sand/dust.*
	  • Quantitative Data: Number of AC units, average capacity, energy efficiency (EER/COP), run-time, diversity factor, age distribution, refrigerant type/charge/leakage.
	- Met Demand (Other Technologies):
	  • Data on fans, evaporative coolers, and emerging technologies (district cooling, passive cooling).
	  • Assess potential of passive cooling in traditional architecture and modern building design. Document the role of nature-based solutions and building envelope improvements in reducing climate vulnerability.
	- Unmet Demand: Household AC ownership rates, access to electricity (urban/rural disparities), passive cooling strategies, required cold chain capacity, food loss data. Focus on vulnerable populations and their access to cooling. Assess the impact of heat stress on labour productivity.

Data Sources	- Multi-Stakeholder Engagement: Leverage existing working groups (Step 2) for data access.
	- Data Collection Methods:
	  • Primary/secondary research, government databases (statistics offices, energy ministries), industry reports (cooling equipment manufacturers, distributors).
	  • Expert interviews, surveys, market intelligence reports.
	  • Data sharing agreements with private sector
	  • *Regional research centres (e.g., RCREEE)*

Data Confidence Level	Data Quality Assessment: - Data currency, transparency, sourcing methodology, *potential biases*, derived quantities, consistency with other datasets. - *Data reliability – especially when collected from informal sectors and areas with limited data infrastructure*.
Data Sensitivities	- Data Robustness: Assess the robustness of data for international comparisons and policy formulation. *Consider the political and economic implications of data on energy consumption, emissions, and vulnerability*. - Government Endorsement: Gauge the level of government endorsement and potential for data-driven policy action. *Navigate potential differences in data interpretation and policy priorities among government entities*.
Assumptions/ Proxies	Contingency Planning: - Develop strategies for data gaps: Expert consultations, proxy data from similar regions, extrapolation techniques. - Develop scenarios for different economic and demographic growth trajectories. *Consider the impact of climate change projections on future cooling demand*. - Assumption Transparency: Clearly document all assumptions and proxies used in the assessment.

Figure 8 Key activities involved in step 3 of the NCAP development process.



Activity 1: Map Sector Considerations

First, the NCAP focuses on identifying key sector-specific considerations for cooling consumption sectors, such as space cooling in buildings, food cold-chain, and urbanization rates, to understand anticipated cooling demand growth and implement interventions. It also maps prevalent sector technologies and sub-categories within the NCAP scope and understands the sector's maturity in energy efficiency and sustainability policies and programs. This helps inform short-, medium-, and long-term interventions for meaningful impact.

Activity 2: Select Sector Objectives

In this activity of the data assessment exercise, sector-specific objectives are defined to ensure efficient use of resources.

Activity 3: Decide What to Calculate

In this activity, the framework's guidance and country data availability will guide the calculation of key metrics (direct emissions, indirect emissions, average equipment energy efficiency, peak loads/electric grid stress, access to cooling, etc.) for each sector in line with sector objectives.

Activity 4: Decide how to Calculate

Perform thorough evaluation of available data, computational resources, and domain expertise, followed by the selection of the appropriate data analysis pathway.

Activity 5: Identify and Collect Input Data

To accurately estimate the numerical outcomes of different cooling scenarios, a comprehensive data collection process, following the data assessment frameworks33, is essential. This involves:

- **Government Data:** Collaborating with relevant government agencies to access official data on energy consumption, population growth, built-up area growth, loss of green and blue infrastructure, economic and social indicators, urbanization rates, climate trends, and policy, regulatory, and institutional indicators.
- **Desk Research:** Conducting thorough literature reviews of industry reports, market analyses, and technical publications to gather information on existing technologies, market trends, and best practices.
- **Physical Market Assessment:** Collecting primary data directly from the marketplace to reflect the typical types, refrigerant used, and energy performance of sold cooling equipment and materials in the building sector.
- **Stakeholder Engagement:** Engaging with a diverse range of stakeholders, including industry associations, manufacturers, distributors, policymakers, and civil society organizations, to gather insights, validate data, and identify knowledge gaps.

By combining these data sources, the NCAP development team can build a robust dataset to inform decision-making and prioritize effective cooling solutions.

Activity 6: Estimate the Baseline

The baseline should be accurately estimated, as future projections will be built upon it, and the base year should be as recent as possible and supported by sufficient and timely data. It needs to include the socio-economic factors that will require monitoring and reporting. These indicators should be defined as early as possible.


Wasl Properties Retrofit, Dubai – UAE
© Drone shot by Hennie Schoeman

Activity 7: Projecting Future Growth Scenarios for Climate-Friendly Cooling

This activity involves modelling future cooling demand growth under three key scenarios:

1. BAU Scenario: This scenario projects the future trajectory of cooling demand based on current trends and stated policies, without significant additional climate-friendly interventions.
2. National Policy Scenario: This scenario models the projected trajectory of cooling demand based on the implementation of currently adopted and officially pledged national policies, considering regulatory measures, energy efficiency standards, organic technology shifts (e.g., to cost-effective higher energy efficient technologies), and refrigerant transition commitments.
3. Net Zero Scenario: This scenario explores the potential impact of implementing the NCAP's recommended strategies and policies on future cooling demand. It highlights the potential for reduced greenhouse gas emissions and improves energy efficiency.

To project these scenarios, countries can utilize a variety of tools, from simple spreadsheet-based calculators to advanced modelling techniques. The timeframe for the projections should align with the country's long-term climate and energy goals.

A well-structured NCAP, with a focus on timely implementation, can deliver substantial environmental and socio-economic benefits over the medium to long term. By setting ambitious targets and prioritizing climate-friendly cooling solutions, countries can mitigate the impacts of climate change and ensure a sustainable future.

Case Study 1 Sectoral current and future cooling demand assessment in Jordan

This analysis will establish a baseline for the country's cooling demand and its impacts, providing insights into future growth, and the best interventions for the country. This will identify the optimal intervention pathways to promote sustainable cooling, showcasing the potential for significant sectoral achievements in terms of energy savings, emission reductions, enhanced climate resilience, and socio-economic benefits under a strategically implemented best-intervention scenario. This will form the basis for developing NCAP recommendations and establishing a sustainable pathway for meeting cooling demand.

Box 2. Cold Chain Cooling Demand Assessment

In the MENA region – all seven types of foodstuffs (meat and poultry, seafood, dairy and eggs, fruit, vegetables, beverages, and other processed products) are considered relevant and important to varying degrees. Data collection for the cold chain may be performed in 2 phases as follows:

- Phase 1: high level; use national data sources to collect:
  - Statistics on food production
  - Number of relevant food chain facilities (including stocks where possible)
  - Levels of food loss (aggregate percentage loss)
- Phase 2: Detailed data; via research and sampled site surveys to collect details on:
  - Equipment stock and applications in each sub-sub-sector.
  - Energy consumption/efficiency for each type of the cold-chain equipment.
  - Main refrigerant type used, typical refrigerant charge, typical refrigerant leakage rate, and typical servicing practices for each type of the cold-chain equipment.
  - Food loss estimates, causes, and associated emissions.
  - Basic capital and operating expenditures (CAPEX/OPEX) of different types of cold chain sub-sub-sectors.

03.3.2 Step 4: Sector-specific Recommendations and Solutions

Step 4 involves a sector-specific analysis to identify solutions and future pathways for addressing cooling growth in each sector. This involves assessing cooling demand, identifying priorities, quick wins, and high-impact interventions. Engaging stakeholders from the public, private, and civil society sectors is crucial for screening actions, considering implementation ease, potential impacts, and synergies with existing government policies. A summary of the qualitative guidance contextualized for the MENA region is shown in Table 7.

