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Item 11 of the provisional agenda for the preparatory segment*

Energy-efficient and low- or zero-global-warming-potential technologies: outcomes of the workshop on energy efficiency (decision XXXIV/3, para. 4 (a))

Existing policies addressing interlinkages between phasing down hydrofluorocarbons and enhancing energy efficiency: case studies

Note by the Secretariat

1. The annex to the present note sets out case studies to complement the note (UNEP/OzL.Pro/Workshop.12/2–UNEP/OzL.Pro/35/10) on existing policies addressing interlinkages between phasing down hydrofluorocarbons and enhancing energy efficiency prepared in accordance with subparagraph 4 (b) of decision XXXIV/3, on enabling enhanced access and facilitating the transition to energy-efficient and low- or zero-global-warming-potential technologies.

2. For the purposes of that note, the Secretariat identified and summarized 15 case studies demonstrating how relevant policies have been introduced and implemented in various countries. These case studies provide descriptions of the context and challenges faced, the solutions implemented, and, where available, the costs of implementation as well as lessons learned from the experiences. While care has been taken to review the case studies by their implementers to the extent possible, parties and workshop participants may submit further corrections or additional information about these case studies to the Secretariat, should they wish to do so. The Secretariat is appreciative of all guidance and input received from those who submitted the case studies and those who have reviewed them.

* UNEP/OzL.Pro.35/1

List of case studies

1. Refrigerant transition and energy efficiency policies in China

A. Introduction

3. Since 2010, the demand for air-conditioning systems in China has surged at a rate faster than anywhere else in the world, leading to a significant increase in energy consumption for heating and cooling. In 2021, heating and cooling accounted for 65 per cent of total energy consumption of buildings in the country.[1] Consequently, more than a quarter of global space-cooling-related emissions occur in China alone.[2]

4. As the world's leading producer, exporter and user of air conditioners, the commitment of China to enhancing energy efficiency through Minimum Energy Performance Standards (MEPS), among other measures, can facilitate global equipment transition, improve energy efficiency, and reduce greenhouse gas (GHG) emissions from this sector.[3]

B. Context

5. *Green and Efficient Cooling Action Plan:* In June 2019, China introduced its national Green and Efficient Cooling Action Plan, [4] which sets out energy efficiency and market penetration targets for air conditioners and other cooling products for 2022 and 2030. The plan includes upgrading MEPS for air conditioners and refrigerators, expanding the supply of green and high-efficiency cooling products, promoting the consumption of such products, enhancing cooling-efficiency retrofits, and fostering international cooperation. By 2030, the energy efficiency of large public buildings is expected to increase by 30 per cent, overall cooling energy efficiency by more than 25 per cent, the market share of green and efficient cooling products by more than 40 per cent. This should result in annual electricity savings of 400 billion kWh, according to the plan.

6. *Revised MEPS for air conditioners:* After the launch of the action plan, and in synergy with the implementation of the Kigali Amendment, China upgraded the MEPS for room air conditioners (GB21455-2019) and multi-connected air-conditioning (heat-pump) units (GB21454-2021). These are the two dominant air-conditioning products for the residential and light commercial sectors. Leading manufacturers and industry and consumers associations were actively involved in the revision of the MEPS. The impact of typical refrigerants on energy efficiency of the systems was considered, however GWP value limits are not prescribed in the final MEPS.

7. The levels in the new MEPS are aligned with the United Nations Environment Programme (UNEP) United for Efficiency (U4E) Model Regulation Guidelines for air conditioners for higher energy efficiency requirements and testing approaches,[5] and inspired the Association of Southeast Asian Nations and the Southern African Development Community to adopt new regional MEPS for air conditioners to meet the U4E Model Regulation Guidelines.[6]

8. Compared to the previous MEPS, the new standard has brought fixed-speed and variable-speed air conditioners under one scale, [7] ranging from "Grade 5" as the lowest to "Grade 1" as the highest standard; Grade 5 is the minimum energy performance level for fixed-speed units and Grade 3 is the minimum energy performance level for variable-speed units.[8] The new "Grade 1" sets a world-leading standard for energy efficiency on a par with the highest grades in Japan and the European

[1] International Energy Agency, "An Energy Sector Roadmap to Carbon Neutrality in China", September 2021, p. 136.

[2] Lei Zeng and others, "China's MEPS Lead to Major AC Market Transformation", CLASP, June 2023, p. 3.

[3] Energy Foundation. "Energy Efficiency of China's Exported Room Air Conditioners", 2022, p.1 (Chinese only).

[4] This is a joint plan between the National Development and Reform Commission, Ministry of Industry and Information Technology, Ministry of Finance, Ministry of Ecology and Environment, Ministry of Housing and Urban-Rural Development, State Administration for Market Regulation, and National Government Offices Administration.

[5] Michael Garry, "Chinese manufacturers support UN guidelines for air conditioner energy efficiency", *ACCELERATE: advancing clean cooling*, 8 May 2020, available at https://accelerate24.news/hvac/chinese-manufacturers-support-un-guidelines-for-ac-energy-efficiency/2020/. The U4E Model Regulation Guidelines recommend aligning the MEPS efficiency levels with the new Chinese MEPS and labels.

[6] Association of Southeast Asian Nations Cooperation Project Report: Harmonizing Energy-Efficiency Standards for Room Air Conditioners in Southeast Asia, p. 22.

[7] Before 2019, there were two MEPS for room ACs: GB12021.3-2010 for fixed-speed room ACs, revised in 2010; and GB 21455-2013 for variable-speed room ACs, developed in 2008 and revised in 2013.

[8] Cool Coalition, "China's new room AC energy efficiency standard comes into effect", 31 July 2020.

Union. In addition, the "minimum allowable energy efficiency value" for variable-speed room air conditioners (the new "Grade 3") is estimated to be 32-54 per cent more stringent than the 2010 MEPS for fixed-speed units.[9] The updated MEPS include unified seasonal cooling and heating energy efficiency performance through a seasonal energy efficiency ratio (SEER) for cooling and annual performance factor (APF) for year-round cooling and heating performance. This provides a more accurate measurement of energy efficiency than the traditional energy-efficiency ratio (EER) metric.

C. Other actions taken

9. China also established, in March 2005, a mandatory energy efficiency labelling system. By the end of 2022, the China Energy Label had been applied to 11 product categories[10] within the refrigeration, air-conditioning and heat pump sector.[11]

10. As part of the Montreal Protocol commitments, China has actively facilitated the introduction of lower-global-warming-potential refrigerants. The Government has banned the new construction or expansion of facilities that produce and rely on controlled substances used as refrigerants, blowing agents and other controlled uses. The Government has also encouraged industries to speed up development of products with higher efficiency performance using low-global-warming-potential refrigerants and promoted the reuse and safe disposal of refrigerants. The Chinese government is focusing on the promulgation and revision of product and safety standards for environmentally friendly refrigerants. Efforts are also under way to incorporate global-warming-potential information into the China Energy Label. In 2021, the average refrigerant global-warming-potential of room air conditioners in the Chinese domestic market was lower by 33.6 per cent than in 2017. However, for products intended for export this reduction was only by 11.8 per cent.[12] While HCFC-22 is being phased out, HFC-32 has become the dominant refrigerant used in room air conditioners, followed by R-410A.

11. Programmes that aim to foster innovation are in place. According to *The Level of Energy Efficiency, Energy Conservation Level, and Access Level of Key Energy-Using Products and Equipment (2022 Edition)*, an advanced level, surpassing the latest MEPS, has been introduced for cooling products such as room air conditioners and heat pumps. Through the "enterprise standards forerunner programme", [13] manufacturers in the refrigeration, air-conditioning and heat-pump sector are encouraged to develop their own corporate standards with efficiency requirements exceeding the national MEPS, with the highest level of efficiency serving as a benchmark for the rest of the market. Collaboration between industry and academia are also encouraged to foster research and development.

12. The retail sector has actively participated in energy transition. For example, in 2022, the National Development and Reform Commission (NDRC) and other ministries jointly published the Implementation Plan for Promoting Green Consumption. The activities include the establishment of green and low-carbon product sales zones for e-commerce platforms, shopping malls, and supermarkets with incentives such as consumption vouchers, green credits, green subsidies and discounts offered for the purchase of greener and low-carbon appliances and other products.

13. In some cities, initiatives like the "trade-in" campaign and "home appliances to the countryside" programme have been launched. Consumers participating in these programmes upgrade to newer, high-efficiency appliances through subsidies and other incentives. In addition, in 1991 the Chinese government established the annual National Energy Efficiency Promotion Week and the National Low Carbon Day[14] to boost public awareness. Public sector actors are encouraged to purchase products of higher energy efficiency aligned with revised MEPS through public procurement processes.

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[9] United for Efficiency's Model Regulation Guidelines Supporting Information. https://united4efficiency.org/wp-content/uploads/2020/05/U4E_AC_Model-Reg-Supporting-Info_20200227.pdf.

[10] Includes 2 categories of domestic refrigeration products and 9 categories of commercial refrigeration products.

[11] China National Institute of Standardization, "White Paper for Energy Efficiency Standards and Labelling Programme", 2023, p. 26 (in Chinese only),

[12] Energy Foundation "Energy Efficiency Study of China's Exported Room Air Conditioners" 2022, p. 10 (in Chinese only)

[13] It is organized by eight ministries and commissions, including the State Administration for Market Regulation, the National Development and Reform Commission, the Ministry of Science and Technology, the Ministry of Industry and Information Technology, the Ministry of Finance, the People's Bank of China, etc. The first batch of enterprise standard "forerunners" was released in 2020.

[14] Since 2013, the third day of the National Energy Conservation Awareness Week has been designated as the National Low Carbon Day.

D. Results

14. The implementation of the new MEPS has accelerated the room air-conditioning market's transition to higher-efficiency technologies and lower global-warming-potential refrigerants. The market share of Grade 1 products grew from 19 per cent to 56 per cent from 2020 to 2022.[15] Furthermore, ultra-high-efficiency room air conditioners (with efficiency higher than Grade 1 (annual performance factor (APF) of ≥6)) have become more widely available. These long-term shifts, driven by the updated MEPS, are projected to prevent at least 382 metric tonnes CO_2 emissions between 2020 and 2030, and the cumulative energy savings could amount to at least 729 TWh domestically.[16]

15. Regarding the revised MEPS for multi-connected air-conditioning units, the testing method was enhanced with a more rigorous APF. In October 2021, the implementation of these MEPS resulted in an overall energy-efficiency improvement of 40.5 per cent compared to 2008. In total, this revision is projected to yield over 278 billion kWh in energy savings by 2030.[17]

E. Lessons learned[18]

16. The following lessons can be drawn from the project:

(a) It is important to set ambitious targets for energy efficiency to set a clear direction and purpose, continuous improvement and inspire confidence among the market players, including investors. Such a policy leadership would provide a longer-term policy signal to manufacturers, enabling them to meet the efficiency targets cost effectively by providing adequate time for investment planning.

(b) Measures should target the entire cooling industry, from products and building to cold chain systems, while also covering existing stocks of products through retrofitting as well as new products.

(c) Energy efficiency and low-global-warming-potential refrigerants should be taken into consideration at the same time to achieve net climate benefits from the process.

(d) Engaging a diverse range of stakeholders, from government ministries and administrations to manufacturers, consumers, industry associations, and small- and medium-sized enterprises in the supply chain organizations, is of paramount importance.

