2019

CHILLING PROSPECTS:
TRACKING SUSTAINABLE COOLING FOR ALL

SUSTAINABLE ENERGY FOR ALL

#CoolingforAll

KIGALI COOLING EFFICIENCY PROGRAM

CONTENTS

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FOREWORD

H.E. DR. VINCENT BIRUTA

Minister of Environment
Government of Rwanda

The Kigali Amendment to the Montreal Protocol represents a once in a generation opportunity to deliver on the HFC phase down, contribute to the 1.5°C pathway of the Paris Agreement, and improve the lives of millions by realizing the Sustainable Development Goals. Its entry into force in early 2019 is a testament to the environmental, climate, and social benefits it can deliver, but also to concerted political will to replicate the success of the world's most effective environmental treaty - the Montreal Protocol.

That aspiration can only be achieved through a coordinated effort to provide access to sustainable and affordable Cooling for All. With just over ten years to deliver the Sustainable Development Goals and avoid the most catastrophic impacts of climate change, this is not an abstract concept. Cooling for All is an issue of equity that demands our focus right now.

With record levels of heat capturing global attention, it is far too simple to consider the problem, and its solutions, solely in terms of air-conditioning. Cooling for All is not only urgent, it is also complex. For the most vulnerable populations, it requires access to quality, reliable electricity that can power life-saving equipment, cities that are built to protect people from extreme heat, and cold chains that bring farmers out of poverty and keep vaccines and medical products safe for use. Developing solutions to these issues requires a holistic approach and a complete understanding of the need across agricultural, medical, and energy sectors.

Released in 2018, *Chilling Prospects: Providing Sustainable Cooling for All* was a global wake-up call and a call to action. This report takes stock of the progress we have made and celebrates the acceleration in solutions to sustainable access to cooling. It

includes the development of National Cooling Plans in Rwanda, India, and China, as well as city-led action to protect the vulnerable from heat extremes. In the last year, innovative prizes to address air-conditioner efficiency, cooling by nature, and the transformative power of cool roofs have been launched and garnered significant interest.

While there has been marked global action on sustainable access to cooling, there is still significant work to do in scaling solutions and delivering them to those who need them most. There are still at least one billion people at high risk of lack of cooling access, and more than two billion who are ready to acquire a cooling device. While opportunities exist to accelerate action on finance for access to sustainable cooling, coordinating our efforts with these communities is necessary to achieve transformative impacts.

With the urgency and complexity of the challenge in mind, we must ask: What are the gaps that prevent holistic and accelerated action to provide affordable, efficient, and sustainable cooling for all?

This question grounded the research for this report, paired with the question of how: How will we generate solutions that meet the global cooling demand within the scope of the 1.5°C scenario set out by the Paris Agreement?

Through the analysis of the demographic and geographic trends of highest risk and vulnerability, this report advances a needs-based methodological tool that will help countries and communities to understand the full scope of cooling needs. Across human safety and comfort, agricultural productivity and nutrition, and medical services, cooling needs – and the solutions to address them – are diverse. This report provides governments with a blueprint to understand those needs through data and brings together policy, finance and technology solutions that can deliver cooling for all.

I know that by bringing together the right data, the most innovative businesses, smart finance, and the best policies, we can deliver on the promise of the Kigali Amendment, the Paris Agreement and the Sustainable Development Goals. Here in Rwanda, we are happy to share what we have learned so far in service of this important mission and to learn from others across the globe.

We hope you will join us.

H.E. DR. VINCENT BIRUTA
Minister of Environment
Government of Rwanda

EXECUTIVE SUMMARY

The world is getting hotter and drier. Climate impacts are being universally felt, most tangibly in the volatility and frequency of extreme weather events, and every year the situation becomes more dire. In 2019, the International Panel on Climate Change (IPCC) reported that at 1.5°C of warming, 2.3 billion people could be both exposed and vulnerable to heatwave events,[i] a threshold that could be reached as early as 2030.[1] It also reported that food loss and waste account for 8-10 percent of annual GHG emissions and that food security, particularly the production of nutritious fruits and vegetables, is vulnerable to climate change.[ii] The World Health Organization (WHO) reported that global vaccination rates remain at a stubborn 86 percent, and that 19.4 million infants were not reached with routine immunizations, including the temperature sensitive DPT vaccine.[iii]

Unsurprisingly then, in 2018 and 2019 the issue of cooling and how we deliver it affordably and sustainably has emerged as a focus of governments, health care companies, food manufacturers, real estate firms, air-conditioning and refrigeration equipment manufacturers, refrigerant producers, as well as development institutions. Rather than viewing access to cooling as a luxury, they recognize that in a warming world, access to sustainable cooling is a necessity. Cooling is an issue of equity that underpins the ability of millions to realize the Sustainable Development Goals (SDGs). Safe living and working conditions, safe and nutritious food, and effective vaccines and medical care depend on access to cooling, and as need for cooling grows, we must deliver it in a manner consistent with the Paris Agreement on Climate Change and the Kigali Amendment to the Montreal Protocol. It has to be sustainable.

This report is a follow-up to *Chilling Prospects: Providing Sustainable Cooling for All,* the first report to define and quantify the magnitude of the global cooling access challenge, including an assessment of 52 countries facing the biggest risks, measured by extreme heat, food losses, and damaged or destroyed vaccines and medicines. This report serves as a status update. It profiles fast action in access to cooling, provides an update on global access to cooling gaps, and provides policy makers, the private sector and development financiers with tools and guidance on how to accelerate progress on areas of priority.

FAST ACTION TO ACCESS ON COOLING

Since the release of *Chilling Prospects,* there have been important moments of progress in countries identified as highest at risk. In 2019, two major economies published national cooling plans: the India Cooling Action Plan (ICAP) and the Green Efficient Cooling Action Plan in China. Of the nine priority countries identified in 2018, Brazil, Bangladesh, and Nigeria are also currently working to develop national cooling plans. Additionally, Rwanda and Trinidad and Tobago have demonstrated critical national leadership on cooling policy. Indian cities have acted to protect their populations from extreme heat with the National Disaster Management Authority building capacity in local governments to develop life-saving heat action plans.

Simple solutions to enhance access to cooling have also been championed with prizes like the Million Cool Roofs Challenge and the Ashden Cooling by Nature Award, recognizing the critical role of innovation in urban greenery for cooling cities. Through its Global Cooling Prize, the Rocky Mountain Institute and partners have successfully engaged industry in the goal of designing a five times more efficient air conditioner at no more than two times the cost. Through public-private partnerships (PPPs), industry has shown itself as a crucial partner in testing solu-

[1] Allen M., *et al.* (2018) SUMMARY FOR POLICYMAKERS, in IPCC (2018) GLOBAL WARMING OF 1.5 °C, 6 ("Human activities are estimated to have caused approximately 1.0 °C of global warming above pre-industrial levels, with a *likely* range of 0.8 °C to 1.2 °C. Global warming is *likely* to reach 1.5 °C between 2030 and 2052 if it continues to increase at the current rate. *(high confidence)*").

Chilling Prospects: Providing Sustainable Cooling for All used the terms Rural Poor, Slum Dwellers, Carbon Captives, and Middle Income to segment the market. In this report, Slum Dwellers are termed Urban Poor and Carbon Captives are termed Lower-middle Income.

Rural Poor – Approximately 365 million

The rural poor lack access to electricity and are likely to live in extreme poverty. Many of them are likely to engage in subsistence farming and lack access to an intact cold chain enabling them to sell their products further afield at a higher price. Medical cold chains may also not be intact, putting lives at risk from spoiled vaccines.

Urban Poor – Approximately 680 million people

The urban poor may have some access to electricity, but housing quality is very poor and income may not be sufficient to purchase or run a fan. They may own or have access to a refrigerator, but intermittent electricity supplies may mean that food often spoils and that there is a high risk of food poisoning.

Lower-middle Income – Approximately 2.2 billion people

The lower-middle income represent an increasingly affluent lower-middle class that is on the brink of purchasing the most affordable air conditioner or refrigerator on the market. Limited purchasing choices available to this group favor cooling devices that are likely inefficient and could cause a dramatic increase in energy consumption and associated GHG emissions.

Middle Income – Approximately 950 million people

The middle income are people who have owned an air conditioner and may be able to afford a more efficient one. They might make conscious choices not to own an AC unit or minimize its use. They may represent the established middle class where affordability may also allow them to move to better designed, more efficient housing and working environments.

tions and preparing them for scale in priority markets, and remains actively engaged in the critical task of gathering data on agricultural cold chains to overcome barriers to investment in growing markets.

Policy makers in both developed and developing countries have now started to focus their attention on the critical role of access to cooling in addressing poverty and achieving the SDGs. With the launch of SEforALL's Cooling for All Secretariat along with leadership from national governments and new civil society initiatives, there is a growing awareness of the role of access to sustainable cooling in lifting people from the base of the pyramid and providing them with life changing opportunities to protect themselves, improve their health and increase their productivity.

TRENDS IN COOLING ACCESS

This report provides an update on trends in cooling access. While challenges in measuring the spectrum of enhanced access to sustainable cooling persist and point to a need to refine the model, the segmentation of risk groups, or potential markets, in terms of the rural poor, the urban poor, and the lower-middle income, and tracking them annually, is crucial to building awareness and understanding the magnitude of the challenge and the actions that need to be taken.