Table 7 Qualitative guidance for step 4 of the cNCAP MENA

Question to Explore	Associated Aspects (MENA Context)
Heightened/ Accelerated Interventions	- Sector-Specific Recommendations: Synthesize findings from Step 3 (demand assessment) and Step 5 (intervention scenarios) to develop detailed recommendations for each key sector (buildings, cold chain, industry, transport). *Address region's unique challenges:* • *Adaptation to extreme heat through passive cooling to address access to cooling gap* • *Adaptation to extreme heat through behavioural measures and community and systemic measures* • *Adaptation to extreme heat through nature-based solutions* • *Improved equipment efficiency* • *Water-efficient cooling (water-energy nexus in cooling technologies)* • *Sustainable cold chain for food security (food-energy nexus in cold chain)* • *LRM challenges* • *Use of DC systems in high demand areas to minimize electricity and water use* • *Integration of renewable energy into cooling systems* - Prioritization and Phasing: • Categorize recommendations into short-term (quick wins), medium-term (scalable solutions), and long-term (transformative strategies) – *considering trade-off between political and economic stability when phasing intervention.* • Identify high-impact, low-cost interventions for immediate implementation – *account for potential resource constraints and bureaucratic complexities*.
Recommendation Prioritization	- Implementation Feasibility: • Assess the ease of implementation based on resource availability (financial, human, technical), regulatory framework adjustments, and stakeholder buy-in. • Evaluate the capacity of local cooling industry (manufacturing/service) to adopt new technologies. • Understand potential gendered benefits of better cooling access, economic developments and job creation. - Impact and Benefit: Evaluate the potential impact of recommendations on energy consumption, electricity infrastructure, emissions reduction, *refrigerant consumption*, cooling access (thermal comfort and *cold chain*) – especially for the most vulnerable groups, economic development and job creation, climate resilience and adaptation.
Synergy with Existing Policies & Programs	- Policy Alignment: evaluate the radically new policies versus aligned policies with existing national development plans, energy strategies, climate policies, and building codes. - Interlinkages and Integration: Identify interlinkages between NCAP recommendations/interventions and existing government programs (e.g., energy efficiency programs, sustainable agriculture initiatives, urban development projects, *refrigerant management*, *cooling access, water-energy nexus in cooling*) - Accountability and Ownership: map recommendations to relevant government entities (ministries, agencies) and assign clear roles and responsibilities for implementation. *Avoid siloed implementation and foster inter-ministerial coordination and establish clear mechanisms for monitoring and evaluation with unbiased pollical influence.*

This step outlines sector-specific priorities, quick, high-impact interventions, and strategic longer-term interventions to support the country's climate-friendly cooling drive.

While the *Holistic Methodology for Developing a National Cooling Action Plan32* provides a rich set of information and potential resources, Box X provides a list of additional resources that may benefit the MENA region.

Box 3: Additional Resources

The Cool Coalition

- Valuable hub for knowledge, tools, and international collaboration on sustainable cooling.
- Features an online "Cool Calculator" to evaluate a 2050 scenario tool designed to help stakeholders plan for the decarbonization of the cooling sector.
- Features an extensive "Database" of data, case studies, and information on various aspects of sustainable cooling, such as energy efficiency in cooling, alternative refrigerants, and passive cooling strategies. This information can support evidence-based decision-making in the NCAP process.
- The "Flagship Resources" section offers key reports, policy briefs, and other publications from the Cool Coalition and its partners.

The Multilateral Fund for the Implementation of the Montreal Protocol

- An archive of more than 10,000 decisions dating back to 1991
- Detailed guides and project submission forms
- Information on funding opportunities
- Results of demonstration projects and periodic scorecards
- Annual newsletters
- Factsheets offer ongoing insight into the Fund's performance and achievements

The Green Cooling Initiative

- Country data on historical, BAU, and intervention emissions scenarios
- Technology reviews and case studies
- Guidelines

Cool Up Programme

- Sample NCAPs and supporting documentation (Egypt, Jordan, Lebanon, and Türkiye at different implementation stages)
- Technology landscapes
- Policy landscapes
- Finance landscapes

SEforALL Chilling Prospects series

- Data on access to cooling
- Cooling needs assessment
- Case studies for sustainable cooling solutions

Additional resources on HFC phase-down, new energy efficiency funding windows in the MLF and NDC and LRM strategies are also available from the Multilateral Fund and CCAC Cooling Hub, respectively. The CCAC continues to work closely with A5 parties to implement comprehensive LRM strategies, aligning national actions with global climate objectives and fostering international cooperation to accelerate the adoption of sustainable cooling solutions

- *Project Guides & Tools | Multilateral Fund*
- *Lifecycle Refrigerant Management (LRM) | Climate & Clean Air Coalition*
- *Guidance on Sustainable Cooling Approaches for Enhanced NDCs | Climate & Clean Air Coalition*

United for Efficiency (U4E)

- Provides integrated policy approaches for a sustainable and cost-effective transition to energy-efficient appliances – including cooling equipment
- Valuable hub for guidelines, knowledge, tools, and valuable resources
- Provide preliminary country energy and emissions savings potential for adopting different policy measures for different appliances – including cooling
- Information on sustainable procurement guidelines
- Support for the implementation of product registry systems

UNEP Global Alliance for Buildings and Construction (*UNEP Global ABC*)

- Global and regional roadmaps that forge the pathways towards zero-emissions, efficient, and resilient buildings and construction sector
- Provide resources on flagship projects, sustainable building materials hub, and extensive database
- Provide detailed information on multitude of building sector relevant information including finance, passive cooling, clean heat, adaptation, and much more
- Host regular events to support the passive cooling sector

The Passive House Institute:

- Offers free resources and educational material for developing capacity on passive construction
- Provides information about passive building, requirements, user manuals, and refurbishment techniques

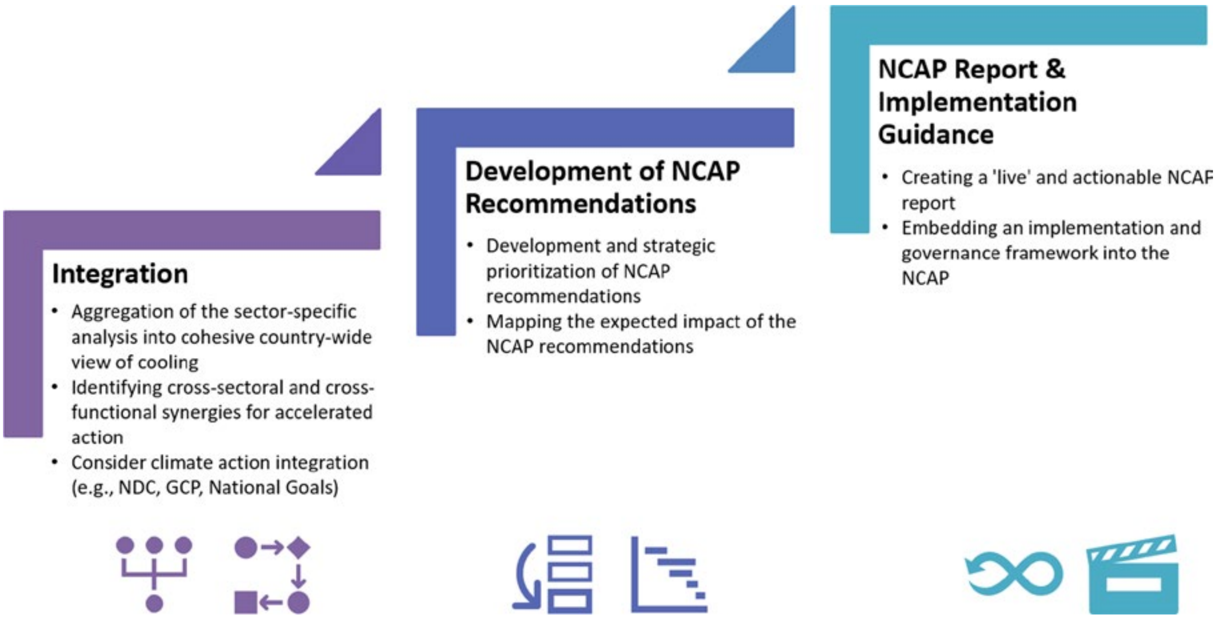
Other Relevant Passive Building Resources:

- *World Economic Forum description and outlook for passive housing*.
- *Habitat for Humanity; Urban Energy Technical Note 08: Passive Cooling*.
- Passive House Institute New Zealand (*PHINZ*) that provide training materials and a wealth of case studies
- Indian Institute for Human Settlement (*IIHS*) that provide extensive capacity building resources related to sustainable urban development and perform state-of-the-art research in passive cooling

03.4 Stage III: Synthesis and NCAP Creation

The third stage integrates all NCAP activities and analyses towards the creation of the cooling action plan, as summarized in Figure 9. It entails consolidating sector-specific assessments into a cohesive nationwide cooling scene, while identifying cross-sectoral synergies, and establishing actionable goals and recommendations with broad stakeholder buy-in. Ensuring effective stakeholder engagement is critical at this stage for achieving holistic outcomes and integrative benefits.