[15] CLASP, "China's MEPS Lead to Major AC Market Transformation", June 2023, p. 3.

[16] Ibid., p. 22.

[17] Sustainable Energy for all, "Chilling Prospects 2022: China's progress towards sustainable cooling", 22 June 2022.

[18] "China's National Green and Efficient Cooling Action Plan", presentation delivered by China National Institute of Standardization, 13 December 2022.

2. Transcritical CO_2 refrigeration systems for supermarkets in Chile

A. Context and challenge

18. Until 2014, Chile had no experience with CO_2-based technology within the refrigeration and air-conditioning sector, which had already been used in approximately 3,000 stores worldwide. The supermarket sector in Chile, dominated by four major chains covering 90 per cent of the sector, had relied heavily on HCFC and HFC refrigerants.

B. Action

19. Launched in 2014, the demonstration project "Strengthening technical capacity for the adoption of supercritical CO_2 refrigeration system as alternatives to HFCs in the supermarket sector in Chile" aimed to introduce this technology to the local commercial refrigeration sector. It sought to mitigate initial costs and develop technical capacity for installation and maintenance.

20. The NOU, which falls under the Ministry of Environment, implemented the project together with supermarket companies, the Chilean Association of Supermarkets, the Chilean Chamber of Refrigeration, Air Conditioning and Refrigeration system designers.

21. The demonstration project's major focus was on addressing the lack of local knowledge and expertise for adopting and managing such technologies. To bridge this gap, international experts from Canada and the United Kingdom were invited to share their expertise on the use of CO_2 systems in supermarkets. A study tour to Italy for engineers, trainers, and experts, along with participation in international HVRAC exhibitions, facilitated exchange of knowledge. To provide proper technical guidance, two full-time international supervisors, experienced in transcritical CO_2 systems, supported the auditing, installing, programming and commissioning process.

22. Training courses were organized for technical personnel of supermarkets and for local experts. To develop servicing and installation skills, 2,000 hours of training was delivered with more than 10,000 hours of on-site installation. The project implementing agencies facilitated meetings between providers and supermarkets, to ensure the access to and availability of equipment in Chile. This refrigeration technology was piloted in a Jumbo Supermarket in the city of Valdivia.

23. The project was funded by the Multilateral Fund (MLF) ($460,000) as part of the HCFC Phase-out Management Plan (HPMP) Phase I and by the Climate and Clean Air Coalition (CCAC) ($482,790). The cost of the first installation of the technology in one supermarket in 2017 was $260,000. These resources also went to hiring international experts and organizing training and workshops to raise awareness and build solid capacity for safe adoption of this technology.

Supporting policy framework

24. In 2021, Chile published its National Law on Energy Efficiency, setting the need for MEPS, labels and energy efficiency measurements across the refrigeration and air-conditioning sector. By the end of 2023, the Ministry of Energy is set to release MEPS for refrigerated display counters to further support the deployment of CO_2 technology in commercial refrigeration. The Ministry will also circulate guidelines on the best practices for the operation, design and maintenance of commercial refrigeration and air-conditioning equipment for cold rooms, in line with the United for Efficiency (U4E) initiative guidelines. Workshops for stakeholder engagement, and pilot projects with selected companies, to test identified best practices will be organized.

25. The initiative was later complemented by a project to develop MEPS for cold chambers and refrigerated display counters. This project, started in 2021 for a duration of 45 months, was implemented by the National Ozone Unit (NOU) and the United Nations Industrial Development Organization (UNIDO) as an implementing agency and co-financed by the Lawrence Berkeley National Laboratory ($100,000) and the Kigali Cooling Efficiency Programme ($446,000), with in-kind contribution from the Government of $536,400.

C. Outcomes

26. The NOU published a study in 2018 comparing the energy efficiency between supermarkets using CO_2 and HFCs which concluded that that the CO_2 transcritical system with adiabatic cooling was 44 per cent more efficient than the HFC system. This has prompted major supermarket chains to consider such systems as their first replacement alternative in new stores and for retrofits.

27. The number of installed transcritical CO_2 refrigeration systems increased to 30 in 2023, used by more than 20 supermarkets, as well as 5 food processing factories. Five additional projects are ongoing. Chilean experts also offer training in other countries, and two training centres on CO_2 refrigeration are under development in the country.

28. The project helped to reduce the cost of the CO_2 refrigerants and its systems installation in Chile, and to increase the maintenance capacity and the competitiveness of such systems:

(a) In 2023, CO_2 -based equipment is 5 to 10 per cent more expensive than HCFC and HFC equipment, whereas in 2017 CO_2 -based equipment was 20 to 30 per cent more expensive.

(b) In 2023, CO_2 refrigerant is 20 to 40 per cent less expensive than HCFC-22 and R-404A, whereas in 2017 CO_2 refrigerant was 30 to 50 per cent more expensive.

A. Lessons learned

29. The following lessons can be drawn from the project:

(a) It was crucial to build the initial absorptive capacity through demonstration projects, training and stakeholder discussion/coordination for the technology transfer in the country.

(b) The introduction of such technology needs to demonstrate clear economic benefits for the companies, which can adopt them without the need for subsidies.

(c) Mandatory MEPS, by setting performance benchmarks, have helped to drive the market towards more energy efficient technology.

(d) Involving the head of companies was challenging but their buy-in was important to drive the change.

(e) The NOU played a key role in ensuring close collaboration and coordination between the Ministry of Energy and the relevant stakeholders, and maintaining the linkages between HPMP, the Kigali Implementation Plan (KIP) and energy efficiency activities.

3. ASEAN Cool Initiative for MEPS harmonization

D. Context

30. The Association of Southeast Asian Nations (ASEAN) comprises Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

31. The demand for space cooling in the ASEAN region has increased dramatically since 1990, and this demand is projected to continue growing owing to rising incomes and temperatures in this region which is dominated by a tropical climate. Today, space cooling accounts for approximately 10 per cent of total energy demand, while only 15 per cent of homes in Southeast Asia have air-conditioning. Cooling during peak demand can account for 50 per cent of power usage.

E. Challenges

32. Most ASEAN member States have put in place MEP for room air conditioners. There is, however, a great variation of reported efficiency values of refrigeration and air-conditioning equipment, and they remain largely below the standards that China adopted in 2010[19] (see case study 1). The average efficiency of air-conditioning models purchased is low in comparison to the best-performing models available in the market.

33. ASEAN member States depend on intra-ASEAN trade and imports from China of air conditioners. This inconsistency in MEPS in different ASEAN member States hinders the potential for economies of scale, future competitiveness of local manufacturing, environmental benefits, and consumer savings that could result from regional alignment of MEPS and labelling.

F. Proposed action

34. The long-term goal of the ASEAN MEPS project[20] is to progressively increase the level of MEPS and to accelerate the deployment of higher efficiency air conditioners in ASEAN countries by removing non-tariff barriers to trade. It is envisaged that MEPS will be aligned with the Model Regulation Guidelines for Energy-efficient and Climate-friendly Air Conditioners[21] developed by the U4E partnership, which conform with levels set by countries such as China and draft regional levels in Southern Africa (see case study 4).

35. The ASEAN region has already agreed to a Regional Policy Roadmap for Energy-efficient Air Conditioners[22] to go for MEPS ISO CSPF of 3.7, which is similar to the MEPS levels in India and Rwanda by 2023 that are 20 per cent more stringent than previous regional levels and for a more stringent MEPS ISO CSPF of 6.09 by 2025 (which is aligned to the MEPS level suggested in the U4E Model Regulations and used in countries like China). In March 2023, Singapore[23] was the first country to announce they would directly implement MEPS levels aligned with the 2025 regional MEPS levels.

G. Implementation

36. The project includes the following activities:

(a) Undertaking data collection on products in the market and a technical analysis for respective ASEAN Government on updating regulations;[24]

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[19] Recommendations for Updating the ASEAN Regional Policy Roadmap on Energy-Efficient Air Conditioners, 2021, available at https://united4efficiency.org/wp-content/uploads/2022/07/Policy-Recommendations-to-Update-the-Regional-Policy-Roadmap-for-AC.pdf.

[20] The project is led by UNEP U4E in collaboration with ASEAN Centre for Energy (ACE) and Lawrence Berkeley National Laboratory and International Institution for Energy Conservation.

[21] https://united4efficiency.org/resources/model-regulation-guidelines/.

[22] The ASEAN-SHINE programme of 2012, funded through the European Union Switch-Asia Programme, delivered a regional policy roadmap, offering guidance to member States on the adoption of MEPS. https://united4efficiency.org/resources/recommendations-for-updating-the-asean-regional-policy-roadmap-on-energy-efficient-air-conditioners/.

[23] https://united4efficiency.org/progress-in-asean-region-on-enhancing-energy-efficiency-requirements-of-home-appliances/.

[24] https://united4efficiency.org/wp-content/uploads/2022/07/Policy-Recommendations-to-Update-the-Regional-Policy-Roadmap-for-AC.pdf.

(b) Developing stringent regulations, including MEPS and refrigerant requirements on room air conditioners which will create a mandatory floor for the products entering the market;

(c) Updating the regional policy roadmap to cover all air conditioners with cooling capacities up to 4.5kW;

(d) Updating the regional analysis which will be used for an awareness-raising campaign among policymakers on the benefits of the updating MEPS;

(e) Supporting ASEAN governments on stakeholder engagement and consultations;

(f) Conducting an analysis to demonstrate the positive impact of the proposed MEPS, low-global-warming potential refrigerants, and labels;

(g) Awareness-raising among local small and medium-sized enterprises, manufacturers, assemblers and suppliers as well as technological assistance in capacity-building measures to ensure their products are up to ASEAN standards.

37. The initiative contributes to the ASEAN Plan of Action for Energy Cooperation 2016–2025, which aims to enhance energy connectivity and market integration to ensure energy security, accessibility, affordability, and sustainability for all ASEAN member States.

H. Expected outcome

38. The aim is that Governments implement the ASEAN Regional Policy Roadmap by directly moving to the 2025 regional MEPS ISO CSPF of 6.09, identical to the current MEPS in China (see case study 1). The project estimates the potential energy savings from such regional harmonization by 2040 “to be equivalent to that produced by 65 large power stations (500MW)”.

39. This proposed timeline should give sufficient time for ASEAN member States to benefit from the economies of scale of energy-efficient air conditioners in China. The economic impact on consumers and manufacturers, however, would vary between countries and requires careful timing for adoption and implementation by each country of the region.

I. Lessons learned

40. The following lessons can be drawn from the project:

(a) Understanding the socioeconomic and geographical contexts of the target countries including factors such as level of economic integration, policy integration and trade flows, energy consumption patterns, access to energy resources, and the status of infrastructure.

(b) Encouraging the active involvement of all stakeholders, including government bodies, industry, consumers, and non-profit organizations to build a strong consensus among these parties to drive the necessary regulatory and policy changes.

(c) Establishing a robust and enforceable regulatory framework, including setting MEPS at both regional and national levels, providing incentives for compliance, and enforcing penalties for non-compliance and a range of supporting policies to support demand and uptake.

(d) Awareness-raising, capacity-building and training for industry professionals on energy-efficient design and technologies, educating policymakers about the benefits of energy efficiency, and raising public awareness about the benefits of energy-efficient appliances.