The analysis shows that across the 52 high-impact countries 1.05 billion people among the rural and urban poor people remain at high risk from a lack of access to cooling. A further 2.2 billion lower-middle income people pose a different kind of risk: they will soon be able to purchase the most affordable air conditioner or refrigerator, but price sensitivity and limited purchasing options mean they favor devices that are likely to be inefficient, threatening energy systems and resulting in increased GHG emissions.

Compared to 2018, the analysis as seen in Table 1 shows a decrease of approximately 55 million people who are at highest risk of a lack of access to cooling, from 1.1 billion. The number of urban poor at highest risk has grown by approximately 50 million from 630 to 680 million, while the rural population has decreased by approximately 105 million from 470 million to 365 million. The lower-middle income population has seen a reduction from 2.3 billion in 2018 to 2.2 billion in 2019. Across the 52 high- impact countries, at least 3.2 billion people face cooling access challenges in 2019.

Driving the change for rural people living in poverty is a significant increase in rural energy access, notably in India, Bangladesh and Indonesia, as well as continued urbanization trends in Africa and Asia. While energy access lowers risk exposure, it does not necessarily imply enhanced access to cooling, given the need for Tier 2[2] energy access to operate simple fans and the fact that poor people in rural areas face risks on multiple fronts. Significant concentrations of rural people at highest risk remain in Sub-Saharan Africa, particularly in Mozambique, Nigeria and Uganda.

In cities, the growth in the number of urban dwellers at highest risk between 2018 and 2019 is consistent with population growth and urbanization rates in the developing world, which have, in some instances, quadrupled during the last 50 years.[iv]

The decline in the lower-middle income population between 2018 and 2019 is indicative of a growing global middle class and lower prices for entry-level AC and refrigeration units. In Indonesia for example, which has seen a significant reduction in its lower-middle income population, the World Bank estimates that about 20 percent of the population are middle class and a further 45 percent of Indonesians are considered no longer vulnerable to poverty. Household consumption in Indonesia rose by 5.1 percent in 2018.[v]

A geographic comparison shows that in Africa, the growth rates of those at highest risk from a lack of cooling access—rural poor and urban poor—have increased beyond population growth rates. Of the high-impact African countries identified, 12 have over 60 percent of their populations at highest risk. In Asia,

[2] ESMAP (2015). Beyond connections – Energy Access Redefined presents Tier 2 of the Multi-tier framework as a lower access to household electricity services, enough to power general lighting, television and fan.

TABLE ES 1: CHANGES IN VULNERABILITY BETWEEN 2018 AND 2019

POPULATIONS AT RISK	HIGH RISK		MIDDLE RISK	LOW RISK
	RURAL POOR	URBAN POOR	LOWER-MIDDLE INCOME	MIDDLE INCOME
RISK INDICATORS	• Lack of access to energy • Proportion of rural population living in poverty	• Lack of access to energy • Proportion of population living in urban slums	• Proportion of population living on less than USD 10.01 / day outside of rural or urban poverty	• Proportion of population living between USD 10.01 and 20.01 / day
2018 ACCESS GAP	470 million	630 million	2.3 billion	1.1 billion
2019 ACCESS GAP	365 million	680 million	2.2 billion	950 million
CHANGE	-105 million	+50 million	-100 million	-150 million
FINDINGS AND TRENDS	• Significant increase in rural energy access, notably in India • Continued urbanization trends in Africa and Asia	• Continued urbanization and fast-growing cities in Africa and Asia	• Purchase of cooling devices associated with income growth, notably in Indonesia • Lower prices for entry-level AC and refrigeration units	• Increased purchasing power and growth of an established middle class
NOTE	• 1.05 billion remain at highest risk, compared to 1.1 billion in 2018. • While energy access lowers risk exposure, it does not necessarily imply enhanced access to cooling, given the need for Tier 2 energy access to operate simple fans. • Changes in volume do not necessarily imply a transition from one population at risk to another.			

there was a slight decrease in populations at highest risk from 2018 to 2019, although 615 million people are still identified to be within the two high-risk groups.

MOVING FORWARD: NEEDS-BASED ASSESSMENT AND FINANCE

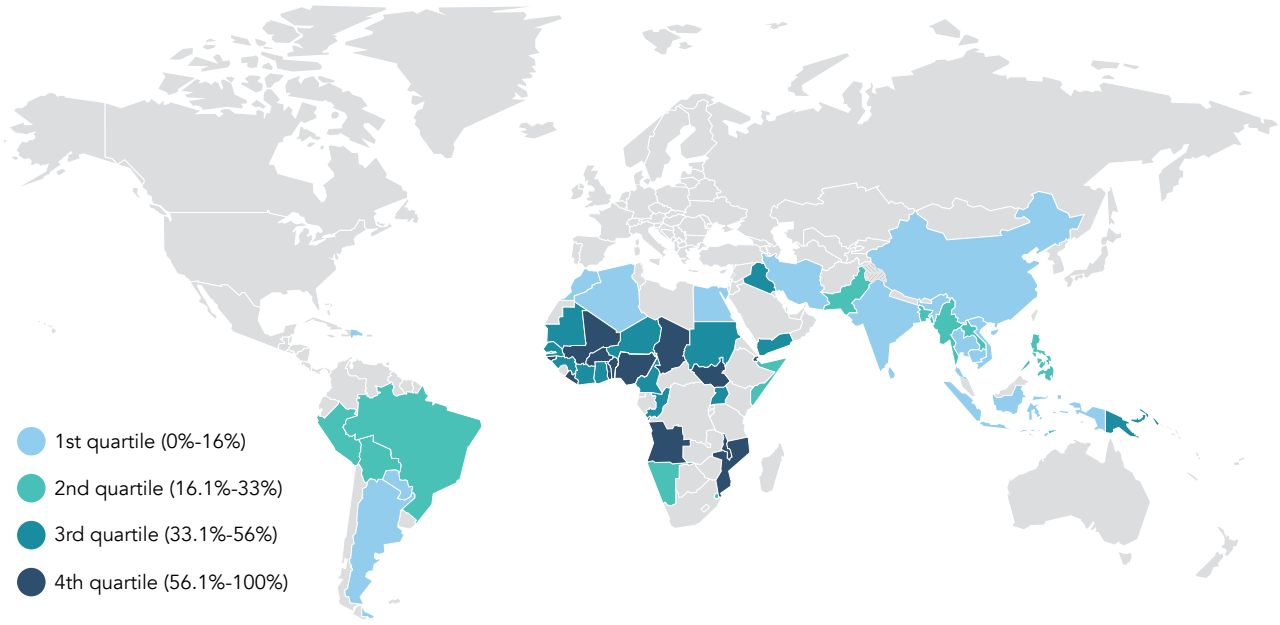
Delivering sustainable cooling for all requires a holistic approach that moves beyond equipment-based projections and addresses the full scope of cooling demand across thermal comfort, agricultural production, nutrition, and the provision of effective health services. An underestimation of the scale of the cooling demand could ultimately have far-reaching social, economic and environmental consequences. In response to this, the Cooling for All Secretariat at SEforALL and Heriot Watt University have partnered to create the Cooling for All Needs Assessment, a tool for governments, development institutions, and NGOs to measure the full spectrum of cooling needs and aggregate policy, technology, and finance measures to address them.

The needs assessment is a living document and is based on the principle that, in order for a country, city or community to ensure that the cooling needs of their population are met, they must first understand what those needs are. Through assessment across human comfort and safety needs, health service needs, food and nutrition security and agricultural needs, demand can be understood systemically and measured fully. A roadmap to delivering access to sustainable cooling for all can then be developed. These needs anchor a framework of analysis to measure present and future community, regional, and national access to cooling requirements. Each has a series of guiding questions that inform next steps for demand measurement.

Human comfort and safety: for living, learning, working, and mobility

- To what extent does the population have ac-

FIGURE ES 1: SHARE OF POPULATION AT HIGHEST RISK (RURAL AND URBAN POOR COMBINED)



Note: Each quartile includes one fourth of the countries. The percent represents the range of the share of population at high risk for each quartile.

Notes on all maps contained in this report: 1. The dotted line represents approximately the Line of Control in Jammu and Kashmir by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. 2. All maps were produced by SEforALL. They are based on the UN Map of the World, which can be found here: http://www.un.org/Depts/Cartographic/map/profile/world.pdf. The boundaries, colors, denominations and any other information shown on these maps do not imply, on the part of SEforALL, any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries.

cess to the space and mobility cooling that is adequate to maintain safety and productivity at home, in places of education and in the work environment and while moving between each?

Food and nutrition security and agriculture: for nutrition, rural incomes, and connectivity

- To what extent does the population have access to the food they need to maintain a healthy (and socially acceptable) diet?
- Is income from agriculture and fisheries sufficient to keep workers out of absolute and relative poverty?

Health services: for safe medical clinics and the secure transport and storage of vaccines and medicines

- Are national vaccine programs reaching their target population?
- Is there sufficient unbroken cold chain to ensure the provision of medicines and healthcare products?
- Are health infrastructure buildings equipped with the cooling they need to deliver adequate and reliable health services?

Using these guiding questions, the methodology then provides specific indicators for each guiding question. The indicators offer a starting point to establish a baseline for access to cooling, understand the implications of cooling demand, make outcome-based investments that target vulnerable groups, and track progress.

The diversity and complexity of cooling needs are a central part of the challenge in developing finance tools that reduce vulnerability. Utilized in a national cooling plan or equivalent set of measures, a needs-based approach can inform finance by identifying what is achievable with private investment and blended finance and what is only achievable through public support. It can

create a foundation for financing strategies that complement investment plans (where investment plans will indicate *what the investment needs are*, financing strategies will indicate *what type of financing is needed*).