Figure 9 Summary of Stage III of the NCAP development process



03.4.1 Step 5: Integration

The integration of sector-specific cooling demand assessments into a cohesive nationwide overview is essential for developing a comprehensive NCAP. By aggregating data from various sectors, policymakers can gain insights into the country's overall cooling growth trajectory, the relative importance of each sector, and potential synergies between different sectors. This analysis helps identify priority areas for interventions and formulates key recommendations for the NCAP, such as harmonizing energy efficiency and refrigerant transition efforts. Ultimately, this integrated approach enables a more strategic and impactful approach to promoting climate-friendly cooling solutions.

Box 4: Considerations for NDC Integration – Approach (*Cool Coalition*)

The Cool Coalition guide is a three-stage methodology to integrate sustainable cooling into NDCs.

1. Defining baseline in alignment with NDC (HFCs and energy-related emissions)
2. Formulating Targets: setting sector-specific targets aligned with broader national climate goals. The guide emphasizes the importance of developing an NCAP as the basis for NDC integration, establishing the database and an implementation plan.
3. Establishing cross-ministerial governance structures to foster collaboration across the energy, health and agriculture sectors, alongside the development of robust MRV systems (KPI: CO_{2eq} emissions reductions, cooling access rates).

The guide provides country case studies that share their strategies. Nigeria, Cambodia, for example, integrated its NCAP into its NDCs, focusing on heat-resilient infrastructure, passive cooling and efficiency along with 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. Vietnam included cooling into its NDCs and Net-zero Climate strategies. 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.

Box 5: Considerations for NDC Integration – policy options (*CCAC*): The CCAC NDC Guide includes

1. Accelerated Implementation of the Kigali Amendment: KIPs and associated actions can be highlighted in the NDCs as clear mitigation commitments. However, it's essential to outline the financial needs, technology requirements, and institutional arrangements under national, regional, and international frameworks.
2. Reducing Cooling-Related Energy Consumption: yields substantial indirect CO_2 emission reductions and supports national energy goals. This involves two complementary strategies:
3. LRM: Integrating a comprehensive LRM approach into NDCs ensures alignment with Montreal Protocol goals while delivering climate, economic, and compliance benefits. Effective refrigerant management includes tracking, recovery, recycling, and destruction. It also minimizes emissions from refrigerant banks, supporting sustainable and climate-friendly cooling access.
4. Voluntary Early Transition to Low-GWP Alternatives: Countries can achieve early climate gains by transitioning ahead of the Kigali schedule, particularly by moving directly from HCFCs or high-GWP HFCs to low-GWP refrigerants in feasible sectors. This leapfrogging strategy prevents the creation of future refrigerant banks and avoids locking into intermediate technologies that are less environmentally sound. However, bridging the access gap with inefficient technologies risks exacerbating emissions, energy waste, and economic costs. Countries must prioritize sustainable, efficient solutions to deliver both equity and climate resilience.

As a general guidance for the MENA region, it is important to ensure consistent units across sectors and sub-sectors for effective nationwide aggregation. It is also important to have consistency between cooling demand (e.g., cooling load in buildings, refrigeration equipment, cold rooms, and refrigerated trucks, etc.) and cooling supply (e.g., air conditioning and refrigeration system cooling capacity, etc.). Defining equipment use patterns is important to understanding the annual operating hours and, consequently, the annual energy consumption. For example, some of the MENA countries have residential buildings running 24/7 in the summer (3600 or more hrs/year), while others only operate when occupied (1600 or fewer hrs/year). Residential refrigeration equipment operation is also dependent on culture; the load depends mainly on the loading pattern, how many times per day the door is opened, and for how long. Ultimately, unit-level annual energy consumption can be aggregated to stock annual energy consumption.

The sector-specific working groups can also derive conversion factors for the different sectors based on the demand side (e.g., kWh/m2 for residential and commercial buildings, kWh/TR for cold rooms and commercial refrigeration, tons of oil equivalent – toe/TR for refrigerated trucks, etc.). This requires local capacity and depends greatly on the stock data availability in Step 3.

Future scenarios might include ways to close the cooling access gaps that need to be accounted for during the integration step. Metrics developed should be used consistently, like primary energy consumption - toe, or equivalent emissions (tons of CO2e – tCO2e). One caveat to consider here is the future estimate for toe and tCO2e, which is largely impacted by the ability of MENA countries to implement their renewable energy transition plans. This is primarily driven by the national political and economic situation.

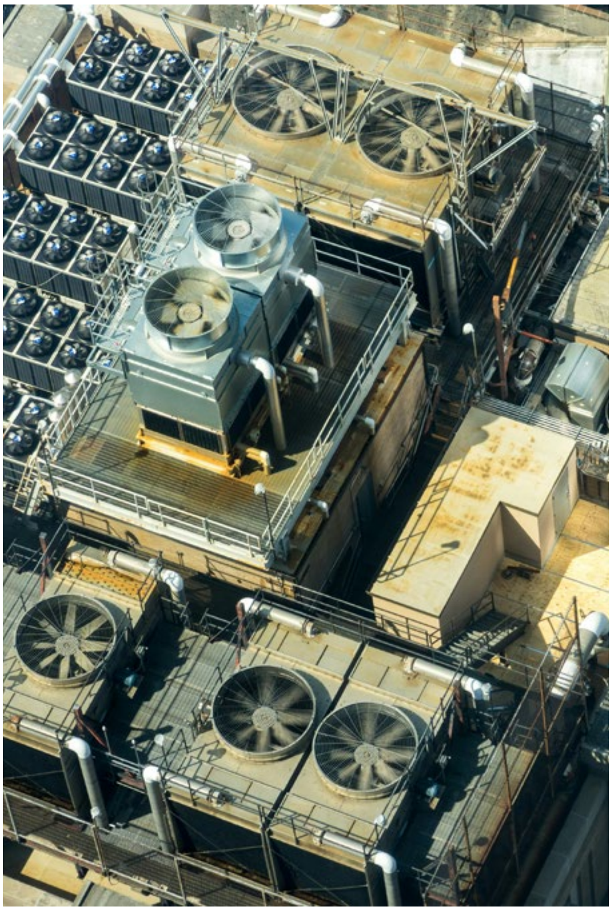
The cNCAP MENA recommends developing a multi-dimensional live dashboard for communicating the output of step 5 during the stakeholders' consultation meeting. The dashboard should be created as a live document that can aggregate data from the different sectors and subsectors and display the total energy/emissions information with and without interventions.

This step consolidates sectoral assessments into a unified nationwide cooling assessment, giving a view into the relative importance of sectors based on expected demand growth and interventions impact. It also highlights opportunities for cross-sectoral synergistic actions.

03.4.2 Step 6: Development of NCAP Recommendations

This activity combines work to derive NCAP recommendations and establish integrative pathways for low-climate impact cooling. The first essential step is to consolidate sector-specific interventions into a comprehensive menu of solutions. This process involves aggregating these interventions, identifying potential synergies and interdependencies among policy actions, and ensuring alignment with ongoing efforts. Crucially, engaging all relevant public and private stakeholders throughout this stage is vital to align diverse interests, secure maximum buy-in, and guarantee the effective implementation of the final NCAP recommendations.

A governance body, such as a steering committee with representatives from relevant ministries, can facilitate necessary stakeholder alignment. This body is key for reviewing NCAP outcomes, assessing recommendations against national objectives, and ensuring alignment with existing policies and programs, thereby obtaining inter-ministerial support.