4. Regional EAC-SADC project on energy-efficient cooling appliances

A. Context

41. The East African Centre of Excellence for Renewable Energy and Energy Efficiency (EACREEE) and the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE) are implementing the Energy-Efficient Cooling Appliance Project in the East African Community (EAC)[25] and the Southern African Development Community (SADC)[26] regions. The project involves 21 countries of the EAC and SADC region. Technical support is provided by the UNEP U4E initiative.

42. Rising urbanization and climate change are driving up the demand for room air conditioners and domestic refrigerators in these regions. It is expected that by 2040, the electricity demand for both products will increase by more than 2.5 times if energy efficiency policies are not implemented.[27]

43. The regional market assessment conducted as part of the project found that, out of all EAC and SADC member states, only seven countries[28] have set MEPS for either room air conditioners or refrigerators, of which mandatory MEPS were introduced in 4 countries and voluntary MEPS in three countries with different levels of implementation. Rwanda introduced MEPS and labels for room air conditioners and refrigerating appliances, also indicating global-warming-potential limits for refrigerants based on U4E Model Regulation Guidelines.[29] Some of the MEPS for refrigeration appliances of other countries are aligned with the European Union regulations and classifications, which apply the energy efficiency index. Mandatory MEPS and labelling regulations for refrigerators exist also in Kenya, Mauritius, and South Africa. In addition, energy labels from different origins and languages, such as the European Union, India, the United Arab Emirates and China, have been used in countries of both regions.

B. Challenges

44. Energy-efficient products are generally expensive, and only a few countries in the region have financial incentives to support the deployment of energy-efficient cooling equipment. The use of inefficient second-hand appliances is prevalent in both subregions because they are affordable. Existing policies restricting the importation of used cooling appliances are not fully implemented or enforced. The subregions import cooling equipment that have s variety energy labels from the different countries of origin, which are not directly comparable to each other and may confuse consumers.

45. Most countries in these subregions have energy policies but do not adequately address matters of energy efficiency. There is a lack of coordination or harmonization of market monitoring systems for product certification and registration. Infrastructure for testing or verifying energy efficiency performance, such as test laboratories, is limited.

C. Action

46. The regional EAC–SADC energy-efficient cooling appliance project aims to develop a policy framework for harmonized MEPS and labelling for household refrigeration appliances and room air conditioners, and their domestication in all member States of both regions. The regulations set requirements for energy efficiency and for global-warming-potential of refrigerants (global-warming-potential of 20 for residential refrigerators, 150 for self-contained and portable air conditioners and 750 for ductless air conditioners).

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[25] EAC member States: Burundi, Democratic Republic of the Congo, Kenya, Rwanda, South Sudan, Uganda, United Republic of Tanzania.

[26] SADC member States: Angola, Botswana, Comoros, Democratic Republic of the Congo, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, United Republic of Tanzania, Zambia, Zimbabwe.

[27] United for Efficiency initiative, “Overview of the Market on Refrigerating Appliances and Room Air Conditioners in East and Southern Africa”, 2021.

[28] Democratic Republic of the Congo, Kenya, Mauritius, Rwanda, Seychelles, South Africa, Uganda.

[29] Adopted ISO 16358 of Cooling Seasonal Performance Factor (CSPF) 3.80 for cooling capacity below 4.5kW for air conditioners, refrigerant and foam blowing agent used in refrigerators to have global warming potential of 20.

47. In 2020, a market assessment was conducted to understand the status of cooling appliances in the two subregions. Technical notes were then developed to provide policy recommendations based on the outcome of this assessment. Regional technical committees were established in 2021 to guide the development of the MEPS and labelling. To ensure close collaboration among the partners, a dedicated staff from UNEP-U4E at SACREEE coordinated the overall project. The MEPS for refrigerators have been aligned with those planned for implementation by South Africa as many appliances sold in the region originate from that country and thus are also being tested there. In addition, some manufacturing companies in Zimbabwe and Eswatini have their own testing laboratories for refrigerators. Air conditioners are not manufactured in SADC and thus are mostly tested in the countries of origin of this equipment.

48. The activities of this project were coordinated with another ongoing project on Energy-Efficient Lighting and Appliances, implemented in East and Southern Africa by UNIDO, and resulted in harmonized MEPS for lighting products in both regions, which were finalized in 2021.

D. Outcome

49. In August 2023, the majority of the SADC member States voted in favour of the adoption of regional MEPS, awaiting the approval by the SADC Cooperation in Standardization (SADCSTAN) executive committee as of September 2023. Owing to a shortage of financing, the regional harmonization in the EAC region has not yet been finalized.

50. The overall project budget up to now is estimated to be approximately $400,000 (inclusive of staff, regional and international experts). The project is funded by the Global Environment Facility (GEF), the Clean Cooling Collaborative (formerly K-CEP) and the Department for Environment, Food and Rural Affairs (DEFRA) of the United Kingdom of Great Britain and Northern Ireland with in-kind time and human resources contribution from national stakeholders.

51. It is estimated that, if policies are implemented, the adoption of energy-efficient and climate-friendly refrigeration and air-conditioning products in both regions can save almost 10 TWh of electricity by 2040, equivalent to four coal power plants of 500 MW, reduce CO_2 emissions of almost 8 million tonnes and save $1.2 billion through reduced electricity bills.

E. Lessons learned

52. The following lessons can be drawn from the project:

(a) Developing regional MEPS and labels is a lengthy and bureaucratic process, requiring fostering agreement among a wide range of numerous stakeholders. The results are worth it, however, as MEPS and labels have multiple benefits, including avoiding dumping of low-energy-efficient appliances on a wide scale. The same level of MEPS and labels can drive economies and markets towards the adoption of products that comply with a common set of regulations.

(b) It is vital to address both the energy efficiency of refrigeration and air-conditioning appliances and promote refrigerant transition, especially in developing markets where air conditioners and refrigerators with high global-warming-potential and ozone-depleting potential are prevalent. Therefore, the maximum global-warming-potential and ozone-depleting potential limits should be included in MEPS for cooling products.

5. MEPS for commercial refrigerating appliances in Brazil

A. Context

53. Brazil, with its growing population, anticipates a nearly 30 per cent increase in energy consumption by 2030. One of the energy consuming sectors is commercial refrigeration including supermarkets. As of 2023, 95 per cent of commercial refrigeration equipment is manufactured locally according to the National Energy Conservation Programme (PROCEL) estimation. The main customers for commercial refrigerators are supermarkets, bars, restaurants and hotels. It is estimated that refrigeration systems account for more than 65 per cent of the energy consumed at an average supermarket in Brazil. Despite the heavy usage, there has been no standardized method for measuring and comparing energy consumption across these systems. While Brazil has voluntary energy efficiency labelling, mandatory MEPS only exist for domestic air conditioners and household fridges and freezers but not for commercial refrigeration.

B. Action

54. UNEP U4E initiative supported the implementation of a National Framework for Leapfrogging to Energy-Efficient and Climate Friendly Commercial Refrigerating Appliances in Brazil, that lasted from July 2021 to June 2023, with the aim of laying a foundation for the adoption and implementation of MEPS for commercial refrigeration. Through its Integrated Policy Approach,[30] focusing on the need for and a set of policy options and support tools, U4E has created Model Regulation Guidelines for Energy-Efficient and Climate-Friendly Commercial Refrigeration Equipment[31] that serves as a template for developing a regulatory and legislative framework for enhancing energy efficiency in this sector through the design and implementation of MEPS and labelling. It also specifies the refrigerant's global-warming-potential value. The project received funding from the Green Climate Fund of $599,704. It is estimated that the adoption of MEPS could reduce the energy consumption in this sector by over 15 per cent within 10 years of its implementation.

55. In June 2023, the Ministry of Mines and Energy and U4E held the last meeting of the project to discuss the way forward. The next steps are to discuss the proposals within the Policy Working Group, so as to frame a solid legal framework for MEPS and energy efficiency labels. The National Institute of Metrology, Standardization and Industrial Quality (INMETRO) will initiate the regulatory process defining the MEPS, and other efficiency initiatives such as the endorsement label of PROCEL and the requirements for sustainable public procurement.

C. Outcomes

56. The Ministry of Mines and Energy coordinated the project implementation in collaboration with 19 institutions, including commercial refrigerator manufacturers, laboratories, certification organizations and industry associations that came together under a policy working group. Key outcomes of their collaboration include:

(a) National market assessment for commercial refrigerators published;

(b) Analysis of international best practices regarding MEPS and labels for regulation of commercial refrigeration;

(c) Recommendations for metrics, test standards, MEPS levels and labels for commercial refrigerator developed and posted in April 2023 to be considered in the future regulation;

(d) Recommendations for conformity assessment and market surveillance based on country practices in monitoring, verification and enforcement of energy efficiency and relevant international experience;

(e) Guidelines on sustainable public procurement of refrigerators, to include MEPS for commercial refrigeration as the criteria for bulk procurement by the public sector were developed. It identified the main opportunities for the introduction of sustainability criteria in the public

[30] https://united4efficiency.org/our-approach/

[31] U4E, "Supporting developing and emerging economies to accelerate the transition to energy-efficient and climate-friendly equipment: model regulation guidelines", November 2021, revised July 2023.

procurement process and provides recommendations on refrigeration equipment in official procurement catalogues.

57. The project also helped to build the initial capacity of stakeholders, including national laboratories, on monitoring, verification and enforcement of MEPS, in particular testing standards and product database led by t INMETRO, which is in charge of the national labelling programme as well as market surveillance. A regional workshop was also convened to present the project results to other interested countries in the regional common market, MERCOSUR, on MEPS and labels for commercial refrigerators. Such information sharing may contribute to the harmonization of requirements in the region.

D. Lessons learned

58. The project's success largely stems from consistent stakeholder engagement. Policy Working Group with representatives of all countries, established from the beginning, was key to gain their buy-in to the process and achieving the goals of the project. Tapping into all key national stakeholders ensures the lasting impact of the initiative even without continued international development support. Teaming up with the Collaborative Labelling and Appliance Standards Programme (CLASP), which has important expertise in energy efficiency in the region, also played a pivotal role in pinpointing national priorities.

6. Refrigerant Driving License

A. Context

59. The phasing down of hydrofluorocarbons (HFCs) necessitates transition to low global warming alternatives. While most of these refrigerant alternatives are more environmentally friendly because they do not deplete the ozone layer and have reduced global-warming-potential, some are either flammable, toxic or operate under high pressure. This makes their adoption challenging, especially in the context of parties operating under paragraph 1 of Article 5 where the servicing sector is not always sufficiently prepared to safely handle those alternative refrigerants. In many countries, small businesses, often operating informally, dominate the servicing sector. There also is a risk of increased direct emissions from refrigerants and indirect emissions from additional energy consumption if refrigeration, air-conditioning, and heat-pump equipment is not installed, operated, and serviced properly.

60. While a refrigerant contained within a sealed system is not intended to be emitted to the atmosphere under normal operation and with proper end-of-life disposal, in actual practice systems are subject to leakage. Leaks result in both refrigerant loss (with cost and environmental impact) and increased energy demand (leaky systems operate inefficiently). Refrigeration, air-conditioning, and heat-pump equipment requires proper maintenance to minimize losses. Operation of a system with a lower-than-the-design refrigerant charge results in increased – and wasteful – energy use.

61. To deal with these issues and improve energy efficiency, there is a need for structural change in national competency and skills development frameworks in the servicing industry. This requires providing additional training and relevant education to ensure safe handling of alternative refrigerants and equipment while avoiding leakage and maintaining the energy efficiency of the equipment. It also requires a framework that ascertains whether technicians are adequately prepared with the necessary knowledge and skills so that the public benefits from use of new generation refrigerants.