Access to sustainable cooling finance is expanding, but it must grow quickly and substantially enough to meet the increased need for cooling services. There are signs that cooling is gaining importance with bilateral donors and the development finance community, as well as within the Montreal Protocol, and many international funds like the Green Climate Fund and the Global Environment Facility are bolstering their dedication to various cooling initiatives. The World Bank Group has announced a program within the Energy Sector Management Assistance Program (ESMAP) to develop necessary market infrastructure, financing mechanisms, policies, and regulations that support sustainable cooling, including cold chain.

These emerging opportunities signal the need not only for coordination, but for a clear road map based on cooling needs and with equity as a value. This is in stark contrast to equipment-based projections which do not take into account the base of the pyramid population. They also make clear the need to track access to cooling finance flows, which is currently difficult due to the issue's nascency. Indicative access to cooling finance can be understood through proxies such as access to electricity and climate finance to specific sectors, but a more granular approach would be beneficial as finance expands.

RECOMMENDATIONS

This report offers a set of recommendations for specific actors to urgently accelerate progress on access to sustainable cooling. It also identifies cross-cutting issues to be addressed that are relevant to multiple stakeholders regardless of their sector. A first step for all actors is to understand the enormity of the challenge and that we have only begun to make progress on delivering sustainable cooling for all.

For Government Policymakers

National and sub-national governments must catalyze accelerated action on sustainable access to cooling by creating comprehensive cooling plans that protect the vulnerable. Understanding gaps in cooling demand with the use of the Cooling for All Needs Assessment is a key first step in determining how to address these gaps. Through this assessment tool, available through the Cooling for All Secretariat at Sustainable Energy for All, policymakers can define targets, and aggregate policy, technology and finance options to address critical cooling needs. Opportunities for partnerships with the private sector must be pursued as a means of achieving market development.

For Donors, Development Practitioners and Financiers

A focus on society's most vulnerable, those at the base of pyramid, must be a priority for development programs and finance to deliver sustainable cooling for all. Interventions must go beyond servicing the space cooling of buildings and address human security and safety, health services, agricultural productivity and food and nutrition security. The application of a cross-sectoral, multi-stakeholder approach is a crucial first step for donors and the development community to maximize finance and impact for access to sustainable cooling at the base of the pyramid. The private sector has also demonstrated its capability to be part of such efforts, and PPPs must be utilized to ensure the demonstration of technology and that new business models can reach scale. In considering finance and assistance, donors and the development community should use the needs assessment to identify desired outcomes and establish what can be achieved with private and blended finance, and what can only be achieved with public finance.

For Industry and Business

Industry should understand the size of the cooling market when counting in the unmet needs of those at the base of the pyramid and, together with government, work to ensure that high-efficiency devices are accessible and affordable. Technological innova-

tion is crucial for creating efficient cooling products, and must be paired with an effort to lower prices and up-front costs and speed deployment of proven approaches in design and engineering. The expansion of cooling as a service and pay-as-you-go models, as well as collaboration with inclusive financial institutions, can help to ensure that everyone can gain access to sustainable cooling. Additionally, industry and business have to step up to deliver skills development and maintenance training.

For Cities and Local Authorities

Cities and local authorities should also use the needs assessment to identify priority actions to protect vulnerable populations. The design or expansion of heat action plans and passive cooling through green spaces and cool roofs are important immediate steps. In addressing longer-term issues, collaboration across urban design and energy planning will be essential to mitigate cooling demand and reduce the urban heat island effect.

To Raise Awareness and Generate Knowledge Across Sectors

There are too many unknowns to deliver sustainable access to cooling for all and this report recommends key next steps to fill those gaps. We desperately need better data on the sufficiency of agricultural cold chains in high-impact countries, a gap the private sector is well-placed to fill. With a growing recognition of the nexus issues between health and energy, improved collaboration between the two sectors must be a priority for both communities and the private sector must be engaged. The recently established global Health and Energy Platform of Action led by the WHO could serve as a basis for new partnerships. Finally, the lack of gender-based analysis is another key weakness that prevents public and private programs from responding to the specific cooling needs of women and girls versus those of men and boys, a knowledge gap that Sustainable Energy for All is looking to fill.

To Build Capacity and Develop Skills

Efforts by K-CEP, GIZ, OzonAction and development organizations assisting with national cooling plans (NCPs) have laid a strong foundation which can be expanded on to build the global capacity necessary to deliver cooling for all. Training capacity and centers for promoting focused work on access to cooling in vulnerable countries, either at the country or regional level, should be established as a means to scale up current efforts. One model worthy of consideration is that of the Global Network of Regional Sustainable Energy Centres, led by the United Nations Industrial Development Organization (UNIDO), that provide a network and resources for regional practitioners.

To Benchmark Progress and Track Finance

While there are clear and acknowledged gaps in the data that preclude a complete understanding of risk across the spectrum of access to cooling, globally available data will continue to support tracking of cooling access gaps for those at the highest risk. As greater emphasis is placed on cooling by development finance institutions and bi- and multilateral donors, there will be a clear need to track financial flows directed towards access to cooling for vulnerable populations. Understanding the amount, geography, type of finance and the rate of distribution and absorption is critical to prioritizing new investments.

As populations grow, heatwaves intensify, and the global middle class expands, the role of cooling in the productivity of developed economies and the safety of people has never been easier to appreciate. The developed world now understands how cooling made the transition from a luxury in the mid-19th century to a necessity today.

It is the responsibility of governments, industry, civil society, and the development community to internalize the lesson that delivering access to sustainable cooling to vulnerable populations is an issue of equity and to apply it with urgency. With solutions at hand, growing interest, and ambitious commitments, ensuring we deliver results for those at the base of the pyramid requires a clear road map based on cooling needs, one which moves beyond equipment-based projections, and that places equity at the heart of our efforts.

ABBREVIATIONS

USD	United States Dollar
AC	Air Conditioner
CaaS	Cooling as a Service
LMI	Lower-Middle income
CII	Confederation of Indian Industry
CLASP	Collaborative Labeling and Appliance Standards Program
CO_2	Carbon Dioxide
CRAA	China Refrigeration and Air Conditioning Association
CSOs	Civil Society Organizations
DFID	Department of International Development (United Kingdom)
ESMAP	Energy Sector Management Assistance Program
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)
GT	Gigatons
GW	Gigawatt
GWP	Global Warming Potential
HAP	Heat Action Plan
HFCs	Hydrofluorocarbons
HVAC	Heating, ventilation, and air conditioning
ICAP	India Cooling Action Plan
iCS	Institute for Climate and Society

IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
K-CEP	Kigali Cooling Efficient Program
kWh	Kilowatt hours
LDCs	Least Developed Countries
MEPS	Minimum Energy Performance Standards
MTF	Multi-Tier Framework
NAPs	National Adaptation Plans
NDCs	Nationally Determined Contributions
NRDC	Natural Resources Defense Council
RAC	Refrigeration and Air Conditioner
RMI	Rocky Mountain Institute
RP	Rural Poor
SIDS	Small Island Developing Nations
UP	Urban Poor
SDG	Sustainable Development Goal
SEforALL	Sustainable Energy for All
UHIE	Urban Heat Island Effect
TWh	Terawatt hours
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
WHO	World Health Organization

GLOSSARY

Base of the Pyramid is a term used to describe the most vulnerable members of the population, who live on less than USD 2.50 a day.

Cold Chain is a temperature-controlled supply chain, consisting of a sequence of refrigerated production, storage, and distribution activities, along with associated equipment and logistics, which maintain a desired low-temperature range. It is used to preserve, extend, and ensure the shelf life of products.

Cooling Access Gap is considered to comprise those who simply do not have appropriate access to cooling now or in the near future and cannot reap the many socioeconomic, health, and environmental benefits of this access, and those who are expected to gain access to cooling in the next decade(s) but are unlikely to have access to sustainable, efficient, and affordable cooling solutions under a business-as-usual development path.

The Cooling for All Secretariat is a coordinating platform, hosted by SEforALL, designed to enhance focused responses to the issue of access to cooling. The Secretariat works with industry, philanthropy, implementing CSOs, and development partners to develop and test new solutions in priority geographies, track and increase finance in access to cooling, and engage governments on the issue of access to cooling.

Food loss, food waste, and **food wastage** are terms related to the food supply chain. Food loss is the unintended reduction in food available for human consumption, resulting from inefficiencies in supply chains: poor infrastructure and logistics or lack of technology, insufficient skills or poor management capacity. Food waste refers to discarding or alternative (non-food) use of food that is safe and nutritious for human consumption along the entire food supply chain, from primary production to end household consumer level. Food wastage encompasses both food loss and food waste.

Kigali Amendment to the Montreal Protocol is an agreement to phase down global production and consumption of hydrofluorocarbons (HFCs). The agreement entered into force on January 1, 2019.

Minimum energy performance standards (MEPS) are specifications that contain a number of performance requirements for an energy-using device and limit the amount of energy that can be consumed by a product. They are often determined by national governments.

National Cooling Plan is a plan developed by a national government that can take different forms, but often includes components such as: outlooks on how cooling demand will evolve and grow over time, strategies that promote sustainable and smart cooling practices across the nation, roadmaps and timelines to adopt and increase the stringency of MEPS, and identification of potential to use financial mechanisms.

Heat Action Plan is a plan developed at municipal or regional level that includes several measures to address extreme heat waves through the implementation, coordination and evaluation of activities aimed at avoiding and reducing negative health impacts on the population.