The recommendations typically fall into three broad categories:

- **Regulatory Interventions:** Foundational steps for scaling up sustainable cooling, including labelling, MEPS, building energy codes, and vehicle emission standards. In addition, National and City level planning/ regulatory framework for district cooling may be needed to enable the development of resource-**efficient cooling** technologies. Finally, Advanced institutional frameworks for strategies like building interventions and demand-side energy management may be needed progressively.
- **Technology Interventions:** Enhancing the efficiency of existing cooling technologies, exploring alternative and low-energy technologies, using different refrigerants, providing cooling solutions for off-grid or weak-grid areas, and conducting research and development for innovative, low-climate-impact cooling solutions.
- **Market Enablement (Supporting Instruments):** Supporting the sustainable cooling market through different instruments, such as:
  - Financial instruments like debt subsidies, innovative business models for sustainable cooling and public procurement,
  - Providing equitable access to financing for women-led businesses in the cooling sector, and ensuring fair and safe working conditions,
  - Capacity-building for institutions and professionals, such as technician training and promoting women in STEM, and targeted training for women and youth in sustainable cooling
  - Raising consumer and stakeholder awareness.

These supporting instruments are best leveraged when combined with policy or technology interventions to maximize their impact and benefits.

The integrative effects of interventions working together are generally greater than individual interventions. For example, policy measures are more effective when combined with institutional capacity building and raising awareness among users and stakeholders. Efficient technologies and refrigerant pathways benefit significantly from financial and technical assistance. Thus, a multipronged approach, tailored to a country's market conditions, is typically required to address cooling challenges effectively.

The recommendations should propose interventions that:

- **Represent a holistic approach to low-climate impact cooling:** This includes reducing future cooling demand through passive cooling strategies, maximizing efficiency with technologies that require less energy and use lower GWP refrigerants, and optimizing cooling operations through user behaviour interventions and good maintenance practices.
- **Utilize synergies between processes and sectors: This involves harnessing all available energy resources to achieve universal access to cooling.**
- **Combine policy instruments, technology, and market enablers optimally.**
- **Align with the country's high-level objectives, international commitments, and national priorities.**

The menu of recommendations typically comes with a trade-off between the level of effort, expected impact, and associated cost. It is important that the NCAP development team carefully studies this trade-off and prioritizes the recommendations to ensure the country achieves its goals. The NCAP development team may consider interventions with long-term self-sufficiency as a priority – especially if they become self-financed (e.g., feasible DC technologies).

Level of Effort refers to the level of effort anticipated to implement the recommendation. In determining the level of effort, countries should explore what are the possible challenges, as well as enablers for implementation. The level of effort can be indicative of the duration and financial resources needed to implement different interventions.

Expected Impact describes the total energy savings and emissions reduction that can be attributed to each recommendation or intervention. In the MENA region, it is also important to consider things link cooling access and refrigerant circularity. Finally, it is important to investigate how the expected impact and other socio-economic co-benefits are aligned with the country's priorities and/or SDGs.

Associated Cost refers to estimates for proposed recommendations or interventions. The NCAP development team should include ballpark estimates or categorization of financial resources for proposed recommendations, such as low-, medium-, or high-cost measures. This information will be meaningful for countries during the prioritization process, considering the overall cost-benefit aspect, not just the upfront implementation cost.

Table 8 Qualitative guidance for step 6 of the cNCAP MENA

Parameter	Guiding Questions	Considerations
Level of Effort	- Policy and regulatory barriers: • Are there any changes required in the existing policy or regulatory framework? - MENA countries have varying degrees of regulatory maturity. Some have well-established building codes and energy efficiency standards, while others are still developing these frameworks. - The presence of energy subsidies can create significant policy barriers, as they often discourage the adoption of energy-efficient technologies. NCAPs must address this. - The political stability and bureaucratic efficiency of each country will heavily influence the ability to implement new policy. - Institutional barriers: • How many agencies/stakeholders need to be involved; are there any multi-agency complexities? - Interministerial coordination may be lacking or challenging in some MENA countries. • Are adequate institutional capacities available? - Cooling professionals lack technical expertise to implement sustainable cooling - Private sectors' inclusion in policy making is important to ensure buy-in - How resource-intensive will the implementation process be? • Are skilled human resources available? - The availability of skilled labour for installing and maintaining advanced cooling technologies is a concern. - Financial resources are also a factor. Some MENA countries have access to substantial funding, while others rely on international aid. • Are the technologies available to support the recommendation? - Important to differentiate between technology availability and accessibility - Some MENA countries have significant financial constraints. - Assess potential enablers that could support implementation • Are there any synergies with existing government schemes and programs? - Many MENA countries have Vision 2030, established SDG goals, and documented NDCs. NCAPS should seek synergies with these initiatives - Regional cooperation, political, technical and financial	- To the extent possible, identify the relevant body that can steer the implementation process and coordinate among the relevant ministries as well as the private sector entities. - To the extent possible, provide timelines relevant to policy formulation and implementation. - Based on available information, assess which recommendation can be taken up in the short term, medium term and long term.
Associated cost	- What is the expected magnitude of upfront investment (low-cost, medium-cost, and high-cost measures)? - What are the existing or potential funding sources for the proposed recommendation?	- In addition to the upfront cost, the anticipated cost effectiveness of the proposed measure (excellent cost-benefit ratio, moderate cost-benefit ratio, and low cost-benefit ratio) should be considered in conjunction while prioritizing.
Expected Impact	- What is the magnitude of energy and emissions reductions with respect to the country's commitments (national and global)? • Given the region's high cooling demand, sustainable cooling interventions can have a significant impact on energy consumption and greenhouse gas emissions. - How far do these reductions help the country meet existing NDCs and formulate future NDCs? - How scalable is the recommended action? - What are the socio-economic co-benefits associated with the actions? How well does it support the country's priorities and SDGs? • Cooling access is an important factor to consider in the NCAP development. - Who are the intended beneficiaries? Which segment of the population does the recommendation target (government, rural, urban, manufacturers, farmers)?	- Identify quick wins and intervention areas that will result in the highest impacts in alignment with the country's priorities. For example, energy savings and grid benefits, reduction in emission, socio-economic benefits for the population including but not limited to energy equity, food security, health benefits, etc.

Countries may wish to consider using prioritization matrices to map the different recommendations/interventions to the most appropriate criteria for the country. These matrices are typically higher-order matrices; however, they could be simplified to 2-D matrices, as is the case when just considering the level of effort and expected impact. In this case, the highest priority recommendation would be the ones that would fall in the low effort, high impact recommendations. An example of prioritization matrices would include the following parameters: effort/cost, market barriers, and climate impacts. A composite priority indicator would be evaluated such that measures with low effort/cost low market barriers and high climate impacts receive the highest priority while high effort/cost high market barriers and low climate impacts receive the lowest priority. Countries should then consider the trade-offs between high effort/cost high market barriers and high climate impacts and low effort/cost low market barriers but low climate impacts.

Table X Example Prioritization Matrix for Sustainable Cooling Measures

Intervention / Measure	Effort & Cost (1=Low, 5=High)	Market Barriers (1=Low, 5=High)	Climate & Energy Impact (1=Low, 5=High)	Composite Priority (High = Quick Win)	Notes
Ceiling / Pedestal Fans Deployment	1	1	4	★★★★☆	Very low cost, widespread adoption possible; reduces AC demand significantly.
Cool Roofs & Reflective Paints	2	2	5	★★★★★	Proven passive strategy, reduces building heat load, scalable in hot climates.
Public Awareness & Behaviour Campaigns (set-point changes, AC maintenance)	1	1	3–4	★★★★☆	Immediate impact, cost negligible, but requires consistent communication.
Efficient Lighting (LEDs) to Reduce Internal Heat Gain	1	1	3	★★★★☆	Reduces cooling load while cutting electricity bills.
Improved Building Envelope Standards (new builds)	3	3	5	★★★☆☆	High long-term impact, but slower adoption due to codes and enforcement.
MEPS for Air Conditioners (higher efficiency, lower-GWP refrigerants)	4	3	5	★★★☆☆	Major impact, but requires policy/regulation and market readiness.
District Cooling in Dense Urban Areas	5	4		★★☆☆☆	High impact but capital-intensive, not a quick win.
Nature-based Cooling (urban trees, shading structures)	2	2	4	★★★★☆	Moderate effort, relatively low cost, additional co-benefits (health, air quality).

The NCAP team should compile a list of expected benefits from implementing the recommendations, such as energy and climate impacts, avoided grid capacity, and emission reductions. They should establish links to support national and international commitments, such as the Paris Agreement and the Kigali Amendment to the Montreal Protocol (e.g., refrigerant LRM). Socioeconomic benefits should be highlighted (e.g., cooling access, improved cold chain), particularly in relation to the SDGs and national objectives. Benefits should be monetized to facilitate cost-benefit analysis.