B. Action — setting minimum qualification requirements globally

62. The Refrigerant Driving Licence (RDL)[32] aims to promote a set of minimum and globally recognized best practices to identify, handle, charge, recover and recycle current and future refrigerants. It responds to the challenges associated with the safe transitioning to low and zero global-warming-potential refrigerants and enhanced energy efficiency of equipment containing them through:

(a) Global recognition by promoting globally recognized and accepted minimum competencies and skills for technicians to safely handle and manage refrigerants. It ensures that technicians possess the knowledge and expertise required to work with alternative refrigerants, making it a crucial qualification in the transition to environmentally friendly refrigerants. The programme serves as the basis for mainstreaming the course material and competency standards into the national systems of technical and vocational education and training (TVET), thus ensuring its institutionalization and long-term sustainability.

(b) Industry and professional support as the RDL programme is endorsed and supported by eleven key industry and professional associations from around the world. This widespread support enhances its credibility and encourages technicians to participate, as they see it as an opportunity to have their competencies internationally recognized.

(c) Standardized assessment of qualifications as the programme offers a comprehensive process that includes both online theoretical examinations and hands-on practical skills assessments. It tests technicians' competencies on the installation, operation, leakage checking, maintenance and removal of the refrigerant. Other topics include fabricating copper tubing, evacuation, and charging, as well as recovery and recycling equipment and refrigerant.

(d) Accessibility by making the examinations and resource materials available in English, French and Spanish. By integrating it into the ongoing HPMP and upcoming KIP the initial launch of the programme can be financially supported through the Multilateral Fund to create a basis through a pool of initial competence for further domestication and take-up of the training and certification.

[32] Introduced by the UNEP OzonAction Compliance Assistance Programme in collaboration with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) and the European Association of Refrigeration, Air Conditioning and Heat Pump Contractors (AREA).

(e) Alignment with international standards contributes to the professionalization of the refrigeration and air-conditioning servicing sector workforce, ensuring that technicians are qualified in the best and safest practices, thus minimizing risks to the public and maintaining intended energy efficiency of equipment.

63. The RDL is a turnkey programme that includes an online examination of 100 multiple choice questions and an in-person practical examination administered by a local assessor and remotely monitored. For the practical examination, candidates rotate among the available testing stations so that simultaneous testing can take place. Technicians who pass both examinations receive an RDL Certificate and an RDL Wallet Card which can be presented to employers and clients.

C. Outcome

64. The Multilateral Fund has supported the training of 262,000 refrigeration and air-conditioning technicians to date. The RDL will be an important tool for countries to ensure that their technicians have the minimal competencies and skills required for the proper and safe handling of refrigerants. It is designed to support the completion of the HCFC phase-out and starting a smooth and safe HFC phase down in Article 5 countries, in line with the Kigali Amendment. Trials of the RDL programme have been conducted in Grenada, the Maldives, Rwanda, Sri Lanka, Suriname, and Trinidad and Tobago, where 123 candidates took the examinations with 44 earning passing scores.

D. Lessons learned

65. The following lessons can be drawn from the project:

(a) Technicians should be adequately trained or have experience in the safe and sound handling of refrigerants before enrolling in the RDL.

(b) Technicians considered passing the RDL as a validation of their knowledge and hard work. They viewed the RDL as an opportunity to showcase their competencies and have them internationally recognized. The fact that a global array of associations support and are associated with the programme made the technicians eager to participate. Technicians saw the RDL as affirming the essential contributions they make to safeguard the environment and ensure public safety.

(c) In a world of flammable refrigerants, ideally every technician should be trained on best and safe practices, and each one of those who have been trained should be confirmed to have acquired the knowledge through a credentialing process. The RDL provides this last, crucial step in achieving a competent workforce.

7. Supporting adoption of sustainable heating and cooling equipment in low-income and disadvantaged communities

A. Context

66. Over 40 per cent of households in the state of California in the United States of America cannot afford to install electrical appliances in their homes because of the required upfront capital investment. Replacing a gas water heater with heat pump equipment has an installation cost of more than $1,000 above the cost of another gas-powered heater. There is also a lack of knowledge among consumers and contractors about the advantages of energy-efficient technologies.

B. Action

67. In 2018, the California Public Utilities Commission (CPUC), in partnership with utility, investment and other organizations[33] started the statewide TECH Clean California initiative,[34] focusing on heating, ventilation, and air-conditioning and also heat-pump water heater retrofits in buildings. The initiative aims to incentivize the residential sector to switch to more energy-efficient technologies. It also includes outreach activities for consumers and contractors, and offers training to installation technicians. Part of the initiative focuses on enhancing access for low-income and disadvantage communities.

68. The funding for the initiative was authorized by a Senate Bill with a total cost, including co-funding, of $116 million, to be implemented over 4 years, including $72 million for the incentive scheme only. The State of California 2022/2023 fiscal year budget allocated an additional $50 million, of which 40 per cent goes towards specifically addressing the needs of low-income communities as well as supporting installation and servicing contractors, who are often single entrepreneurs or small enterprises, to obtain licences and expand their workforce.

69. Leveraging an existing campaign, “The Switch is On”,[35] the initiative focuses largely on informing consumers about the benefits of sustainable appliances in homes and providing necessary support to contractors, who are the key intermediaries in the interaction of the supply chain with final customers. Training is provided to contractors so that they can recommend and install sustainable heat-pump technologies at clients’ homes, develop their business and provide sustainable and affordable products. The initiative has developed six specific solutions to overcome the adoption barriers and specifically targets low-income households and multifamily housing:

(a) The Inclusive Utility Investment financial incentives model, which is different from on-bill loans or repayment, ties the cost recovery to energy savings (linked to a utility “meter” in the home), thereby promoting the most energy-efficient equipment. The Silicon Valley Clean Energy, a public agency, provides technical and financial assistance of a total $3 million for risk management, design and launch.

(b) Identification of the right customers that would benefit the most from the replacement of an inefficient electric air-conditioning system with a heat pump helps to design a proper outreach and incentive strategy. Through monitoring the meter data, those who already use smart meter-based services and display a disproportionately high cooling load are targeted.

(c) Retrofitting low-income households with low adoption rates with more energy-efficient technologies is a priority, including through providing training to contractors for a proper conversion process.

(d) Special incentives for multifamily homeowners to transition to electricity-powered appliances, providing technical assistance to design and install such systems as well as to monitor the operation of the systems once they have been installed.

(e) Streamlining and simplifying the granting of permits for heat-pump water heaters is a pilot project to have permit approvals for contractors and homeowners to install heat-pump water heaters within a day, based on the building code and electrical code requirements, including the energy load. The project also trains the buildings sector for the switch and use of the new technology.

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[33] Including with Energy Solutions, the Association for Energy Affordability, Building Decarbonization Coalition and Vermont Energy Investment Corporation.

[34] https://techcleanca.com/

[35] https://switchison.org/

(f) Empowering and training contractors to manage the electrical load once the equipment has been installed and providing incentives such as giving contractors $50 for each customer enrolling in a load shifting programme.

C. Outcome

70. As of 2023, the initiative had conducted outreach activities to around 1,000 contractors, hosted events with heating, ventilation, and air-conditioning and heat-pump water heater distributors, engaged with manufacturers, distributors, utilities, contractor trainers and the building industry to expand the equipment and the training programmes.

71. More than 14,000 units have been installed, with $38 million incentives paid, resulting in an estimated 14,500 tonnes of avoided CO_2 equivalent of greenhouse gas emissions per year.

8. Product registration systems

A. Context

72. A product registration system is an important policy instrument for sustainable product management that can help with promoting, monitoring and enforcing energy efficiency during the phase-down of HFCs. Originally developed by the private sector to track sales of individual product lines, product registration systems have evolved into comprehensive data repositories, providing valuable insights to different stakeholders. Governments can monitor goods entering the market and ensure their compliance with respective regulations.

B. Challenges

73. Regulatory bodies may struggle to verify products entering the market, especially imported ones, for their conformity with MEPS, In the context of the refrigeration and air-conditioning sector, this can be related to the complexity of the market and the number and variety of cooling products available, or a lack of adequate testing facilities. Many national licensing systems for the export and import of substances controlled under the Montreal Protocol do not monitor products that contain such substances, which otherwise would have been useful for keeping track of how and where the substances are used, and in developing targeted strategies. Moreover, there is a barrier associated with the availability of relevant alternative technologies and their adoption.

C. Proposed action

74. A product registration system can be a key resource for those undertaking monitoring, verification and enforcement activities related to MEPS and labelling programmes. Product information systems can provide valuable data about sectors, users, and types of products entering the market to help to develop effective strategies under KIPs and estimate stocks and banks of such equipment and refrigerants. This information can be used to assess the effectiveness of current policies and inform future policy development. It helps to manage incentive schemes, tax credits and rebates to encourage the demand side. Requiring manufacturers to provide detailed information about product energy efficiency in a centralized, government-managed and reliable database can help to increase consumer understanding and confidence, thereby driving market demand for more efficient products. It can help institutions involved in bulk procurement to identify verified products that meet green or sustainable public procurement specifications.

75. Managing one centralized database accessible to market players, where information is verified by a government body, can reduce the need for an additional system to track equipment thereby reducing costs and workloads for applicants and regulators. In the case of regional systems among trading partners, such as ASEAN, they can help to reduce barriers to trade in energy-efficient products by simplifying compliance for importers and manufacturers.

D. Implementation

76. The management of product registration systems is typically the responsibility of a national energy department, an environmental agency, a consumer protection body, or a similar organization. The implementation of product registration systems involves product testing by a laboratory or conformity assessment body, application submission by the applicant (manufacturer, importer, or distributor), compliance review by the programme manager or regulatory authority, and publication of approved product details on the public portal of the product registration system website. UNEP developed guidance documents[36] under the U4E partnership, for the development and implementation of product registration systems in support of MEPS and labelling. A prototype product registration system[37] is available for countries interested to implement it. The system is based on global best practices and contains the essential elements of a registration system, including user input forms, data tables and output reports.

[36] Product Registration Systems - United for Efficiency (united4efficiency.org).

[37] https://united4efficiency.org/resources/prototype-product-registration-system/

E. Examples of implementation

77. Several countries and regions have product registration systems in place for refrigeration and air-conditioning products. This trend is increasing globally, with more countries recognizing the importance of such systems for monitoring energy efficiency and compliance with environmental regulations, including those related to the phase-down of HFCs under the Montreal Protocol.

78. The joint initiative of the Australian and New Zealand Governments for the Equipment Energy Efficiency Programme based on the Energy Rating Label, which also covers air conditioners, refrigerators and freezers, makes the product registry database publicly accessible, thus allowing consumers to choose the most energy-efficient products. The Zoned Energy Rating Label[38] divides products by a seasonal efficiency rating depending on three distinct climates prevalent across the two countries (hot, average and cold). Importers, manufacturers or suppliers of products that are regulated for energy efficiency in Australia and New Zealand have legal obligations to ensure that these products are registered,[39] and if required by the legislation, that Energy Rating Labels are displayed at the point of sale.