Needs assessment is a systematic process for determining and addressing needs or gaps between current conditions and desired conditions. The discrepancy must be measured to appropriately identify the need present.

Sustainable Cooling is providing access to cooling options that are environmentally sustainable, efficient,

and affordable, as well as sufficient to meet local demands without encouraging potential over-consumption of cooling solutions that are not compliant with the Paris Agreement or the Kigali Amendment to the Montreal Protocol.

Sustainable Development Goals (SDGs), introduced in 2015 after the conclusion of the Millennium Development Goals, the SDGs are a set of 17 inter-related "Global Goals", with 169 sub-indicators. The goals were adopted by 193 countries and target both developed and developing countries, on a time-frame to 2030.

The Paris Agreement is a legally binding global climate agreement adopted by 195 countries in December 2015 and entered into force in November 2016. It aims to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

Urban Heat Island Effect (UHIE) is the phenomenon that urban and metropolitan areas tend to be hotter than rural areas due to a combination of factors, including less vegetative cover, less reflectiveness, and lower evaporation. This exposes more people to the risks of heat extremes, adding significantly to the demand for air-conditioning and creating a need for cities to prepare heat action plans.

1. INTRODUCTION

In early 2019, the Kigali Amendment to the Montreal Protocol came into force, and with it, a growing coalition of states committed to phasing down the production and consumption of hydrofluorocarbons (HFCs), powerful greenhouse gasses which threaten our collective ability to meet the targets of the Paris Agreement. If fully implemented, the promise to reduce the use of HFCs by more than 80 percent by 2050 could avoid up to 0.4°C of warming by the year 2100, contributing to the Paris Agreement's goal of limiting global temperature rise to well below 2 °C above pre-industrial levels. Including efficiency gains, the climate benefit could be even more significant.[3]

The opportunity does not lie solely in the potential avoidance of climate impacts. The Kigali Amendment also catalyzed a transformative opportunity to deliver access to sustainable cooling for all. As the world works to implement the collective promise of the SDGs, **development institutions, industry associations, national governments, civil society organizations (CSOs), and philanthropy have recognized that access to sustainable cooling, like energy access, is a major issue for development, and that cooling is about much more than thermal comfort for those with reliable access to electricity.** In a warming world without access to sustainable cooling, we cannot deliver the modern, reliable and affordable energy services demanded by SDG 7 while achieving SDG13, and make good on our broader commitment to the overall SDGs. In addition to addressing the health and safety risks that protection from heat and functioning cold chains can provide, access to cooling supports the delivery of multiple SDGs, notably those related to poverty, health, nutrition, gender equity, and productivity.

In service of the SDGs

Access to sustainable cooling has also been recognized as a matter of urgency in how countries mitigate and adapt to climate change. Rising demand for space cooling alone could as much as triple the amount of energy required compared to current levels.[vi] Across all sources of cooling demand, the energy required to deliver access to cooling globally could reach 19,600 terawatt hours (TWh) by 2050 without efficiency measures, representing an increase of more than five times.[vii] The scale of the energy demand challenge also highlights the need to approach the issue from a resilience and adaptation perspective, in order to reduce cooling demand across energy systems. The World Bank's Action Plan on Adaptation and Resilience, for example, has recognized the opportunity to capture multiple benefits, highlighting simple solutions, such as green spaces, cool roofs and street trees as a way to secure "triple wins" across development, emissions reductions, and enhanced resilience.[viii] Together, the implications of delivering access to sustainable cooling call for a holistic approach that moves beyond focusing on space cooling only, applies energy and cooling demand reductions first, and meets remaining needs with solutions that align with GHG reduction targets in the Paris Agreement and maximize the economic, social, and public health benefits that access to sustainable cooling delivers.

[3] Issues related to energy efficiency while phasing down hydrofluorocarbons (decision XXIX/10): access of parties operating under paragraph 1 of Article 5 of the Protocol to energy-efficient technologies in the refrigeration, air-conditioning and heat pump sectors. Available at: http://conf.montreal-protocol.org/meeting/mop/mop30/groups/energy-efficiency/English/MOP30-CRP2.e%20revised_9%20Nov%202018_final.docx

With new momentum and associated challenges on access to cooling comes the need for a foundational support structure to serve as a coordinating mechanism, a clearinghouse for different stakeholders to identify and amplify successful experiences and identify areas where further effort is needed. To this end, in 2019, Sustainable Energy for All (SEforALL) established a Cooling for All Secretariat, hosted at SEforALL as a coordinating platform to enhance focused responses to the issue of access to cooling. The Secretariat will work with industry, philanthropy, implementing CSOs, and development partners to develop and test new solutions in priority geographies, track and increase finance in access to cooling, and engage governments on the issue of access to cooling.

The consequences of inaction are dire. Already, 30 percent of the global population is exposed to life-threatening temperatures for nearly 20 days a year.[ix] In countries with vulnerable populations, the risks presented by a lack of access to sustainable cooling become more significant as temperatures and socioeconomic inequality increase. The Intergovernmental Panel on Climate Change's (IPCC) 2018 Special Report on 1.5°C of warming put this into stark, global terms, warning that at 1.5°C of warming, and under shared socioeconomic pathway 3[4] (high challenges to mitigation and adaptation), 2.3 billion people are both exposed and vulnerable to heatwave events, a number that grows to 3.5 billion at 3°C of warming.[x] Observations show that the rate of global annual temperature increase has more than doubled since 1981, from 0.07°C per decade to 0.17°C per decade.[xi] With the IPCC forecasting that the planet could surpass the threshold 1.5°C as early as 2030, the urgency of the challenge, and the need to act immediately, is thrown into sharp relief.[5]

It is the nature of these risks and vulnerabilities that this report addresses. It is in our cities, our built environments, and cold chains – the uninterrupted refrigerated production, storage and distribution required to deliver medical products and fresh produce -- where risks to vulnerable populations are greatest due to a lack of access to sustainable cooling.

SDG 2 – ZERO HUNGER

The role of agricultural supply chains in delivering SDG 2, which calls for an end to hunger and malnutrition by 2030 as well as the doubling of agricultural incomes for small-scale food producers, has been broadly recognized, yet the role of clean and unbroken cold chains in achieving them has yet to be fully realized. Several studies indicate that low income countries suffer the greatest losses, with Sub-Saharan Africa's loss of fruit and vegetables due largely to a lack of a reliable cold chain.[xii] The IPCC also warned in its report on 1.5°C of the impacts of a warming world on agricultural production and food and nutrition security, and that climate change could reverse progress on SDG 2. While the report focused primarily on crops that do not require cooling, it concluded that a global decline in livestock production of 7–10 percent is expected at about 2°C of warming, with associated economic losses between USD 9.7 and 12.6 billion.[xiii] On a local level, food prices will be affected by changes in temperature and precip-

[4] Socio-economic pathways are scenarios used to derive emissions scenarios without and with climate policies; Socio-economic pathway 3 indicates that there will be high challenges for mitigation because of regionalized energy and land policies, as well as adaptation, due to slow development. They were developed by the International Committee on New Integrated Climate Change Assessment Scenarios.

[5] Allen M., *et al.* (2018) SUMMARY FOR POLICYMAKERS, in IPCC (2018) GLOBAL WARMING OF 1.5 °C, 6 ("Human activities are estimated to have caused approximately 1.0 °C of global warming above pre-industrial levels, with a *likely* range of 0.8 °C to 1.2 °C. Global warming is *likely* to reach 1.5 °C between 2030 and 2052 if it continues to increase at the current rate. *(high confidence)*").

itation, potentially rising by 84 percent by 2050.[xiv] In its 2019 Special Report on Climate Change and Land, the IPCC found that food loss and waste account for 8-10 percent of annual GHG emissions and cost USD 1 trillion annually. In addition, food security, particularly the production of nutritious fruits and vegetables, is vulnerable to climate change.[xv]

SDG 3 – GOOD HEALTH AND WELLBEING

Access to sustainable cooling is also closely related to the global community's ability to deliver on SDG 3, which targets ending communicable diseases by 2030 and delivering access to safe, effective, quality and affordable essential medical products and vaccines for all. Unreliable medical cold chains threaten the effectiveness of vaccines and other medical supplies that require refrigerated transport to rural clinics, and once arrived, require cold storage powered by reliable energy that is not often available. A 2018 survey found that only 41 percent of health care facilities in 78 low- and middle-income countries had reliable energy access.[xvii] In the case of a potentially lifesaving Ebola vaccine that requires uninterrupted cold storage from import to delivery at between -60 and -80°C, access to energy and cooling is pivotal in the containment of a potentially dangerous outbreak.[xviii]

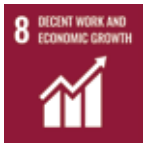
SDG 5 – GENDER EQUITY

Access to sustainable cooling supports the realization of SDG 5. Men, women, boys, and girls experience access to cooling differently, and value cooling services differently. Within the risk groups defined by this report, the rural poor have deeply gendered experiences with access to cooling and electricity according to their societal standing and roles within communities and households. Within the risk groups at the base of the pyramid, women and girls are often disproportionately impacted by a lack of access to sustainable cooling and enhanced access could lead to lower vulnerability to mortality risk and poverty. Women often experience lower mobility than men, meaning that they are less likely to be able to take advantage of public cooling centers, making them more vulnerable during a dangerous heat wave. Studies conducted in Europe and China have shown that in both relative and absolute terms, women have higher mortality risks during such events.[6]

[6] Studies include Kovats RS, Hajat S, Heat stress and public health: a critical review. Annual Review Public Health. 2008; 29. Pgs. 41-55, Achebak, Hicham, et al, Heat-related mortality trends under recent climate warming in Spain. PLoS Med, 2018, 15(7): e1002617, and Dong, Wentan, et al, Impact of heat wave definitions on the added effect of heat waves on cardiovascular mortality in Beijing, China, International Journal of Environmental Research and Public Health, 2016, 13(9): 933.