This step offers practical recommendations to address the country's cooling needs, suggests actionable pathways, and seeks alignment among key stakeholders and government entities.

03.4.3 Step 7: NCAP Document

The final step in the NCAP development process involves crafting the NCAP document, ensuring it includes essential elements for its operationalization. Key elements to include are an implementation and governance framework, a monitoring protocol, key success factors, and a process for recalibration to keep the NCAP actionable and up to date.

The key elements of an NCAP document include:

1. Cooling Context:
   - Socio-economic context: Overview of cooling demand growth drivers, macro-trends, and access to cooling.
   - Policy context: Overview of key policies, programs, and international commitments like the Montreal Protocol and Paris Agreement.
   - Technical and market context: Overview of prevalent cooling technologies, efficiency practices, and market behaviours.

MENA countries may wish to include context-setting narratives such as those related to cooling access, hot weather, cold chain, refrigerant management, and future electricity generation mix and emissions.

2. NCAP Introduction and Orientation:
   - Inception prompt (e.g., international commitments, national agenda, political will)
   - Broad objectives, scope, and boundary
   - Key terminologies and future scenarios
   - Overarching assumptions and report organization
3. NCAP Development Framework: a description of the stakeholder groups, working groups, and supervisory committees involved
4. Aggregated Nationwide Overview of Cooling:
   - Sector-to-sector comparison of cooling demand, cooling energy consumption, and emissions
   - Relative savings potential for each sector
5. Sectoral Cooling Demand Assessment and Outcomes:
   - Present and future cooling requirements, refrigerant demand, and energy use
   - Sector-specific priorities and strategic intervention opportunities
6. Prioritized Recommendations of the NCAP:
   - Synergies and interdependencies among policy interventions
   - Criteria for prioritizing recommendations and their expected impact
7. Implementation Guidance:
   - Implementation and governance framework
   - Linkages between NCAP recommendations and government entities
   - Monitoring protocol, key success factors, and recalibration process

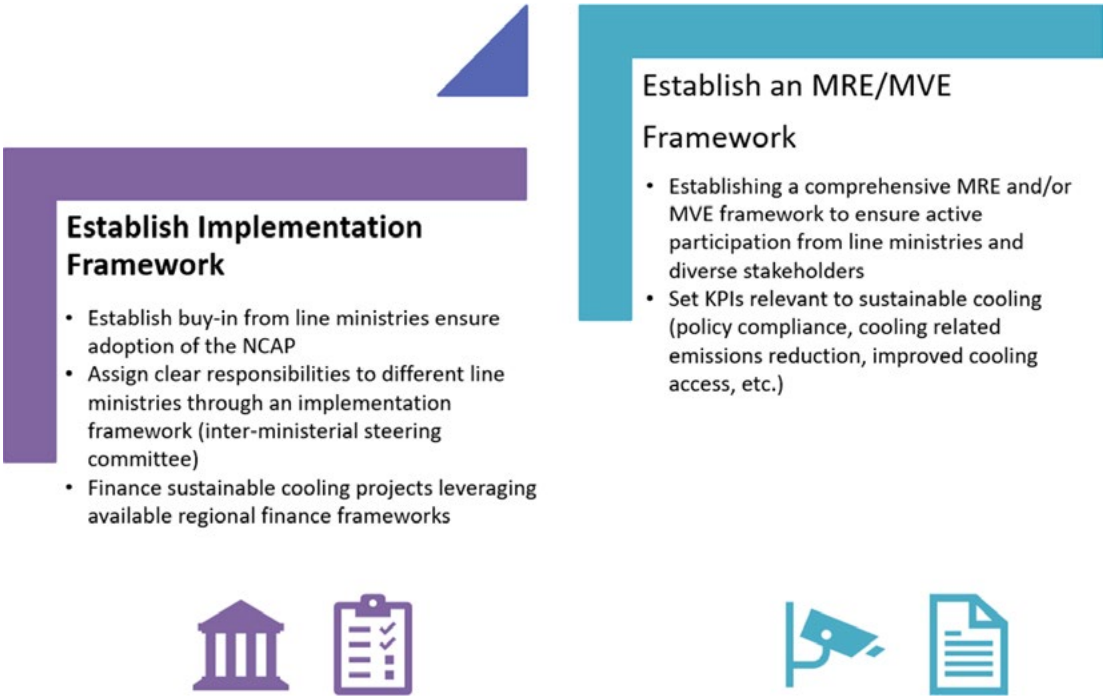
Embedding implementation guidance ensures the NCAP is actionable, supported by a governing committee, monitoring systems, and financial resources from various development banks and national funding. This step ensures the NCAP remains a "living document," open to updates with new data and information.

This step documents the NCAP into an actionable plan with defined ownership and governance to guide and monitor implementation and future adjustments, if needed.

03.5 Stage IV: cNCAP Implementation Framework, Monitoring, Reporting, and Evaluation

The final stage of the cNCAP methodology is meant to establish a framework for implementing the NCAP and monitoring its progress over time. This is shown in Figure 10. This stage is crucial to ensure the government and public reap the benefits of the NCAP and that all efforts are properly coordinated.

Figure 10 Summary of Stage IV of the NCAP development process.



03.5.1 Step 8: Establish an implementation framework

Once the NCAP document is established as a "live" document, the government focal point shall present the NCAP to line ministries and/or the cabinet of ministers and establish the buy-in for it to be adopted. Afterwards, the focal point should coordinate the establishment of an implementation framework that assigns clear responsibilities to different line ministries. It is advisable that an inter-ministerial steering committee be formed to oversee the implementation of the NCAP. Finally, it is critical that countries establish a finance framework for sustainable cooling following key findings from the cNCAP MENA development stages and leveraging available regional finance frameworks such as:

- National Fund for the Management of Energy and Renewable Energies and Cogeneration (FNMEERC), National Energy Efficiency Program (PNME) and TAKA NADIFA in Algeria[42].
- Green Economy Financing Facility (GEFF II) in Egypt.
- Jordanian Renewable Energy & Energy Efficiency Fund (JREEEF) - residential sector programs in Jordan.
- The National Energy Efficiency and Renewable Energy Action (NEEREA), GEFF Lebanon, the National Heat Pumps Project and the Italian Energy-Efficient Home Appliances Program (IEEHA) in Lebanon.

42 https://meetmed.org/wp-content/uploads/2024/04/meetMED-Guidebook-2024-.pdf

Table xx. Qualitative guidance for step 8 of the cNCAP MENA.

Key Activity	Guidance
Present NCAP to Decision-Makers	- Deliver a concise, evidence-based presentation of the NCAP to the cabinet of ministers or equivalent decision-making body. - Emphasize the NCAP's alignment with national development goals (energy security, climate action, health, resilience, green jobs). - Emphasize the cross-cutting nature of the NCAP and how it contributes to the achievement of multiple national development goals. - Tailor the presentation to the specific interests and priorities of each line ministry and the cabinet of ministers.
Establish Institutional Ownership	- Assign a lead coordinating ministry (often energy, environment, or planning) with the authority to oversee cross-sector collaboration. - Identify clear focal units within each relevant line ministry (e.g., environment, energy, health, housing, urban development, finance, education, agriculture). - Formalize roles through official directives, memoranda of understanding, or cabinet decrees.
Create an Inter-Ministerial Steering Committee	- Mandate representation from key ministries, national standards bodies, finance institutions, private sector associations, and civil society organizations. - Define responsibilities such as monitoring progress, resolving conflicts, and aligning with international commitments (Paris Agreement, Kigali Amendment, SDGs). - Establish a secretariat to provide technical, administrative, and reporting support.
Develop a Financing Framework to fund NCAP activities	- Map national and regional financing sources (green funds, climate finance facilities, development banks, bilateral donors, private sector investments). - Prioritize blended finance approaches that combine public funding, concessional loans, and private sector investment. - Ensure the financing strategy supports both supply-side interventions (efficient technologies, refrigerant transition) and demand-side measures (passive cooling, behavioural change, building codes).