79. In conjunction with the ASEAN Centre for Energy, U4E is supporting the ten ASEAN countries to harmonize product registration activities in the region with financial support from the Clean Cooling Collaborative. The ASEAN regional database[40] (currently covering air conditioners, refrigerators and lighting) is designed to serve as a centralized repository of information about products registered in the ASEAN countries. It can be accessed only by the designated authority of a member State. It builds on the national registration systems of 6 ASEAN members States with the aim of adopting a regionally coordinated approach, which would facilitate reduced costs and enhanced enforcement of energy efficiency regulations. The existing national Product Registration Systems of the various countries continue to operate for the time being.[41]

80. The European Product Registry for Energy Labelling (EPREL)[42] helps to ensure compliance with European Union energy labelling regulations and with market surveillance. As of 1 January 2019, authorized suppliers must register their products (including air conditioners, and a variety of refrigeration appliances for domestic and professional use) in EPREL. The database displays the product energy label and provides additional information in a product's information sheet in all official languages of the European Union. EPREL is open for public access thus allowing consumers to consult the information and compare products. EPREL contributes to reducing energy use by guiding its users towards the most energy-efficient products while encouraging manufacturers to develop new, more efficient models to appear in the highest and more rewarding ranks.

81. In the Philippines, high energy-consuming products like domestic refrigerators and room air conditioners are mandated to be registered in the product registry.[43] They must adhere to the established MEPS regulated by the Philippine Energy Labelling Programme (PELP). Domestic manufacturers and importers need to also include the refrigerant type, its charge size, and its global-warming-potential for the registration. The global-warming-potential value serves as the foundation for calculating the direct emissions from these subsectors and planning activities for the implementation of the Kigali Amendment. Cooling equipment emissions are accounted for in the higher tier greenhouse gas inventory for the establishment and improvement of the Nationally Determined Contribution (NDC) under the Paris Agreement on Climate Change. The data provided in the registry has become the basis for calculating both direct and indirect emissions. The overarching policy that provides the mandate for such measures has been the Philippine Energy Efficiency and Conservation Act, introduced in 2019. This Act enforces the MEPS and mandates energy labels on cooling appliances for all manufacturers and importers. The energy labels include the global-warming-potential of refrigerants, which constitutes an important step towards integrating energy and refrigerant policy measures to maximize climate benefits. The Philippines has also developed the National Cooling Action Plan which will now be updated to include PELP as an important measure supporting implementation of policies related to the Montreal Protocol and Paris Agreement.

[38] Understand the Zoned Energy Rating Label | Energy Rating.
[39] Energy Rating - Search the Registration Database.
[40] ASEAN Centre for Energy - Regional Product Database.
[41] Product-Registration-System-Roadmap_ASEAN_Final_200622.pdf (united4efficiency.org).
[42] Refrigerators with a direct sales function (europa.eu).
[43] Supported by the Cool Contributions fighting Climate Change (C4) II project by GIZ Proklima.

9. Ecofridges initiative: Green on-wage financing in Ghana

A. Context

82. Consumers in developing nations like Ghana prioritize cost when buying refrigeration, air-conditioning and heat-pump appliances, often not being aware of the potential long-term savings when using more energy-efficient technologies. The Ghanaian market, consequently, has large quantities of less efficient, often second-hand, refrigeration and air-conditioning equipment, relying on controlled substances imported from abroad. On average, the energy efficiency of purchased cooling systems is just one-third of the highest efficiency commercially available.[44]

B. Challenges

83. Local financial institutions lack the knowledge necessary to adjust their traditional consumer-orientated loans to account for the environmental performance of products. Informing and engaging the financial sector to facilitate the provision of financial instruments that help consumers favour energy-efficient appliances would be very beneficial, given their potential for environmental and economic benefits (see case study 7).

C. Action

84. EcoFridges introduced the Green On-wage financing (GO) scheme, offering loans to both public and private sector workers, allowing them to upgrade their old refrigeration and air-conditioning appliances to more energy-efficient ones without high upfront expenses or collateral requirements. Employers act as loan guarantors of the salaried customers' loans, thus eliminating the need for rigorous credit assessment and collateral. The project builds upon the success of the 2012–2016 Refrigerator Energy Efficiency Project, which focused on improving energy efficiency of refrigerators manufactured and imported into Ghana.[45]

D. Implementation

85. Only products meeting the energy efficiency standards and labelling regulations updated in 2022 were used in the scheme. According to MEPS technical specifications of eligible refrigerators were set at 5-star for energy efficiency and global-warming-potential of not greater than 20 for refrigerants, while for room air conditioners these were at 3-star with global-warming-potential of not greater than 750.

86. Local partner banks provided loans to customers looking to buy these appliances, offering favourable terms at 0 per cent interest for over a year or at a reduced special interest rate over 18–36 months.

87. Local vendors of refrigeration and air-conditioning equipment were also involved to provide training to servicing technicians for proper installation and maintenance and conduct customer awareness campaigns on the benefits of the products.

88. The project included:

(a) Product testing by a third-party accredited laboratory, which provided product reports, while the Ghana Standards Authority verified product compliance;

(b) Monitoring and verification to track sales of new products and returns of old ones to evaluate the project's impact;

(c) Provision of incentives for users to turn in their old equipment to certified waste collectors to ensure sound disposal of used equipment in collaboration with environmental regulators.

89. The following policies in place provided an enabling regulatory environment for the project implementation:

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[44] G. Dreyfus, N. Borgford-Parnell, J. Christensen, J., D.W, Fahey, B . Motherway, T, Peters, R, Picolotti, N. Shah, and Y. Xu, "Assessment of Climate and Development Benefits of Efficient and Climate-friendly Cooling", Institute for Governance & Sustainable Development and Centro Mario Molina.

[45] Promoting Appliance Energy Efficiency and Transformation of the Refrigerating Appliances Market in Ghana project: https://erc.undp.org/evaluation/evaluations/detail/8563?tab=recommendations and http://www.energycom.gov.gh/efficiency/the-success-story-of-the-eerp.

(a) Energy Efficiency Regulation of 2008, which bans the import and sale of used air conditioners, refrigerators, refrigerator-freezers, and freezers;

(b) Energy Efficiency Standards and Labelling regulation for refrigerators of 2009, revised in 2022;

(c) Energy Efficiency Standards and Labelling regulations for manufactured and imported air conditioners, 2022.[46] The latest MEPS have a 1–7-star rating system with the revised energy efficiency index;

(d) Management of Ozone-Depleting Substances and Products Regulations, 2005,[47] that domesticates the Montreal Protocol provisions in national legislation and sets restrictions on the use of ozone depleting substances. It is currently being amended to include the phase-down commitments for HFCs under the Kigali Amendment.

E. Outcomes

90. As of June 2023, the scheme had led to the sale of 3,304 energy-efficient appliances which corresponds to a reduction of 27,172 MWh of electricity consumption and more than 22,000 tonnes of CO_2 avoided emissions. The programme has also increased cash sales of such appliances by lowering their prices thus making more energy-efficient refrigeration and air-conditioning equipment more readily available and affordable. Total finance mobilized to support the scheme is 19.06 million in Ghanaian cedi (around $1.6 million).

F. Lessons learned

91. The following factors contributed to the impacts of the project:

(a) Stakeholder engagement from onset to foster the ownership of the process;

(b) Continuous awareness-raising among all stakeholders (such as vendors, financing institutions and the public);

(c) Flexibility in financial mechanisms that adjusts to customer feedback;

(d) Building on existing policies and regulations such as MEPS, energy labels, and others;

(e) Ongoing funding and supporting policy measures, like public procurement and tax incentives.

G. Replication

92. **Senegal: EcoFridges On-bill financing**: This initiative gives consumers the option to finance the purchase through monthly payments on their electric utility bills. A review of bill payment history, income and other basic information will be used to determine eligibility for financing. A financial tracking tool is used to follow repayment progress and programme operations to assure the viability of the mechanism over time.

93. **Rwanda: RCOOL Green-On-Wage (GO):** This initiative includes a dedicated leasing product called Coolease for energy-efficient cooling, as well as an on-bill financial mechanism (repayment of a new product assessed as part of the utility bill).

[46] Energy Efficiency Standards and Labelling Regulation 2022. Available at: http://www.energycom.gov.gh/files/Air%20Conditioners%20Regulations%202022.pdf.

[47] Management of ODS and products. Available at: regulation: https://faolex.fao.org/docs/pdf/gha93001.pdf.

10. Cooling as a Service Initiative

A. Context

94. Newer, more efficient, refrigeration and air-conditioning solutions often involve a significant initial investment in equipment, which can be prohibitive for many businesses and individuals. Without a direct incentive to prioritize energy efficiency, some cooling users may opt for cheaper but less efficient systems, leading to higher operational costs and energy wastage. New, efficient technologies bring about uncertainties in performance and cost-benefit, causing hesitation in adoption while existing models often lack real-time performance monitoring, leading to inefficiencies going unnoticed and unaddressed.

95. In addition, there might be mismatches in the demand for cooling and the capacity to supply, especially in peak periods or in areas with unstable power supplies. These challenges, taken together, underscore the need for more innovative approaches to transform the refrigeration and air-conditioning sector towards sustainability, efficiency, and broader accessibility.

B. Action

96. The servitization approach in the cooling sector enables end users to pay per unit of cooling consumed rather than invest in cooling equipment. In this model, the technology provider designs, owns, maintains, repairs, and covers all operational costs including water and electricity for the cooling systems. This incentivizes cooling providers to use the most energy-efficient equipment available in the market with the lowest total cost of ownership. By reducing operational costs throughout the contract duration, they can optimize profits while delivering value to the user. This approach also encourages manufacturers of cooling technology to design appliances for reuse, promoting and normalizing circular economy and minimizing the risk of stranded assets. Moreover, it removes system performance risks for clients by adopting efficient technologies, enabling companies to focus on their core business while supporting them to achieve their climate targets.

97. The Cooling as a Service (CaaS) initiative, led by the Basel Agency for Sustainable Energy (BASE), aims at promoting and mainstreaming this business model worldwide.[48] Unlike energy performance contracts (known as the ESCO model),[49] CaaS payments are not dependent on energy savings, but are based on actual usage. Globally, this business model has been successfully implemented in commercial air conditioning, industrial refrigeration, and cold storage for medical and agricultural supply chains in countries such as Colombia, India, Kenya, Mexico, Nigeria, Singapore, South Africa and companies in the Western Europe.

C. Examples of implementation

Singapore data centre and manufacturing facility[50]

98. The building, operated by Princeton Digital Group, houses a large data centre and high-end manufacturing facility for mobile camera lenses, that require full-time, continuous operation and backup components. Data centres are known for consuming substantial quantities of electricity to operate massive air-conditioning systems to cool the heat generated by IT equipment. In 2014, during the retrofitting, the building owner opted for the CaaS model, buying air-conditioning at a fixed rate on a pay-as-you-use basis from a local provider, Kaer Water. The building owner simply specified the required temperature while Kaer Water assumed all financial and operational responsibility for the equipment purchase, installation, and operation as well as its potential replacement.

99. Through its patented special control system, Kaer Water was able to monitor, measure and track the performance of the facility, required comfort levels, and energy efficiency. As a result, the workforce needed to operate the plant was reduced by 90 per cent. The cooling system's energy efficiency exceeded the highest local building sustainability certification benchmark by 15 per cent.

[48] Cooling as a Service Case Study: White paper. Available at: https://www.caas-initiative.org/wp-content/uploads/2020/08/200828_ColdHubs-2.pdf.
[49] Energy Performance Contracts: Available at: https://www.iea.org/reports/energy-service-companies-escos-2/esco-contracts.
[50] Singapore https://www.caas-initiative.org/wp-content/uploads/2020/12/CaseStudy_Kaer-1.pdf.