Agricultural cold chains are increasingly important to sustainable food supplies in cities. Cities consume between 50 and 70 percent of food globally, and over the last 30 years, the volume of food transported to cities from rural settings has increased 300 percent in India, 800 percent in Africa, and 1000 percent in Southeast Asia.[xvi] As middle-class urban populations grow and demand more nutritional food, and delivery companies such as Alibaba commit to grocery delivery in 30 minutes, the cold chain infrastructure necessary for reduced spoilage represents both a risk and an opportunity. As these markets expand rapidly, ensuring the supportive cold chains are clean and efficient is an imperative for sustainable energy systems, to reduce wastage, and for businesses to ensure satisfied urban customers.

Since women in agricultural labor roles often have fewer assets, and thus a smaller financial safety net, cold chain breakdowns within the agricultural supply chain disproportionately affect women and their livelihoods.[xix] Heat stress can also exacerbate existing gender differences in the world of outdoor work, notably by worsening the working conditions of men on construction sites.[xx] While the gender-risks are evident, the nascent nature of the field of access to sustainable cooling reveals a lack of any formal analyses or disaggregated data of the gendered aspects of the issue.

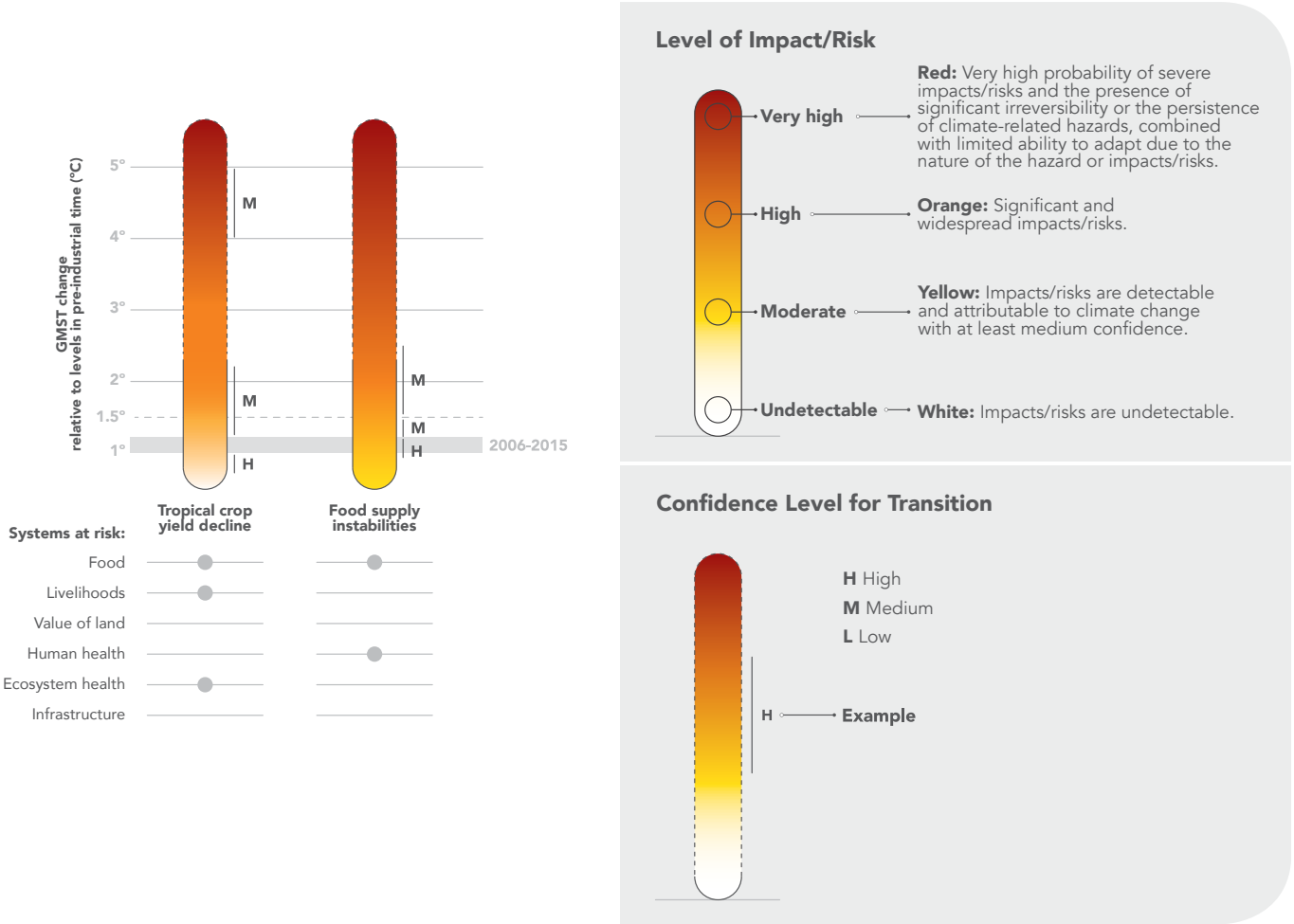


SDGS 8 & 11 – DECENT WORK AND ECONOMIC GROWTH & SUSTAINABLE CITIES AND COMMUNITIES

As urban populations swell and temperatures across different pockets of a city, exacerbated by the Urban Heat Island Effect (UHIE), rise, access to cooling begins to fall and workforce productivity begins to lag;

FIGURE 1: EFFECT OF INCREASES IN GLOBAL MEAN SURFACE TEMPERATURE TO FOOD SECURITY

Risks to humans and ecosystems from changes in land-based processes as a result of climate change



Source: IPCC

estimates of global productivity losses due to heat range from as high as USD 2 trillion by 2030.[xxi] While all occupations, indoor and outdoor, are affected, those working in certain sectors outdoors and occupations involving physical labor, in agriculture, environmental goods and services (natural resource management), construction, and refuse collection, are at higher direct risk of heat fatigue.[xxii] Outdoor midday work ban policies have already been implemented in Oman, Saudi Arabia, and UAE in order to safeguard workers' health – in some instances, the breaks last three hours a day and throughout the three hottest months of the year.[xxiii] Heat extremes cause air quality to worsen, trapping emitted pollution and increasing surface ozone,[xxiv] and in general increasing hospital admissions and mortality rates that surge when temperatures surpass 35°C. Those at greatest risk are the poor, young children, women, the elderly, and those with pre-existing medical conditions who do not have access to cooling.

At 1.5°C of warming an additional 350 million people could be exposed to potentially deadly heat by 2050. At 2°C of warming and in the absence of adaptation measures, Karachi, Pakistan and Kolkata, India could experience annual conditions equivalent to the deadly heat waves of 2015.[xxv]

CHILLING PROSPECTS: PROVIDING SUSTAINABLE COOLING FOR ALL

Recommendations

Define Targets for the Critical Nine Countries: The nine countries with the highest access to cooling gaps must set specific goals for reducing them by sector, specific geographic location and with specific timelines.

Cooler Cities: Cities can take action to reduce extreme heat impacts including local heat action plans, improving building codes and envelopes, utilizing district cooling along with available heat sinks, and by scaling up the use of shading and cool and vegetated roofs and walls.

Cooler Agriculture: There is an urgent need for greater commercialization to improve designs, produce at scale, and develop business models to make solutions for clean agricultural cold chains affordable.

Bring Industry and Finance to the Fore: More must be done to engage manufacturers, entrepreneurs, and financiers to deliver promising cooling technologies to the base of the pyramid. Stronger participation from the financial community must include new partnerships and business models, including servitization.

Support for Capacity Building and Skills Development: Policymakers need to be brought up to date with current thinking, to train people to work on access to cooling, and to develop training programs that support these outcomes.

Raising Awareness: There must be far greater recognition and focus on the critical issue of access to cooling in addressing poverty and achieving the SDGs.

2. FAST ACTION ON ACCESS TO COOLING

Since July 2018, there has been significant fast action on access to cooling. This section details notable developments aligned with the recommendations set out in *Chilling Prospects: Providing Sustainable Cooling for All,* and highlights areas where acceleration is necessary.

DEFINING TARGETS FOR THE CRITICAL NINE

The *Chilling Prospects: Providing Sustainable Cooling for All* report called for nine priority countries to set goals for reducing access gaps by sector, geography, and with timelines through national cooling plans or equivalent processes. In 2018 and 2019, there was notable progress in critical markets such as India and China, as well as demonstrable leadership on access to cooling in Rwanda and Trinidad and Tobago.

In India the national government took an important step by publishing the India Cooling Action Plan (ICAP) in March 2019. The plan is a notable step forward in recognizing the issue of cooling for development, for addressing the threat of climate change, and for recognizing the significance of sub-national activities, particularly those of cities.