Case Study 7
Financing

03.5.2 Step 9: Establish an MRE/MVE Framework

Following the adoption and implementation commencement of the cNCAP MENA, establishing a comprehensive Monitoring, Reporting, and Evaluation (MRE) and/or Monitoring Verification and Enforcement (MVE) framework is paramount. These frameworks will serve as the cornerstone for ensuring active participation from line ministries and diverse stakeholders, driving collective progress towards national sustainable cooling targets.

Table 9 Qualitative guidance for step 9 of the cNCAP MENA

Key Principle and Objective	Guidance	Value
Transparency and Accountability	ensure that data and evaluation results are readily accessible to all stakeholders	foster accountability and builds trust
Data-Driven Decision Making	collect and analyse high-quality data	Informed decision making for resource allocation
Stakeholder Engagement	Active and continuous engagement with all stakeholders: public, private, and civil Establish regular review cycles to adjust the NCAP in response to technological advances, financial opportunities, and market dynamics	Stoked momentum towards success and more inclusive holistic and well-informed cooling action
Adaptive Management	facilitate continuous improvement	Continue to adjust and refine plan
Quantifiable and Qualifiable Metrics	quantifiable metrics: - energy consumption reduction - refrigerant emissions reduction - food loss and waste reduction - financial investments qualifiable metrics: - policy implementation effectiveness - stakeholder satisfaction - behavioural changes	Support compliance with international commitments and transition the cooling sector towards sustainable cooling
Alignment with National and International Goals	align with national development goals, as well as international commitments such as the Paris Agreement and the Kigali Amendment	Data consistency (E.g., BTR, HFC reporting, etc.)

The key components of the MRE framework are to establish a baseline, typically done during the cNCAP MENA step 3, and then to establish clear and measurable baseline indicators. This is then followed by developing a system for tracking progress towards national targets, using a combination of quantitative and qualitative indicators. Some of the key performance indicators (KPIs) include:

- Energy efficiency improvements in cooling equipment (kW/TR)
- Progress on LRM
- National greenhouse gas emissions reduction from the cooling sector
- Adoption of sustainable cooling technologies
- Implementation of building energy codes and standards
- Socio-economic benefits (e.g., increased productivity, reduced food wastage, increased cooling access for vulnerable communities, cooling for commodities (e.g., medicines, etc.), reduced heat stress for workers, etc.)
- Financial investments in sustainable cooling projects

The MVE framework is a critical component of any regulatory or policy implementation system, especially in environmental and energy-related sectors such as sustainable cooling. An effective MVE framework ensures that standards and commitments are complied with, transparently measured, and enforced. It involves six key activities:

1. Monitoring: involves the systematic collection of data to track performance and compliance with policies, standards, or targets. This can be achieved through data collection systems and market surveillance.
2. Verification: ensures that reported or measured data is accurate, reliable, and complies with the defined requirements. This activity involves independent testing of products, audits of facilities, or project-based validation. It should include standardized methods for selecting units or cases for verification testing.
3. Enforcement: used to ensure compliance and correct or penalize non-compliance. A legal authority should be clearly defined to create a legal basis for enforcement actions (fines, product recalls, license revocation, etc.). It is preferable to have tiered or proportional penalties depending on the severity or recurrence of non-compliance and requirements for non-compliant actors to rectify problems (e.g., improved product design, public notice). The compliance standards should be reviewed periodically to account for changes in national policy and technological maturity.
4. Institutional Arrangements: defines the roles and responsibilities of different agencies and actors. Typically, a ministry or national authority is recognized for leading the MVE efforts. This lead agency should coordinate among ministries, customs, testing labs, and enforcement bodies to ensure effective operation. In addition, it is important to ensure proper training and resourcing for agencies, inspectors, and industry stakeholders. Finally, this activity involves stakeholder engagement, including manufacturers, civil society, and the public.
5. Data Management and Transparency: enables efficient tracking, analysis, and communication of MVE outcomes. In this activity, the government should establish centralized databases with secure systems to collect and manage data from various stakeholders. This would make selected MVE data available for public or sectoral scrutiny. The lead agency should make use of IT systems (such as a digital product registry) for remote monitoring, automated flagging, or real-time tracking.
6. Feedback and Continuous Improvement: allows for refining policies and MVE mechanisms over time. Through this activity, the lead agency would perform a periodic assessment of the effectiveness of policies and MVE tools. This can be achieved using an adaptive management approach that modifies the sustainable cooling policies based on MVE findings and incorporates feedback into future planning and international knowledge sharing.

Table 10 provides a summary of typical MVE components for the different activities listed above in three sustainable cooling policy regulatory components: MEPS, Refrigerant management, and building codes.

Table 10 Example MVE components for the different activities – relevant to the MENA region

Component	MEPS	Refrigerants	Building Codes
Monitoring	Market surveillance, declarations	Import logs, leak reports	Permit review, site inspections
Verification	Lab testing, audits	Quota audits, destruction checks	Envelope testing, commissioning
Enforcement	Fines, market removal	Quota penalties, licensing	Permit/occupancy withholding
Institutions	Energy ministries, customs	Environment ministries, importers	Construction Ministries, Urban authorities, inspectors
Data Management	Product databases, label registry	National tracking + customs link	E-permitting and inspection systems
Feedback Loop	Raise MEPS over time	Adjust quotas, expand destruction	Code updates, better training

04 Way Forward: Addressing Regional Challenges and Advancing Sustainable Cooling in MENA

Developing National Cooling Action Plans (NCAPs) is an important first step in setting a clear vision and framework for sustainable cooling in the MENA region. These plans provide the foundation to address urgent cooling needs while aligning with climate and development priorities. To move from planning to impact, countries can strengthen technical and institutional capacities through targeted training programmes and enhance coordination between national, subnational, and sectoral actors, enabling policies, standards, and programmes to be implemented more effectively and at scale.

The region holds immense potential for regional collaboration on MEPS and labels harmonization, which would elevate ambition, support enforcement, overcome market fragmentation, and accelerate the adoption of efficient, climate-friendly cooling technologies. Similarly, a regional approach to M&V offers a more cost-effective solution than individual country efforts, leveraging shared resources and best practices for robust reporting

Building on this foundation, countries can develop investment roadmaps that outline financing needs, potential capital sources, and mechanisms to mobilize resources for sustainable cooling solutions. These can be linked to a pipeline of bankable projects addressing both mitigation and adaptation priorities from deploying high-efficiency technologies and climate-friendly refrigerants to expanding equitable access and climate-resilient infrastructure. Countries can ensure that the achievements of cooling programs are rigorously integrated into national and international reporting, both technically (e.g., avoided GHG emissions, energy savings) and economically (e.g., job creation, reduced energy bills). This strategic integration ensures that sustainable cooling becomes a foundational pillar of climate-resilient development within national strategies like Egypt's Integrated Sustainable Energy Strategy 2040 (ISES 2040) and similar plans across the region, shaping a truly sustainable and prosperous present and future.

05 Case Studies

Case study 1: Sectoral current and future cooling demand assessment in Jordan

Before the NCAP development in Jordan started, the Cool Up Programme conducted a sectoral current and future cooling demand assessment in the country. This Prospects Study would be an important input in the modelling stage of the NCAP preparation, as the modelling approach as well as many of the data inputs could be used. The Prospect Study covered the residential and commercial AC, as well as the commercial refrigeration sectors. The modelling conducted for the NCAP was expanded to include further cooling sectors such as mobile AC and industrial, transport, and residential refrigeration.

In order to create an accurate modelling which reflected the realities of the Jordanian cooling sector, a multi-stakeholder approach was employed. Inputs and data were gathered through participation from government, industry, finance, and academia. This collaborative process, led by the Ministry of Environment and the Cool Up Programme, ensured that the modelling accurately reflected the current technologies in use, the energy efficiency of buildings, and the policy environment.