Clover South Africa – largest dairy company[51]

100. Clover Dairy company was looking to upgrade its Queensburgh factory refrigeration system and contracted Energy Partners in 2021 to install and maintain a two-stage 10 MW ammonia refrigeration system, a 7.93 million Euro cooling as a service project. The 20-year contract includes maintenance and a variable consumption charge based on cooling use. Waste heat from the refrigeration system is also used to generate hot water. A solar photovoltaic system of 1,400 kWh provides low-cost sustainable electricity, thus lowering operational costs. In addition, the suction stage provides chilled water for the factory's heating, ventilation and air-conditioning air-handling units. The new system was expected to save 30 per cent in electricity consumption compared to the calculated baseline and even exceeded this following implementation. The project saves an estimated 4,255 tonnes of CO_2 per year from using efficient refrigeration and solar photovoltaic technology, and 1,950 tonnes per year from additional heat recovery for hot water.

ColdHubs, Nigeria[52]

101. ColdHubs Ltd designs, installs, commissions, and operates 100 per cent solar-powered walk-in cold rooms using R-290 refrigerant for preservation of perishable foods and fruits.[53] It owns all the equipment with the assets, removing the barrier for small-scale operators who cannot afford the capital investment. ColdHubs operates a pay-as-you-store cooling service in which smallholder farmers, retailers, and wholesalers of horticultural produce rent storage space, priced daily per crate at an affordable price. The project effectively extends the shelf life of perishable foods and fruits by up to 21 days, reducing food waste and subsequently increasing the level of income of the farmers and retailers. Presently, there are more than 54 ColdHubs in Southern and Northern Nigeria. The project has also increased the income of its clients by 50 per cent while also creating more than 40 jobs for women. It is estimated that the project has saved 4,625 tonnes of CO_2 emissions and reduced annual energy consumption by 547 kWh. Furthermore, ColdHubs is working on the "Your Virtual Cold Chain Assistant" programme, to deploy a digital layer on the CaaS services of the cold rooms, to optimize the operations and costs within the rooms, while also providing additional value to the smallholder farmers storing their crops, through monitoring and access to markets.[54]

D. Lessons learned

102. CaaS can be implemented in any market provided certain enabling conditions are in place:

(a) A supportive regulatory environment to improve the uptake of service-based business models, defining clearly the rights and responsibilities of service providers and consumers: measures against unfair pricing, dispute resolution procedures, and fiscal incentives for the uptake of such practices can be useful.

(b) Specific tools such as standardized contracts, pricing models and guidelines for risk assessment and management, which are essential to successfully support businesses in designing and deploying cooling service offerings.

(c) Changes in companies' organizational culture, such as procurement policies and adjustments in skills development and support, as well as suitable financing partners. Capacity-building and dissemination activities can lower cultural barriers, raise awareness on the value of the model and increase demand.

(d) Need for service providers to have adequate digital tools for data management to ensure the effective measurement and transparent reporting of cooling delivered, and accurate billing.

(e) The business model aims to enable access to clean and sustainable cooling at scale across regions and industries (even for off-grid applications). Depending on the solution, the integration of additional services such as waste heat recovery or solar photovoltaic can add further value to customers.

[51] South Africa case study: https://www.caas-initiative.org/wp-content/uploads/2021/06/2021_South-Africa_KwaZulu-Natal_LR-3.pdf
[52] Case study Nigeria: https://www.caas-initiative.org/wp-content/uploads/2020/08/200828_ColdHubs-2.pdf
[53] ColdHub: https://www.coldhubs.com/
[54] https://yourvcca.org/

11. Air Conditioners Buyers Club

A. Context

103. Many air-conditioning units in use in Morocco rely on HCFC-22 or R-410A refrigerants, which are controlled by the Montreal Protocol with the aim of ensuring their phase-out and phase down respectively. Many air conditioners are also found to be not properly installed, with clustering and stacking of condensers, poor air circulation, and infrequent or no maintenance for energy efficiency.

104. In addition, the phenomenon of the urban heat island, where urban areas experience much higher temperatures than their suburban or rural surroundings resulting from running such air-conditioning systems, is especially pronounced in Moroccan cities. This disparity can lead to an underestimation of actual energy consumption, as most weather stations (which dictate energy strategies) are located in cooler suburban areas. As a result, many air conditioners consume more electricity than they should. This not only increases costs for consumers but also places a heavier load on the national power grid.

B. Action

105. The Ministry of Energy, Mines and Environment, the National Agency for Energy Efficiency, and the Moroccan National Energy Efficiency Agency in partnership with the Bank of Africa and international partners such as the Institute for Governance and Sustainable Development and CLASP, have developed the Air Conditioners Buyers Club initiative. It uses bulk procurement of highly efficient air conditioners and climate-friendly refrigerators by public and government entities to replacing older air conditioners country-wide with next-generation super-efficient air conditioners using low-global-warming potential refrigerants. Capitalizing on the economies of scale, the aim is to reduce the upfront cost of newer, more energy-efficient air conditioners though bulk purchase combined with professional installation, and servicing to ensure the maximum energy efficiency of these systems during their ownership. In addition, the initiative takes care of the safe waste management of obsolete refrigerants and equipment from replaced air conditioners (see below para 107).

106. The project leverages blended finance solutions, offering both financial incentives and technical support to manufacturers, installation businesses, and end-users. By negotiating prices based on aggregated demand, the bulk procurement strategy aims to foster a sustainable market for low-global-warming potential energy-efficient appliances, especially as the world rebuilds post-COVID-19, with bulk purchases expected to play a significant role throughout the recovery phase.

Implementation process

107. Steps of the implementation process included:

(a) Inventoried a representative sample of refrigerators and air conditioners and determined that equipment was inefficient as purchased, badly installed, and poorly maintained with dirty heat exchangers that further increase energy use;

(b) Developed and used a new carbon metric, Enhanced and Localized Life Cycle Climate Performance (E-LLCP),[55] that takes into account local conditions and the effect of high temperature on the carbon intensity of electricity delivered to refrigerators and air conditioners to select air conditioners with the lowest carbon footprint;

(c) Identified and recruited suppliers of super-efficient air conditioners, willing to demonstrate a reduced carbon footprint in Morocco and to ensure the supply of such equipment;

[55] E-LLCP uses: 1) Local climate conditions, including high temperature and humidity; 2) Local seasonal and time-of-day carbon intensity of electricity sources, including backup electricity generation; 3) Electricity transmission and distribution losses, including through the application of any voltage stabilizers; 4) Energy embodied in water used for power plant cooling; 5) Black and brown carbon power plant emissions; 6) More realistic assumptions about the actual air temperature entering RAC condensers; 7) Realistic assumptions about matching RAC capacity to cooling load; 8) Servicing to maintain efficiency over the lifetime of the installation. IGSD, "Community Benefits of Local Spending of Money Saved with Super-Efficient Air Conditioning Including New Local Employment, 2020.

(d) Designed a test procedure to compare the energy use of existing against new air conditioners that are super-efficient, properly installed and maintained, and operating on low- and zero-global-warming potential refrigerants;

(e) Reached out to the Morocco Hotel Managers' Association to recruit buyers;

(f) Organized the replacement scheme, recovering the ozone-depleting and greenhouse gas refrigerant from equipment for destruction in local cement kilns at favourable prices after having conducted economic and environmental feasibility of such collection and destruction process in the local market.

C. Outcome

108. The following outcomes resulted from the project:

(a) Adoption of the Law on energy efficiency (2021), which law sets criteria of minimum energy performance on appliances and electrical equipment powered by natural gas, liquid or gaseous petroleum products, coal, and renewable energy;[56]

(b) Establishment of Moroccan standard NM 14.2.300 on mandatory labelling (since 2012) that applies to household cooling, cooking and cleaning appliances and to household electric lamps;[57]

(c) A properly installed air conditioner using HFC-32 and with a high coefficient of performance up to 5.3 is estimated to consume 650 kWH of electricity at a cost of about $80, which is $90 cheaper than the old air conditioner that is estimated to consume annually 1200 kWh of electricity at a cost of $170;[58]

(d) Created additional year-round jobs in air-conditioning installation and servicing, recovery and destruction of refrigerants, recycling of useful components from the removed equipment;

(e) Increased the demand to make next-generation cooling technology affordable to Moroccan customers as bulk procurement reduces the cost of supply, marketing, distribution, installation, inspection, service and recovery and recycling at end of product life.

D. Lessons learned

109. The following lessons can be drawn from the project:

(a) Partnership and collaboration with government agencies and non-governmental and local banking institutions play a crucial role in the success of such programmes.

(b) The Buyers Club Handbook[59] provides a number of practical lessons learned and issues for consideration when preparing and running bulk procurement processes drawing from a number of successful examples in India.

[56] Law 47-09: https://climate-laws.org/document/law-47-09-on-energy-efficiency_d99a

[57] https://www.iea.org/policies/1898-moroccan-standard-nm-142300-on-labelling-of-cooling-cooking-and-cleaning-appliances-and-indoor-lighting.

[58] "First results of the Morocco AC Buyers Club pilot project", *Energy efficiency magazine*, n.d., available at https://energyefficiencymagazine.com/index.php/2022/01/03/first-results-of-the-morocco-ac-buyers-club-pilot-project-up-to-70-energy-savings-achieved/.

[59] Institute for Governance and Sustainable Development (IGSD) and OzonAction/UNEP, "Buyers Club Handbook", January 2020

12. Energy efficiency in buildings in the MENA region

A. Context

110. Countries in the Middle East and North Africa (MENA) around the Mediterranean Sea experience hot dry summers and humid and cool winters. With growing urbanization and rising temperatures, there is a growing energy demand for cooling equipment such as air conditioners, use of which leads to increased electricity consumption and greenhouse gas emissions. In Jordan, the residential sector consumes 46 per cent of energy, mainly for heating and cooling. Within households, 60 per cent of the energy consumed goes for heating and cooling. Since 2018, the electricity demand has been increasing annually by 4.3 per cent.[60] In Egypt, residential and commercial buildings consume 60 per cent of the electricity.[61]

111. The building sector in the MENA region has great potential for reducing greenhouse gas emissions by means of climate-friendly construction that helps to reduce the cooling load, thus optimizing the use of mechanical cooling and energy consumption.

B. Challenges

112. Ongoing efforts in the region to increase energy efficiency face challenges, including weak enforcement of building regulations and the high cost of implementing energy-saving measures. In Jordan, for instance, only 9 per cent of buildings followed mandatory energy codes in 2015, and 77 per cent lacked thermal insulation. There is a lack of clear enforcement and implementation schemes, especially during construction. Improved coordination, awareness, and detailed guidance and competence are needed for proper execution and compliance. In addition, construction according to energy efficiency building codes can cost up to 30 per cent more, depending on the project, owing to general lack of expertise, the construction materials chosen and finance. Similarly, Egypt introduced the Energy Efficiency Building Codes in 2005 and 2006, but because of complexities and weak enforcement, no buildings were constructed in compliance with these codes. There is inadequate data about new construction and a lack of a clear baseline for benchmarking of buildings' energy performance.