Developed by the Ministry of Environment, Forests and Climate Change, the ICAP responds to the clear energy implications of expanded cooling demand within its jurisdiction. Cooling access risks in India remain widespread among rural people, the urban poor and those ready to buy their first cooling device. These risks make it necessary to have equivalent engagement and robust policy frameworks that originate from multiple authorities, for example the Ministry of Finance, to provide financing tools to purchase efficient fans, as well as the Ministries of Health and Agriculture to implement policies that improve cold chains. The plan recognizes that implementation necessitates a whole-of-government approach and has recommended a steering committee for its implementation that includes the Ministries of Power, Road Transport and Highways, Agriculture, Industrial Policy and Promotion, as well as representatives of state governments, indus-

ICAP Targets: Using a 20-year target horizon to 2037-2038, ICAP aims to reduce cooling demand by 20-25 percent, reduce refrigerant demand by 25-30 percent, and reduce cooling energy requirements 25-40 percent from 2017-2018 levels.[xxvi] The plan recognizes the critical role of skills development and maintenance, committing the government to training 100,000 servicing sector technicians by 2022-2023, and is rightfully cognizant of the social benefits of expanded access to cooling, including the contribution of cold chain infrastructure to the goal of doubling farmers' income and reducing food wastage, while also noting the need to avoid a massive increase in power demand and greenhouse gas emissions if cooling efficiency is not dramatically increased.

try, and civil society organizations. Key next steps for the ICAP include a strong implementation framework, the integration of supportive passive solutions, such as shading, green spaces, and water bodies, into urban planning frameworks, and filling the acknowledged data gaps on heat stress and the quantity of cooling demand in key sectors, including the transport sector.

The Government of Rwanda demonstrated fast action through its 2019 initiative, the Rwanda National Cooling Strategy. The strategy outlines a holistic approach to sustainable cooling, ranging from reducing thermal loads in buildings and leveraging natural ventilation (with an aim to reduce the need for end-use cooling equipment) while also improving the performance of air conditioners and refrigerators. The plan also calls for the development of a cold chain strategy with appropriate business models that can be sustained for the long term, and addresses the need for market monitoring, verification and enforcement, as well as capacity building and awareness raising. Through this strategy, Inspira Farms and the national government are partnering to develop solar powered rural cold storage and packhouse facilities to benefit 100,000 smallholder farmers.

The Ministry of Environment also took a holistic approach to meet the cooling needs of Rwanda's citizens, collaborating closely with the Rwandan Ministry of Infrastructure, the Rwanda Environment Management Authority, and the Rwanda Standards Board to develop the strategy.

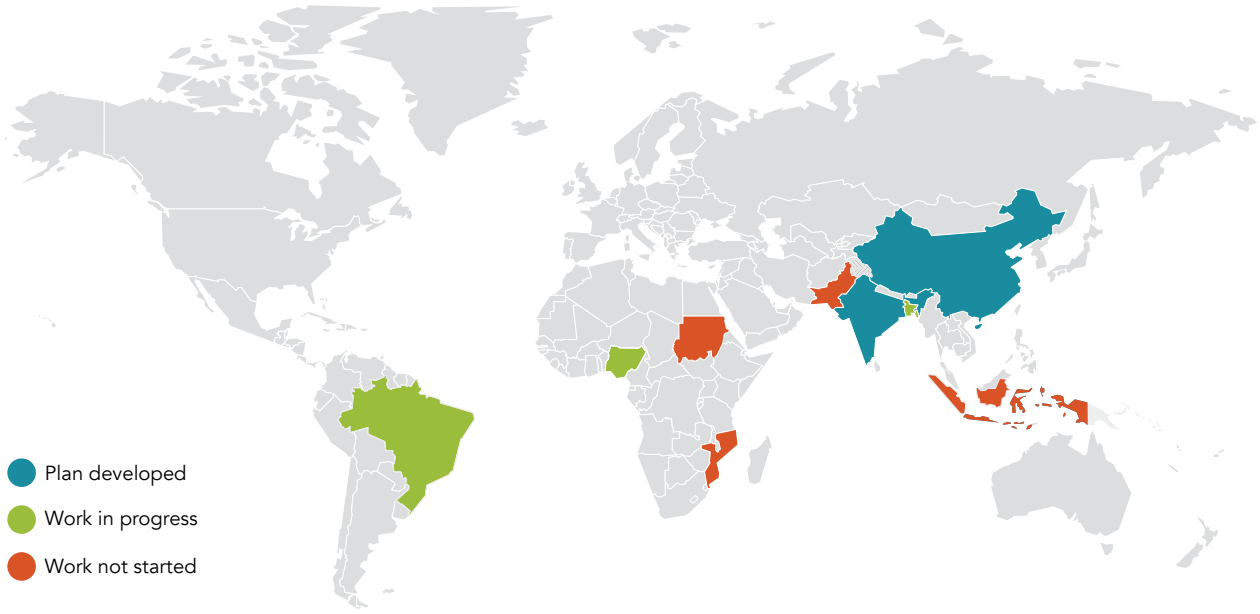
In addition to these examples, of the nine critical countries, Bangladesh, Brazil and Nigeria are engaged in processes to develop national cooling plans.[xxvii] In Bangladesh and Nigeria, these plans are in development in partnership with respective national governments through technical assistance provided by the United Nations Development Programme (UNDP), and in Brazil through the Institute for Climate and Society (iCS).

In June 2019, the Chinese National Development and Reform Commission launched the Green Efficient Cooling Action Plan,[xxviii] a significant step forward from a central economic planning agency. The plan sets forth the goal to increase the energy efficiency of household air conditioners and other cooling products by more than 30 percent and to increase the market share of green, efficient cooling products by 20 percent by 2022. By 2030, the goal is to increase the energy efficiency of cooling in large public buildings by 30 percent, and increase the market share of green, efficient cooling and refrigeration products by 40 percent. The targets will be met through enhancing standards, improving the supply of efficient cooling products, carrying out energy-saving renovation, and deepening international cooperation. As the manufacturer of 70 percent of the global supply of air conditioners and the world's largest exporter, China's efforts to develop new Minimum Energy Performance Standards (MEPS) will also be crucial to the achievement of efficient and affordable solutions sold into markets where vulnerable populations will soon be able to purchase an air conditioner or refrigerator.[xxix] [xxx]

A critical element of achieving clean and efficient cooling, whether incorporated into a national cooling plan or standing alone, is the development or the strengthening of MEPS for appliances. In China, the Green Efficient Cooling Action Plan, kickstarting the process to develop new MEPS, is underway and will contribute significantly to the efficiency level of new devices purchased by consumers globally over the next decade. Fast action on updated MEPS has also occurred in Brazil and Rwanda, and in Kenya, new air conditioner MEPS have the potential to eliminate 73 percent of the least efficient models available in the country.[xxxi] Of the nine countries facing the highest risk from a lack of access to cooling, five countries have adopted MEPS for Heating, Ventilation, and Air Conditioning (HVAC) while only three have MEPS for refrigeration. Improving MEPS through providing more efficient options for potential future customers at the base of the pyramid will have a huge impact on energy demand.

An important complementary measure to MEPS is establishing building energy codes and ensuring

FIGURE 2: STATUS OF NATIONAL COOLING PLANS IN THE CRITICAL NINE

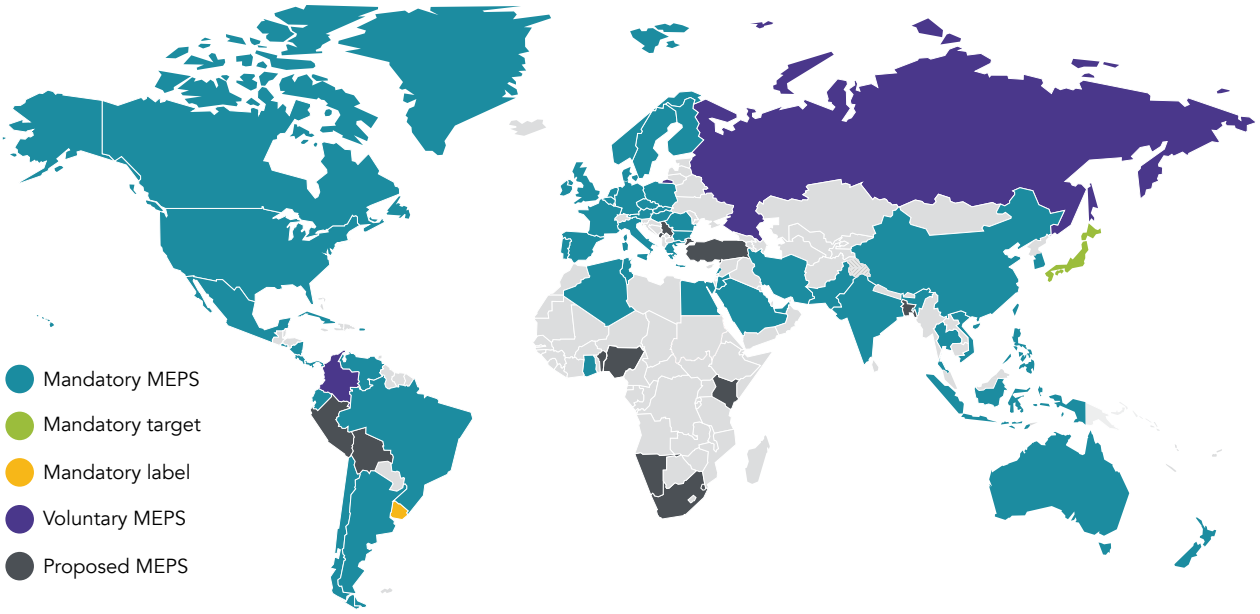


"The National Cooling Strategy was the result of collaboration from across government, civil society and academia. From the Ministry of Infrastructure and the Rwanda Environment Management Authority to the Rwanda Standards Board and Lawrence Berkeley National Laboratory, developing the strategy was truly a team effort. Rwanda has moved quickly and we are more than happy to share the lessons we have learnt so far. But we are only at the beginning of our journey."