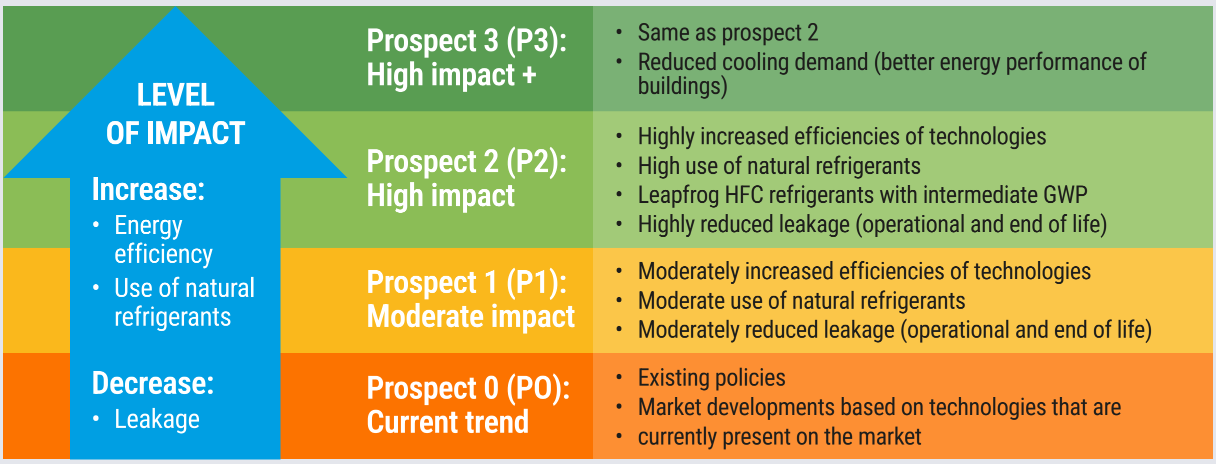
The challenges included limited data on the current state of the cooling sector, particularly regarding air conditioning and commercial refrigeration. This data gap was addressed by conducting on the ground primary data collection and assumptions validated by sectoral experts. Interviews with experts from industry were also conducted to ensure that assumptions about future market trends and technological development were realistic. The collection and validation of data to overcome data gaps ensured that the modelling was as accurate as possible. For policy inputs regarding the current and future regulatory environment, Cool Up was able to draw on insights from the Regulatory Analysis Report for Jordan.[43]

The study[44] showed that the cooling sector projects a fivefold increase in air conditioning units by 2050 and a 35% rise in commercial refrigeration, leading to a significant rise of more than 3.5 times in electricity demand, while emissions (both direct and indirect) could increase significantly without intervention.

The study models four scenarios, ranging from the current trend (P0) to three mitigation scenarios (P1–P3)[45] presented in Error! Reference source not found., with P3 showing the most ambitious results, including a 46% reduction in electricity demand and up to a 73% decrease in emissions by 2050. These findings emphasize the need for early, ambitious actions involving energy efficiency, refrigerant transitions, and supportive policies to meet sustainability and climate targets.

While the modelling has been since updated and will be included in the published Jordanian NCAP, the approach and steps taken were critical for the work later done in the NCAP modelling.

Figure 11 Cool Up program prospects and mitigation actions



43 https://www.coolupprogramme.org/knowledge-base/reports/regulatory-analysis-jordan/

44 https://www.coolupprogramme.org/knowledge-base/reports/cooling-sector-prospects-study-jordan/

45 Three mitigation scenarios: Prospect (P1) Moderate impact, Prospect (P2): High impact, Prospect (P3): High impact +

Case study 2:
Country context mapping in Egypt (Cool-Up)

The Cool Up Programme conducted and published a study on the status of the cooling sector in Egypt.[46] The study gave an overview of the air conditioning, commercial refrigeration, and refrigerant markets. While this study preceded the NCAP by over a year, a deeper understanding of the national cooling sector context was important in identifying the need for a comprehensive policy action plan like the NCAP.

A key strength of the cooling sector status report was the comprehensive data collection through expert interviews and global models, which provided insights into the status-quo air conditioning and commercial refrigeration markets. The expert interviews were crucial for gaining insights into parts of the market where data was not available and for validating the outputs from global models at the Egyptian national level.

Beyond the cooling sector status report which focused on the market, the Cool Up Programme also prepared reports on the finance[47] and policy[48] landscapes regarding cooling in Egypt. These reports together gave a comprehensive overview of the entire cooling sector in Egypt and represented a context mapping.

The mapping identified the need for enhanced awareness and capacity building among stakeholders regarding low-GWP refrigerants, as safety concerns and lack of knowledge hindered their adoption. Additionally, the absence of national regulations on F-gases and the incomplete ratification of the Kigali Amendment created legal uncertainties[49], impeding long-term planning and investment in sustainable cooling technologies. The country context mapping showed that Egypt presents a strong market potential for energy-efficient and climate-friendly cooling solutions, especially with further regulatory, financial, and technical support.

This mapping laid a foundation for the development of an NCAP, as it proved a deeper contextualized understanding of the cooling sector in Egypt. It identified initial policy recommendations and strategies to promote sustainable cooling in Egypt and showed that a coordinated policy approach via an NCAP could ensure a pathway to sustainable cooling.

Case study 3:
MEPS in Lebanon

The Lebanon National Cooling Action Plan (NCAP)[50], supported by UNDP, outlines key measures aimed at transitioning the country toward sustainable and efficient cooling. The NCAP emphasizes the need for establishing Minimum Energy Performance Standards (MEPS) and labelling systems for refrigerators and air conditioners, as currently, Lebanon lacks these regulatory tools.

It also estimates the cost of implementing an incentive and disposal system for these appliances at approximately USD 187.5 million over nine years. The plan identifies critical challenges such as low appliance efficiency, limited market incentives for energy-efficient products, and the absence of enforcement mechanisms.

Proposed measures include setting ambitious MEPS, promoting low-GWP refrigerants, improving technical capacity in the servicing sector, and developing financing mechanisms to support the replacement of inefficient systems. These actions are designed to reduce electricity consumption, lower greenhouse gas emissions, and align with Lebanon's climate commitments under the Kigali Amendment and Paris Agreement.

However, the implementation of these policies has been hindered by Lebanon's ongoing economic and political crises, which have delayed regulatory enforcement and market adoption. Despite these obstacles, the Cool-Up program has facilitated capacity-building initiatives, including training programs for technicians on energy-efficient cooling systems, and has laid the groundwork for future advancements in sustainable cooling.

46 *https://www.coolupprogramme.org/knowledge-base/reports/cooling-sector-status-report-egypt/*

47 *https://www.coolupprogramme.org/knowledge-base/reports/insights-into-egypts-refrigeration-and-air-conditioning-finance-landscape/*

48 *https://www.coolupprogramme.org/knowledge-base/reports/regulatory-analysis-egypt/*

49 *The Kigali Amendment has since been ratified in Egypt, on August 22, 2023*

50 *https://www.undp.org/sites/g/files/zskgke326/files/2023-11/undp-summary-of-national-cooling-action-plans.pdf*

Case study 4:
Improved building codes

The Global ABC Regional Roadmap for Buildings and Construction in the Arab Region[51] highlights improved building codes as a critical case study in advancing sustainable construction practices. Several Arab countries have made progress by updating their building energy codes to incorporate energy efficiency standards, particularly for new constructions.

For instance, Jordan has implemented updates to its National Building Code to include thermal insulation and solar water heating requirements. Similarly, Morocco has introduced thermal regulations for buildings to enhance energy performance. These improved codes aim to reduce energy demand, especially for cooling, which is significant in the region due to its hot climate.

The roadmap emphasizes that effective enforcement mechanisms, capacity building for local authorities, and stakeholder engagement are essential for the successful implementation of these improved codes. Such efforts are pivotal in aligning the region's construction sector with national climate targets and the goals of the Paris Agreement.

Case study 5:
Passive cooling in buildings.

The Dar Al-Oqoud residence in Amman, Jordan (Figure 11)[52] represents the integration of passive design strategies within the BUILD_ME project. Designed by architect Maher Abusamra (MAS Design Studio), this single-family home incorporates traditional Islamic Mediterranean architectural elements, such as load-bearing stone walls, vaulted ceilings, domes, and a central courtyard.

These features, rooted in vernacular design, are strategically employed to optimize natural ventilation and thermal comfort, thereby reducing reliance on mechanical cooling systems. The BUILD_ME team provided technical assistance to enhance the building's energy efficiency, demonstrating how traditional design principles can be adapted to meet contemporary sustainability goals in the MENA region.