C. Action

113. The BUILD ME project[62] focuses on six MENA[63] countries, offering an interactive Building Energy Performance (BEP) tool supporting energy efficient and renewable energy-based heating and cooling system deployment in new buildings. The BEP tool calculates energy demand, greenhouse gas emissions, and cost-effectiveness of building energy efficiency measures, providing valuable data for construction decisions and potential green finance opportunities. In addition, a building typology database provides reference for buildings categorization in the region thus helping to establish the baseline for measuring the energy efficiency. The tools help to provide appropriate information and evidence for new construction decisions that plan building activities to provide sufficient reduction in energy demand. It is also a useful tool for the financial and banking sector to identify, verify and fund opportunities for energy efficiency in the building and construction sector. The BEP tool will be the core of the newly developed Energy Performance Certificate (EPC) scheme for the buildings proposed for the use in the region. The project also offers policy recommendations especially for updating National Energy Efficiency Action Plans (NEEAP) and Nationally Determined Contributions as well as preparing National Cooling Action Plans (NCAP).

114. The Cool Up Programme aims to promote sustainable cooling in Egypt, Jordan, Lebanon and Türkiye by developing relevant policies and regulations, enhancing institutional capacity, and fostering dialogue amongst key national stakeholders. These include national ozone units, relevant ministries, standardization organisations, manufacturers and financial institutions. In addition, Cool Up's demonstration projects help to build trust in sustainable cooling technologies, inspire new technology innovation backed by solid evidence, and help local manufacturers to convert to sustainable product lines. By developing and providing access to new and existing financial mechanisms, the project helps regional and local banks to provide financial products and credit lines

[60] https://www.coolupprogramme.org/countries/jordan/.

[61] http://www.moee.gov.eg/test_new/PDFReports/2020-2021-AR.pdf

[62] https://www.buildings-mena.com/.

[63] Algeria, Egypt, Jordan, Lebanon, Morocco and Tunisia.

for the supply and uptake of energy efficient refrigeration and air-conditioning products relying on low- and zero-global-warming potential refrigerants. The Cool Up programme thus aims at accelerating the early implementation of the Kigali Amendment and supporting the Paris Agreement.

D. Outcome

115. Several pilot projects have been initiated in the region. BUILD_ME supported 15 pilot projects[64] in Egypt, Lebanon and Jordan, providing energy efficiency solutions for improving the building envelope, optimization of the building systems and the utilization of renewable energy and financial calculation and cost effectiveness analysis of the energy efficiency measures.

116. Under the Cool Up programme, Jordan developed the National Cooling Strategy that prioritizes meeting cooling demand in a sustainable way, building a strong manufacturing base for the air-conditioning sector, and the food cold chain to improve food security and fight food loss and waste. The strategy is aligned with the Jordan Economic Modernization Vision and Green Growth Strategy. It has identified building performance standards and codes, passive cooling measures, MEPS and labelling for refrigeration and air-conditioning appliances and refrigerant transition as key intervention areas among others. Following this, a National Cooling Action Plan will be developed with concrete actions and monitoring, reporting and verification requirements for the implementation. The updated Third NEEAP will also comprise sustainable cooling measures such as development of MEPS and labelling for commercial air conditioners and development of a code for district cooling. Commercial banks have been involved to finance and invest in energy efficiency projects.

E. Lessons learned

117. The following lessons can be drawn from the project:

(a) The policies targeting energy efficiency in the refrigeration and air-conditioning and the building sectors need to be aligned and integrated owing to their interdependence. This alignment and integration helps with mutual reinforcement and efficiency of policy implementation and creates a strong push for market transformation. It also helps to unlock and channel financial resources towards this effort.

(b) Financial incentives and funding schemes are important. Blended finance, which combines public, private, and development assistance funds, can play a crucial role in mitigating risks and unlocking larger volumes of commercial capital, making energy efficiency projects more financially viable and attractive for private investments.

(c) Energy efficiency policies need to be made mandatory for long-term sustainability of intended results, and capacity needs to be developed for their implementation and enforcement.

(d) Local manufacturers need to see a clear business case for energy efficiency solutions to switch to energy-efficient technologies.

(e) Training and awareness programmes highlighting the benefits of using energy efficiency measures encourage effective action by stakeholders.

[64] https://www.buildings-mena.com/info/pilot-projects-phase-ii-2019-2021.

13. District cooling systems in Colombia

A. Context

118. In Colombia, urban areas are home to 75 per cent of the population, and the majority (over 70 per cent) of these cities are in a warm climate with a high demand for air-conditioning.

119. A district cooling system provides an effective solution to counteract the urban heat island effect. It consists of underground infrastructure where chilled water is distributed to multiple buildings from a central cooling plant. The cooling demand of a district is centralized, thereby reducing the charge of refrigerants and generating cooling more efficiently through economies of scale.

B. Action

120. In Colombia, the district energy strategy has been implemented in buildings since 2013.[65] The district cooling of La Alpujarra administrative complex in the city of Medellin, where many buildings had been using individualized and energy-intensive cooling systems, was the first pilot project.

121. The project emerged from the demonstration project for integrated management of the centrifugal chiller sub-sector, focusing on the application of energy-efficient CFC-free technologies for replacement of CFC-based chillers approved by the Executive Committee of the Multilateral Fund at its 47th meeting in 2005.[66]

122. The first district cooling system project of La Alpujarra was a pioneer in the country and in the Latin America region, aiming at creating a reference for replication of district cooling in other cities.

123. The project received $14 million in funding from the Swiss Agency for Development and Cooperation ($2.5 million), the public utility company of Medellin (Empresas Públicas de Medellín (EPM)) ($11 million), and the Multilateral Fund ($500,000 used from the $1 million approved by the Executive Committee at its 47th Meeting).

C. Challenges

124. In 2013, the evaluation of the project showed the successful phase-out of CFC-based equipment but recognized a lack of penetration of low-global-warming-potential and energy efficient technologies in the market. Led by the National Ozone Unit, and in collaboration with Medellin's EPM, a cooling district project started that year. The National Ozone Unit worked in close coordination with national and local authorities,[67] public service providers, final users of cooling systems to design the project.[68] The first important activity was to identify through a feasibility study, energy maps and detailed financial studies, including a business plan, a potential cooling district site that met the conditions to host and operate such facility.

125. A range of domestic policy and institutional measures have been put in place to support this project:

(a) Guidelines for sustainable construction including standards in energy savings for buildings (Resolution 549) of the Ministry of Housing;

(b) Programme for Rational and Efficient Energy Use (PROURE), establishing renewable energy targets and energy efficiency indicative goals. The programme established tax benefits for investments in the construction of district cooling systems, in addition to providing an institutional concept of such infrastructure to which other national and municipal policies may refer;

(c) Inclusion of energy-efficiency targets into NDC;

(d) Technical regulation in thermal systems implemented by the Ministry of Mines and Energy;

(e) Integration of district cooling systems in the sustainable public procurement policy, and in urban planning.

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[65] Green Cooling Initiative, "Final report on Strategic considerations for the wider use of low-emission refrigeration and air-conditioning systems in Central and South America in April 2021", Wolfgang Müller, Jörn Schwarz, Felipe A. Toro Chacón, 2021

[66] UNDP, Briefing - Experiences and Case Studies on Energy Efficiency in the Refrigeration and Air Conditioning Sector, https://ozone.unep.org/system/files/documents/UNDP-case-studies.pdf.

[67] Government of Antioquia Province, Provincial Customs Council, Ministry of Environment and Sustainable Development, and Presidential Office on International Cooperation.

[68] UNEP/OzL.Pro/ExCom/80/9.

B. Outcome

126. The district cooling system in La Alpujarra started operations in 2016. The water, cooled by absorption chillers using ammonia at the central plant, is distributed to 3 buildings by a 1.5 km long pipeline system running throughout the district. The electricity is generated from natural gas and waste combustion captured by a turbine at the central plant. There is an extra capacity for future expansion of the plant and its coverage.

127. The results in the district included 100 per cent elimination of ozone-depleting substances; 25 per cent energy saving; 35 per cent greenhouse gas emissions reduction; and 10–13 per cent reduction in thermal energy costs.

128. The success has led to replications in six other major cities in Colombia: Cartagena, Bogota, Bucaramanga, Montería, Villavicencio and Cali. The experience has been shared with other countries in the Latin American region during several workshops. The project has not only served as a blueprint for other Colombian cities but has also garnered international attention, with feasibility studies and similar projects sprouting in regions like the Dominican Republic, Egypt, and Qatar.

C. Lessons learned

129. There is still limited knowledge on district cooling systems around the world. They require significant upfront investment for production and distribution facilities and to ensure a reliable pipe system. Comprehensive developmental studies can, however, guide decision-makers about the viability of these projects, ideally implemented through public-private partnerships. For optimal long-term results, urban planners should consider integrating district cooling systems in densely populated regions, while ensuring provision for future expansion.

14. National Cooling Action Plans

A. Context

130. National Cooling Action Plans (NCAPs) offer a structured and comprehensive policy framework aimed at taking a holistic system perspective on cooling and the important developmental function it delivers. NCAPs can support the implementation of the Montreal Protocol, enhancing the energy efficiency of the refrigeration and air-conditioning sector, and NDCs under the Paris Agreement, and contribute to several Sustainable Development Goals. Given the cross-cutting nature of cooling, NCAPs provide a platform for cooperation and coordination among government entities, industries, the scientific community and consumers. Joint planning and implementation can help to streamline their efforts with the goal of actively managing growth in demand for cooling, reducing its environmental impact and expanding access to it to vulnerable groups. For example, the United Nations Development Programme (UNDP) estimates that the NCAPs of 11 countries, the development of which the organization supported, can realize cumulatively 140 tonnes CO_2 equivalent avoided emissions and will save consumers over $21.6 billion by 2050, as a result of reduced electricity consumption.[69]

B. Challenges

131. Cooling provided by the refrigeration and air-conditioning sector offers multiple diverse benefits: increasing human productivity and economic output, preserving food, keeping medicine and vaccines safe and offering overall comfort and quality of life. It delivers an important function for the well-being of human society which needs to be properly balanced against its significant environmental impacts. To enhance global access to sustainable cooling, that is, without intensifying its current ozone and climate impacts, policymakers, industries and individuals need to transition to more sustainable and also innovative models of cooling. This implies switching to low- to zero –global – warming potential refrigerants, while using more energy-efficient and innovative technologies, and reducing demand for cooling, including using passive non-energy-intensive measures while making cooling more accessible. Dealing with these challenges requires an integrated systems approach, which can be achieved through national cooling action plans.

C. Action

132. Building on the pioneering effort by India led by its National Ozone Office (Ozone Cell under the Ministry of Environment, Forests and Climate Change) which released the Indian Cooling Action Plan in 2019,[70] the UNEP-led Cool Coalition, with funding from the Clean Cooling Collaborative, developed the NCAP methodology. This serves as a guide to comprehensively cover the cooling sector in a structured way which can be readily adapted to fit a country's specific context and national priorities.

133. The methodology is based on a systematic approach to cooling. It facilitates mapping the needs of all relevant sectors and end-uses (e.g., space cooling in buildings, mobile air conditioning, cold chain and refrigeration), considers a variety of measures including non-energy-intensive methods to reduce cooling through better designs and materials and nature-based solutions; improving the efficiency of cooling equipment and appliances; and optimizing cooling operations and general behaviour through good servicing practices and awareness, user adaptations and other ways to ensure that cooling is delivered only where and when it is needed; shifting to low- and zero-global-warming technologies; and ensuring access to cooling for all and protecting the most vulnerable.