H.E. Dr. Vincent Biruta,
Minister of Environment,
Republic of Rwanda, January 2019

their enforcement. While the number of building codes implemented has grown in the past decade, two-thirds of countries still lack them. Like MEPS and product labels, enforcement of building energy codes continues to be an issue, with China being the only country of the nine at highest risk to implement a mandatory code.[xxxiii] In India, where the share of space cooling in peak electricity load is projected to jump from 10 percent in 2018 to 45 percent in 2050, building codes are only partially mandatory.[xxxiv] The country took a step forward in 2018, developing a national model code that prioritizes important measures for cooling such as passive systems and thermal comfort. Across emerging economies like India, strong and enforced building codes are critical for improving energy and comfort outcomes in the current inventory and in planned construction.

FIGURE 3: STATUS OF MEPS AND LABELING FOR AIR CONDITIONERS[xxxii]



Source: IEA

While the development of national cooling plans (or their equivalents) in many of the priority geographies for access to cooling is encouraging, there are clearly challenges. In Indonesia and Pakistan, cooling demand is growing quickly without substantial progress while in Sudan, political upheaval is likely to delay action for several years. Clear lessons also exist regarding the need to give national cooling plans both political backing and priority and legal weight and mandates for inter-ministerial coordination among health, infrastructure and agricultural ministries. There is a further need, when designing plans, to consider the scope of maintenance and service technicians necessary to deliver sustainable cooling outside of the space cooling sector.

COOLER CITIES

Cities have a critical role to play in providing access to cooling and reducing urban heat island effects. Through both climate adaptation and mitigation strategies, measures in their control include the promotion of green and cool rooftops and walls, natural cooling, shading, cool roads and pavements, and the development of local heat action plans.

Heat stress planning is a particularly important city-level intervention. It is typically targeted towards at-risk populations, such as the elderly, homeless, and lower-income households living in poorly cooled housing. Cooling centers provide not only shade and lower temperatures, but also free drinking water, medical attention and even referrals to social services.

In India, where heat waves caused 22,500 deaths between 1992 and 2015, the National Disaster Management Authority categorizes heat waves as a national disaster and has engaged in capacity building to support state and local governments in developing life-saving heat action plans (HAPs).[xxxv] This capacity building specifically recognizes city-level challenges and identifies the urban poor as the sector of the population most vulnerable to extreme heat.[xxxvi]

Programs in India build on the identification of 17 heat-prone states and include training workshops for local officials, development of monitoring and management strategies, and communications campaigns

CONTINUED LEADERSHIP IN AHMEDABAD, INDIA

Ahmedabad, India was the first city in South-Asia to develop a HAP in 2010, and the city has since increased its capacity with six new iterations of the HAP. In partnership with the Natural Resources Defense Council (NRDC), the 2018 HAP incorporated new efforts that included:

- **Greater use of cool roofs through the addition of highly solar reflective paint on buildings across the city**
- **Training for medical professionals to identify and treat victims of extreme heat**
- **Awareness campaigns that target religious groups, among others, and which advertise precautions to take during a heat wave**

– including *Beat the Heat India.* One program, in Andhra Pradesh, saw the state set up 1,168 automated weather monitoring stations capable of providing daily forecasts to residents of all 670 administrative zones through a mobile phone application.[xxxvii] Now, approximately 30 cities across 11 Indian states are engaged in weather monitoring for extreme heat.[xxxviii] In addition to the Indian cities already implementing HAPs, Sagar in Madya Pradesh and Jhansi in Uttar Pradesh launched plans in 2018, while Bhubaneswar, Odisha and Rajkot, Gujarat began developing plans in 2018.[xxxix]

Developed countries are taking measures to ensure that their vulnerable citizens are safe from increasingly more frequent heat waves. In 2003, France had almost 15,000 heat-related deaths during one of the most intense heat waves recorded in its recent history. Since then, the French government has adopted a more proactive policy regarding heat waves, and cities like Paris have implemented early warning measures, established a network of more than 900 public buildings and spaces that can be used as cooling centers and even closed schools during the heat peaks.[xl] The death toll as a result of the June 2019 heat wave was four people.[xli]

Developing cities and states are also recognizing that district cooling systems are cost-effective solutions in the context of heightened energy demand. In Andhra Pradesh, India, the state government has entered into an agreement with UAE's Tabreed to build a district cooling system in the new state capital of Amaravati.[xlii] Through the District Energy Accelerator, funding has also been allocated for fast action to demonstrate the efficacy of district cooling solutions in 2018-2019 by the Kigali Cooling Efficiency Program (K-CEP)[7].

The adoption of cool roofs as a low-cost, high impact solution has also gained momentum. The Million Cool Roofs Challenge is an example of a challenge prize designed to accelerate the adoption of such solutions. By reducing the amount of heat absorbed by the exterior of a building, reflective surfaces, otherwise known as "cool roofs" can cool the top floor of a building by 2 to 3°C and reduce the net energy use of a one-story building with air conditioning by up to 20 percent. Funded

[7] The Kigali Cooling Efficiency Program (K-CEP) is a philanthropic collaborative that works in tandem with the Kigali Amendment of the Montreal Protocol by helping developing countries transition to energy-efficient, climate-friendly, and affordable cooling solutions.

by K-CEP, this Challenge has awarded ten grants worth USD 100,000 to catalyze the installation of one million square meters of new, sustainable, cool roofs. A further USD 1 million will be awarded in 2021 to a winning team that demonstrates the model with the greatest potential for scale.

The Ashden Cooling by Nature Award, supported by SEforALL and K-CEP, has also recognized the role of city planning and the role of trees and vegetation in reducing the impacts of extreme heat in cities. Announced in June 2019, the winner of the 2019 Ashden Cooling by Nature Award was the Colombian city of Medellin's Green Corridors Project, which uses vegetation to cool the built environment and busy transport routes.

COOLER AGRICULTURE

Uninterrupted cold chains are critical to reducing food loss and waste, and yield important benefits in terms of nutrition, agricultural productivity, and reduced emissions. Yet, compared to space cooling, considerably less attention has been given to enhancing agricultural cold chains that support economic development, in particular for smallholder farmers.

One prominent example of fast action in 2018-19 is the Global Leap Off-Grid Cold Chain Challenge, led by CLASP in collaboration with Energy 4 Impact. The competition aims to promote energy-efficient and cost-effective cold storage technology solutions for produce and dairy in sub-Saharan Africa. Ten companies received a technology innovation award in 2018 to move to the second stage of the challenge. CLASP's Efficiency for Access research and development fund has recently opened a GBP £1 million grant call for cooling solutions, and through the Global Leap Off-Grid Refrigeration Competition, is working to identify top performing off-grid refrigerators.

New innovations in cold storage for agriculture are also being tested in priority geographies. In Nigeria for example, the start-up firm ColdHubs is producing cold rooms that can be rented on a 'pay-as-you-store' basis and can extend shelf lives of perishable foods by up to 19 days, reducing post-harvest losses and increasing farmers' incomes.[xliv] Working with the Rockefeller Foundation, Technoserve is recruiting local entrepreneurs to manage community cooling tanks for milk produced locally. In one case in India, this system allowed a dairy producer to earn an extra USD 700 per month that was used to make improvements and fund his children's education.[xlv]

While cases such as these demonstrate the social impact of enhanced cold chain, most models are publicly subsidized, and further research to support investment in integrated cold chains is necessary to understand the value proposition for large scale investment. A report authored by the Shakti Sustainable Energy Foundation and the University of Birmingham on clean and efficient cold chains in India offers a step forward by showing business model solutions to deliver cold chain connectivity in an environmentally sustainable way.[xlvi] Companies that deliver goods to developed world markets are already harnessing these ideas and technologies, but connecting them to the estimated 470 million smallholder farmers and 290 million people whose livelihoods depend on the agricultural value chain remains a challenge on a commercial scale.[xvii]

BRINGING INDUSTRY TO THE FORE

The engagement of manufacturers, entrepreneurs, and financiers is critical to delivering affordable and sustainable access to cooling at the base of the pyramid. A particularly well-noted challenge was the need to increase the efficiency of air-conditioning devices in critical markets with a minimal impact on cost. In late 2018, to address this issue, and with the Indian market front in mind, the Rocky Mountain Institute (RMI) launched the Global Cooling Prize with support from the government of India and Mission Innovation. The prize will provide USD 3 million to incentivize a residential cooling solution that has a climate impact at least five times lower than existing technologies, at no more than two times the cost of those current solutions at full build out. According to RMI analysis, such a technology could prevent up to 100 gigatons (GT) of CO_2 emissions by 2050, de-

FIGURE 4: THE NEED FOR A 5X MORE EFFICIENT AIR CONDITIONER

Electricity consumption from room air conditioner operation in 2050

Source: *Rocky Mountain Institute*

pending on grid transitions to cleaner energy and the pace of scale for the new technology.[xlviii] As of August 30, 2019, the prize had attracted a significant level of interest from industry, including from some of the world's largest air conditioner manufacturers, with over 2000 registrations and 445 intent to apply forms from 56 countries.