Figure 12
Dar Al-Oqoud residence in Amman, Jordan

51 https://globalabc.org/sites/default/files/2023-05/GlobalABC%20Regional%20Roadmap%20for%20Buildings%20and%20Construction%20in%20the%20Arab%20Region.pdf

52 https://www.buildings-mena.com/info/dar-al-oqoud-amman-jordan

Case study 6:
Cooling access through passive cooling

The KONN Modular Homes project in Jordan (Figure 12)[53] addresses the pressing need for affordable and sustainable housing with adequate cooling solutions. Developed by Uraiqat Architects, these single-family modular homes are designed to be both cost-effective and energy efficient. The BUILD_ME project collaborated with KONN to implement energy efficiency and renewable energy measures, focusing on enhancing cooling access for residents.

By incorporating smart modular construction techniques and passive cooling strategies, the homes maintain comfortable indoor temperatures while minimizing energy consumption. This case study illustrates the potential of combining innovative design with energy-efficient technologies to improve cooling access in affordable housing within the MENA region.

Figure 13
KONN Modular Homes project

Case study 7:
Financing

The Cool Up program in Jordan evaluated the economic feasibility of transitioning to low-global warming potential (GWP) refrigerants and more efficient cooling systems in supermarkets and residential buildings. The findings showed that upfront investments in low-GWP refrigerants and energy-efficient cooling technologies are financially viable over time, especially when combined with policy incentives and green financing instruments. These efforts serve as replicable models for scaling sustainable building and cooling solutions across the MENA region.

The Central Bank of Egypt (CBE), for instance, has implemented a strategic initiative mandating banks to allocate 20% of their lending portfolios to support small and medium-sized enterprises (SMEs), including energy efficiency (EE) upgrades and cooling technology improvements. This is complemented by international cooperation, particularly with the European Bank for Reconstruction and Development (EBRD), which has launched dedicated green finance programs to enhance investment in clean cooling solutions.

Instruments such as revolving green credit, public-private partnerships (PPP), and support from funds like the Green Climate Fund (GCF) are helping de-risk investments in energy-efficient and low-global warming potential (GWP) refrigerant technologies. These financial structures demonstrate how tailored financing tools can drive widespread adoption of sustainable cooling in Egypt and serve as a model for other MENA countries.[54]

53 https://www.buildings-mena.com/info/pilot-projects-phase-ii-2019-2021?utm_source=chatgpt.com

54 https://www.coolupprogramme.org/knowledge-base/reports/cooling-sector-status-report-egypt/

Case study 8:
Energy Efficiency, LRM, and refrigerant transition[55]

In 2019, the Government of Morocco, in collaboration with industry stakeholders and non-governmental partners, launched the Morocco Banker's Air Conditioner (AC) Buyers Club. The initiative aimed to facilitate access to high-efficiency, low-GWP room air conditioners (RACs) at competitive and affordable prices.

An initial assessment revealed that Morocco's installed RAC stock was dominated by units with low nameplate energy efficiency, primarily using HCFC-22 refrigerant, with some R-410A units. The units were often poorly installed and inadequately maintained, contributing to higher energy consumption. Additionally, significant urban heat island effects were observed in the cities studied.

To address these issues, the Buyers Club, in partnership with the Bank of Africa, initiated a demonstration project to replace aging RACs with advanced models. The effort included the development of a new life cycle carbon footprint metric that considers factors such as:

- Electricity generation, transmission, and distribution at high ambient temperatures
- Impact of urban heat islands, including the clustering of AC condensers
- Carbon intensity of marginal power demand during peak and off-peak hours

Two conventional RAC units and two state-of-the-art inverter-driven HFC-32 RACs were installed and monitored in Bank of Africa branches in Marrakesh, one of Morocco's hottest cities. The key findings of this study are summarized below:

Particular	Location	Refrigerant	COP/Energy consumption	Energy Cost
Baseline #one	Bank of Africa's Dar Saada, Marrakesh branches	HCFC-22	COP = 2.0 1,800 kWh/year	2,680 Dirham (US$ 280)
Baseline #two	Bab Doukkala, Marrakesh branches	HCFC-22	COP = 2.8 1,200 kWh/year	1,650 Dirham (US$ 170)
Replacement	Bank of Africa's Dar Saada, Marrakesh branches	HFC-32	COP = 5.3 650 kWh/year	790 Dirham (US$ 80)

The HFC-32 inverter RACs demonstrated potential energy savings of up to 70% compared to baseline units. Beyond efficiency, the project highlighted the economic and environmental benefits of safely recovering and destroying obsolete refrigerants (HCFCs and high-GWP HFCs) using local cement kilns.

While the sample size was limited and did not control for variables such as door activity, occupancy, or behavioural preferences, the results clearly indicate that replacing old, inefficient, and poorly maintained RACs can lead to significant reductions in electricity consumption. This contributes to cleaner air, climate protection, and improved public health. Moreover, energy savings can redirect household and business spending toward local goods and services, enhancing community well-being and economic resilience.

55 https://igsd.org/wp-content/uploads/2021/05/Morocco-BMCE-Bank-of-Africa-RAC-Pilot-Final-6-April-2021.pdf

Case study 9:
Bridging the Cooling Access Gap – Scalable Solutions

In the sweltering summers of the Middle East and North Africa (MENA), access to cooling can be a matter of survival. Yet many communities lack reliable cooling even as climate change drives soaring temperatures and demand. Sustainable Energy for All's Chilling Prospects 2022 report found that 1 in 7 people globally (1.2 billion) lack adequate cooling access, which threatens their ability to survive extreme heat, store food, or receive vaccines. The MENA region is on the frontlines of this crisis. In Egypt, for example, average temperatures have risen over 0.5 °C per decade in recent decades, with electricity use climbing 6% annually as people try to keep cool. By 2050, Türkiye's interior regions are projected to be 2.5 °C hotter. This surge in cooling demand is straining energy systems and exposing an expanding "cooling access gap" for the poorest and most vulnerable. Without intervention, MENA faces a stark choice between meeting urgent cooling needs or locking in unsustainable energy use and emissions.

Cooling is not a luxury; it is an issue of equality and a service that must be delivered to those who need it. Experiences from India and Nigeria, show practical, replicable strategies that can bridge the "cooling access gap" while advancing climate goals.

In *India's urban slums*, the Mahila Housing Trust launched the "Climate Saathis" program, training women to serve as energy auditors and local climate leaders. These women promote energy-efficient appliances, passive cooling methods like white-painted roofs, and household education about sustainable energy use. The project has installed over 200 modular roofs and 500 solar-reflective roofs, lowering indoor temperatures by up to 6°C and helping households save more than USD 700,000 annually in energy costs.

Mumbai, struggling with an intensified urban *heat island effect*, is responding by developing *nature-based solutions*. A 3.2-acre Urban Forest and Nature Conservancy Park in Marol is expected to lower local temperatures by up to 3.0°C and provide much-needed green space for over 170,000 residents. It forms part of the city's broader Climate Action Plan to increase urban vegetation and build resilience to rising heat.

In Nigeria, where over 114 million people are at high risk due to the lack of cooling, the government introduced a *Building Energy Efficiency Code* that encourages passive design strategies — including solar shading, natural ventilation, and roof insulation. Pilot projects show that these measures can cut cooling energy demand by up to 44%, while innovations like green walls in Lagos have reduced indoor temperatures by an average of 2.3°C in low-income housing.

In Nigeria, the *CoolCycle project* is helping tackle food spoilage by providing solar-powered cold rooms for fresh produce. CoolCycle, a Youth Sustainable Development Network (YSDN) co-led initiative, aims to reduce post-harvest losses, enhance food security, and promote clean energy use, pioneering a transformative approach to Nigeria's agricultural sector by integrating renewable energy with cold storage technology, aiming to revolutionize food security and enhance livelihoods.

These experiences demonstrate that sustainable cooling can be achieved through community empowerment, policy frameworks, passive cooling and innovation. By adapting these approaches to local contexts, governments and communities worldwide can meet growing cooling needs without exacerbating emissions, thereby securing health, economic, and climate benefits for the most vulnerable populations.

Special thanks to UNEP's funding partners. For more than 50 years, UNEP has served as the leading global authority on the environment, mobilising action through scientific evidence, raising awareness, building capacity and convening stakeholders. UNEP's core programme of work is made possible by flexible contributions from Member States and other partners to the Environment Fund and UNEP Planetary Funds. These funds enable agile, innovative solutions for climate change, nature and biodiversity loss, and pollution and waste.

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