134. The methodology has two distinct elements: an overarching NCAP development methodology that lays out the sequence of activities involved, including guidelines, good practices, and available resources where applicable, and NCAP data assessment frameworks that provide an in-depth view into data gathering and analysis.

D. Outcomes

135. Since the first Indian Cooling Action Plan launched in 2019, around 40 countries have embarked on the development of national cooling action plans, of which at least 19 countries have

[69] Introduction-NCP Summaries-071122_0.pdf (sparkblue.org).

[70] india_cooling_action_plan_2019.pdf (ozonactionmeetings.org).

them already adopted and launched.[71] They have been assisted by UNDP, the UNEP Cool Coalition, the Cool Up programme, and others.

136. Taking Rwanda as an example, the Rwanda Cooling Strategy[72] is a collaborative effort, involving several ministries, the private sector and international organizations providing technical and financial support, with the Ministry of Environment taking overall responsibility for its implementation. Launched in 2019, the strategy aims to optimize space conditioning and refrigeration in line with the Rwanda green growth pathway. The Rwandan economy is growing at an annual average rate of 7.5 per cent and population is increasing, so there is a need to expand electricity access – now at approximately 40 per cent of the population today with the aim to grow three-fold over the next decade – and sustainably meet growing demand for cooling products. To address these challenges, the strategy aims to promote a low carbon economy and support Rwandan commitments under the Kigali Amendment.

137. Specific actions include of the Rwandan Cooling Strategy include:

(a) Establishing MEPS for cooling equipment and restricting the importation of inefficient cooling products and refrigerants;

(b) Creating a national product registration system to capture information on all cooling equipment produced, imported or exported on the Rwandan market and introducing a product labelling to provide consumers with information about energy efficiency;

(c) Raising awareness about adopting efficient cooling technologies and ensuring proper management, including end-of-life product disposal and recycling among industries, importers, retailers and professional bodies. The Rwanda E-waste Dismantling and Recycling Facility is currently piloting the recycling of cooling products. The facility currently recycles the metal parts of the cooling products, recovers the gases and sends them out of the country for recycling, and ensures that the rest of the components are properly disposed of or recycled.

(d) Developing innovative financial mechanisms using blended finance, to overcome first-cost barriers and encourage the adoption of energy-efficient cooling technologies, including on-bill financing schemes and performance-based models. Options include guaranteed performance models ("Energy Savings Insurance"), on-bill financing schemes, service-oriented models ("Pay per use" or "pay-as-you-go"), shared savings energy performance contract models, leasing schemes, sale-and-leaseback models, bulk procurement programmes among others.

(e) Harmonizing the strategy with other ongoing HPMP and NDC revision.

(f) Scaling up cold chain and off-grid cooling infrastructure to support agriculture by establishing energy-efficient and climate-friendly refrigeration and storage solutions. The agriculture sector accounts for 31% of Rwanda's GDP, yet 50% of its production goes to waste, causing smallholder farmers to lose up to 15% of their income[73]. Refrigerated storage technologies currently in use in Rwanda range from grid-connected brick and mortar cold rooms to off-grid solar-powered facilities. Different business models are being tested (e.g., pay per use and leasing, targeting groups of small and medium-sized agribusiness farmers), and refrigerated transport options are being piloted.

E. Lessons learned

138. Based on their experiences, the following lessons learned and guiding principles have been identified:[74,75]

(a) The development of a national cooling action plan should be flexible and tailored to each country's needs. Depending on the context, it can take the form of a national strategy or a workplan as long as it has a legal basis and meets the needs of all stakeholders. For example, in Jordan a national cooling strategy is first developed to be followed by a detailed NCAP (see case study 12).

[71] Information from the Cool Coalition Working Group on NCAPs.

[72] Submission from Rwanda in response to the letter from the Secretariat dated 27 June 2023 seeking information from the parties pertinent to the request in subparagraph 4 (b) of decision XXXIV/3, focusing on policies that address energy efficiency and the transition to low- and zero-global-warming-potential alternatives in sectors using HFCs and other substances controlled under the Montreal Protocol.

[73] Ibid

[74] Principles for National Cooling Plans - Clean Cooling Collaborative.

[75] Beating the Heat: Achieving Sustainable Cooling through National Cooling Plans (sparkblue.org), Side event at the forty-fourth meeting of the Open-ended Working Group of the Parties to the Montreal Protocol.

(b) The NCAP should be flexibly integrated within a country's policy landscape and existing climate, energy and development plans.

(c) It needs to refer to existing and ongoing national policies and programmes and international commitments which, in addition to the Montreal Protocol phase-out and phase-down programmes, can include NDCs under the Paris Agreement as well as their methodologies, terminologies, and approaches for better collaboration and chances of realization of goals.

(d) It should have a collaborative framework that enables multistakeholder engagement. For example, the NCAP of India includes the active participation of 16 ministries, national agencies and other organizations and comprises 6 working groups.

(e) One entity should be designated to ensure overall coordination and ownership of the process, such as the National Ozone Office in India.

(f) Use a broad spectrum of approaches to define and assess the cooling sector and any gaps, and to prioritize future action. Approaches can incorporate active and passive cooling solutions alongside demand management plans. The NCAP of most countries prioritizes the development or updating of MEPS for refrigeration and air-conditioning equipment as a key policy initiative together with enforcement of proper monitoring, verification and enforcement processes. The NCAP of Sri Lanka aims to promote indigenous knowledge on climate-sensitive building architecture and identify traditional practices adopted by ancient Sri Lankans for food conservation and storage. The NCAP of Lebanon will pay attention to consumer awareness to give their clear guidance to energy efficiency appliances and incentives schemes to promote the uptake of more energy efficient products.[76]

(g) The plan needs to maintain a long-term perspective (20+ years) but be a living document open to revision. For example, the NCAP of Rwanda is to be revised at least once every five years to adjust it in line with the pathway of the country's transition to clean cooling[77]

(h) The NCAP needs to have a list of the top five broad-level recommendations, followed by detailed actionable plans indicating timelines, responsible agencies, stakeholders and indicative costs, indicating relevant policy linkages.

(i) The NCAP must recognize the need for additional financial investments to overcome additional economic, legal, and technical challenges which can create market barriers in the cooling sector. It should foster development and access to innovative financing models to manage lending risks and high upfront capital expenditure.

[76] Ibid[77] Rwanda National Cooling Strategy.pdf (fonerwa.org).

[77] Rwanda National Cooling Strategy.pdf (fonerwa.org).

15. Review and updating of MEPS

A. Context[78]

139. Iran is a vast country with a predominantly hot and dry climate. The peak demand for electricity is during the summer to meet the need for cooling, for use in water and gas coolers and chillers. Reducing the cooling demand is one of the main priorities of policies set by the Ministry of Energy. Below are some of the policies and projects to manage the cooling demand in the country.

B. Action

Upgrading existing MEPS for the refrigeration and air-conditioning systems and supporting the implementation of labelling systems

140. To enhance energy efficiency in refrigeration and air-conditioning systems, the Ministry of Energy of Iran has introduced MEPS and has facilitated the development of reference laboratories for the evaluation of energy performance. These enhanced standards and supportive initiatives are crucial steps towards implementing comprehensive energy labelling systems, facilitating informed consumer choices and fostering energy conservation.

141. The instituted MEPS are for the following applications:

(a) Standard 23261 for independent food cold rooms with a capacity exceeding 500 tons;

(b) Standard 10639 for hermetic compressors, outlining the technical specifications, energy consumption testing methods, and energy labelling instructions;

(c) Standard 10637 for refrigerated display cabinets, outlining technical specifications, energy consumption testing methods, and energy labelling instructions;

(d) Standard 10306 for air-cooled packaged air-conditioning units, with technical specifications and the test method for energy consumption and energy labelling instructions;

(e) Standard 3678-2 for both air-cooled and water-cooled chillers;

(f) Standard 6016-2, with technical specifications for window coolers;

(g) Standard 10638 for air conditioners (air conditioners and heat pumps), outlining technical specifications and test methods for determining energy consumption criteria and energy labelling guidelines;

(h) Standard 14577 for refrigerators and freezers, specifying the technical norms and guidelines for energy consumption and labelling;

(i) Standard 3678-2 for evaporative compression chillers (air-cooled and water-cooled);

(j) Standard 4910-2 for household water coolers, outlining technical specifications and test method for determining energy consumption and energy label guidelines - amendment No. 1

Water coolers

142. Water coolers, widely used for residential cooling in Iran, have been a significant source of electricity consumption, especially during peak summer periods in recent decades. Historically, most water coolers installed in the country were less energy-efficient models, relying on ozone-depleting refrigerant gases with high global-warming-potential. Thus, enhancing the energy efficiency of water coolers is crucial for managing the nation's electricity demand for cooling.

143. To address this need, an agreement has been established among the Ministry of Energy, the National Organization of Standards, and the Ministry of Industry, aiming to upgrade MEPS for residential water coolers. The goal is to reduce power consumption by 3000 MW. In 2022, MEPS and associated test methods for water coolers were revised.

144. According to the first amendment of National Standard No. 4910-2 (2022), entitled “Household Water Cooler - Technical Specifications and Test Method for Determining Energy

[78] Submission from Iran in response to the letter from the Secretariat dated 27 June 2023 seeking information from the parties pertinent to the request in subparagraph 4 (b) of decision XXXIV/3, focusing on policies that address energy efficiency and the transition to low- and zero-global-warming-potential alternatives in sectors using HFCs and other substances controlled under the Montreal Protocol.

Consumption Criteria and Energy Label Instructions - Amendment No. 1," the three lowest energy consumption levels (F, E, and G) were removed, and three additional top energy efficiency ratings, A+++, A++, and A+, were introduced. The Office of Monitoring Energy Consumption and Environment Standards has, since the mandatory implementation of these updated MEPS, prohibited the manufacturing of water coolers with energy consumption ratings of F, E, and G.

145. Given advances in high-efficiency electric motor technology in the country, with efficiencies reaching 90 per cent, there are plans to continue the upgrade process. The next three categories (B, C, D) will also be phased out from the energy label of water coolers. Eventually, only categories A to A+++ will be included in the energy label of water coolers. It is anticipated that the mandatory implementation of this standard will, over the next four years, result in a reduction of more than 1200 megawatts in the country's electricity consumption.

146. The end goal is to manufacture water coolers exclusively with high-efficiency and permanent magnet (BLDC) motor technologies, achieving efficiencies close to or exceeding 90 per cent. This commitment reflects a broader drive towards sustainable and energy-efficient cooling solutions in Iran.

Review and upgrading of air conditioner energy label

147. The energy consumption standard for air conditioners has been also revised and updated and was mandated for mandatory implementation from May 2023.

148. In this update, ratings E, F, G have been removed from the air conditioner energy labels, and three new grades, A+++, A++, and A+, have been introduced at the upper end of the energy label rating. The new MEPS is expected to result in substantial energy savings, approximately 1300 megawatts, following the production and implementation of gas coolers meeting the new standards under the revised label. Previously, the classification index of the energy label was based on an Energy Efficiency Ratio (EER). However, the revised standard uses the Seasonal Energy Efficiency Ratio (SEER), offering a more comprehensive and accurate accounting of energy efficiency with consideration of variable weather conditions.

149. The Ministry of Energy has also supported the establishment of reliable reference laboratories to provide a robust framework for implementing energy performance standards for both air conditioners and water coolers within the country.