In China, where many high-volume cooling manufacturing sites exist, the China Refrigeration and Air Conditioning Association (CRAA) has embraced the issue of cooling access with its Secretary General Zhang Zhaohui stating that, "creating clean cooling and heating is our top priority and in line with our future strategy."[l] GREE, a leading national manufacturer of refrigerators and air conditioners, also announced its support for UN Environment's global United for Efficiency (U4E) program, and its development of a model regulation for room air conditioners and refrigerators in emerging markets.[li]

There are also clear examples of PPPs that have drawn on private sector expertise to deliver solutions to vulnerable groups. Under the Partnerships for Growth (P4G) initiative, the World Wildlife Fund for Nature and M-PAYG, a Danish company providing prepaid solar systems in the developing world, are using a mobile pay-as-you-go business model to provide small-scale fisher men and women with off-grid solar cooling solutions in Kenya. The project aims to overcome issues associated with unbanked and off-grid fishers, and, if successful, the business model can be scaled to other coastal areas of East Africa.[lii]

Leveraging its structure as a knowledge-oriented PPP, the National Centre for Cold Chain Development (NCCD) in India has partnered with the private sector to provide training to both private and public sector officers on cold chain technologies. One such partnership is with Danfoss India to support a three-day residential course where trainees are exposed to cold chain systems at their learning center. It includes theory, hands-on mini demonstration units, and supply chain management systems. The NCCD covers the training and residential

expenses of the participants and Danfoss provides the infrastructure. This course, an example of PPP in knowledge sharing, was initiated in 2014 and more than 150 government officials and about 50 private sector officers have benefited from it.[liii]

While progress on bringing industry to the fore has been made in 2019, challenges remain. Despite the potential of the approach, particularly among PPPs with the potential for scale, there are few initiatives that have been co-created with industry and that target vulnerable populations. Solutions are possible however, as demonstrated by P4G, the NCCD and Danfoss initiatives. While there is significant interest, in particular for the agricultural cold chain, a lack of data about markets and customers at the base of the pyramid remains a barrier to entry.

CAPACITY BUILDING AND SKILLS DEVELOPMENT

Given the growth in cooling demand and the need to scale up solutions to protect populations at the base of the pyramid, there is an urgent need to include capacity building and skills development in programs and plans that address these issues. India's Cooling Action Plan, for example, includes a goal of training and certifying 100,000 service sector technicians by 2022-23 and recognizes the need to bring those already trained into the formal sector.[liv]

In the period 2018 to 2019, UN Environment's Ozone-Action and U4E conducted six regional twinning events, which brought Montreal Protocol compliance officers together with energy experts to facilitate the realization of energy efficiency gains that can be

CASE STUDY: TAMIL NADU REGION BANANA FESTIVAL

Every third banana on the planet is produced in India. A third of India's production, 9 million tons, is produced within the state of Tamil Nadu. But, over the years, farmers of Tamil Nadu witnessed a post-harvest loss of 30 percent; bananas were being wasted in a country in urgent need of food for 300 million people.

A task force initiated by the Confederation of Indian Industry (CII), a PPP of industry, government, and civil society, identified three major blocks to reducing harvest loss of bananas, the largest produce stock lost in the Tamil Nadu region: a lack of good agricultural practices at the pre-harvest stage, good post-harvest management and failure to connect with the market. It also found that pre-cooling the newly harvested bananas would extend their shelf life and quality and that the use of ripening chambers would lead to better efficiencies and better control.

Through changes in harvest techniques and pre-cooling, the income of participating banana farmers has doubled and even tripled, while banana wastage has been reduced by almost 20 percent. In 2018, the first Indian bananas were exported to Europe by ship, marking a new era for the farmer that employed ten people ten years ago on whose farm more than 200 families are now dependent.

The solution shows the impact of cold chains for food wastage, the income of rural farmers, and local employment. The model is being evaluated in India as a best practice and could be replicated in Kenya for the mango market and in Indonesian fisheries, among others.

Source: Danfoss Cooling

made in national cooling plans while implementing the Kigali Amendment. Funded by K-CEP, these regional workshops trained 240 officials from nearly 150 countries.[lv] Key messages from participants included the need to make energy efficiency a strong component of future HFC phasedown projects.[lvi] Similarly, the International Energy Agency (IEA) has begun integrating cooling considerations, including access to cooling issues, into the energy efficiency training weeks offered to professionals in the governments of developing countries. Many officials participating in training workshops have requested guidance on setting MEPS and labels for air conditioners and refrigerators in a manner that addresses both energy efficiency and refrigerant transition.

GIZ Proklima also has an established training program as a part of its green cooling initiative. The initiative aims to accelerate the transformation of the cooling sector towards sustainable and energy efficient technologies through the promotion of natural refrigerants and energy efficiency, the creation

of training and certification schemes and through the encouragement of public and private climate finance for leverage. Training programs typically target refrigeration and air conditioner (RAC) technicians, political decision makers and National Ozone Unit (NOU) representatives.

While valuable, these programs have, for the most part, been driven by public and international agencies, largely for the benefit of public servants. Programs need to be diversified, and, given the projected growth of the sector, the private sector must be engaged in the development and delivery of training modules, particularly in priority markets.

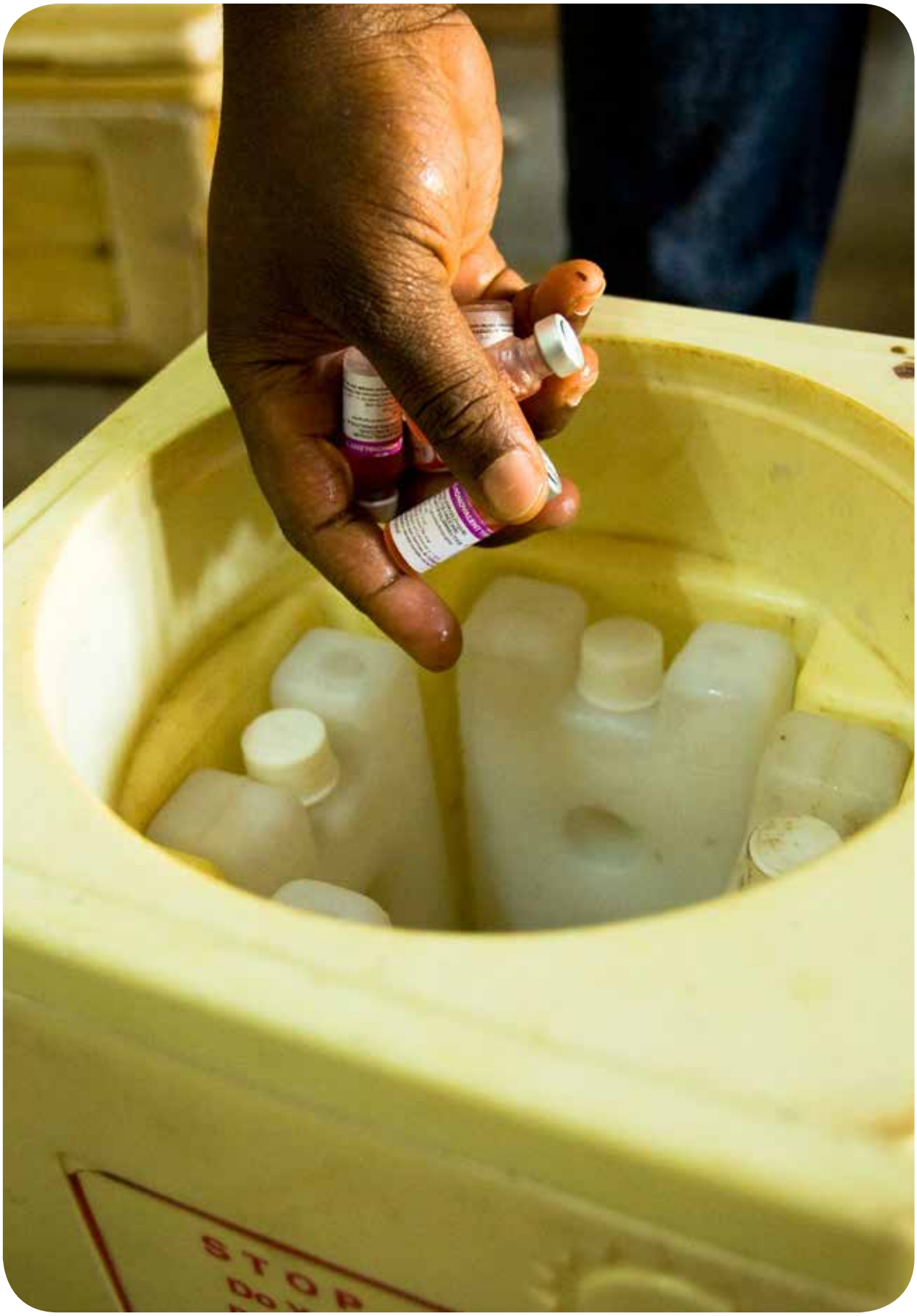
CREATING AWARENESS

Ultimately, one of the primary achievements of the period 2018 to 2019 has been the recognition of access to cooling as an urgent economic development and human security issue propelled by the impacts of climate change. In response, in 2019, SEforALL established the Cooling for All Secretariat as a coordinating platform to enhance focused responses and to work with industry, philanthropy, implementing CSOs, and development partners to develop and test new solutions in priority geographies. With an emerging leadership among national governments and new initiatives from civil society that are intended to demonstrate solutions, there is a growing community dedicated to solutions to protect the most vulnerable from the consequences of dangerous heat and broken cold chains.

This growing momentum is demonstrated in the development focus of the 'Cool Coalition', a global effort led by UN Environment, the Climate and Clean Air Coalition, K-CEP and SEforALL to inspire ambition and accelerate action on the transition to clean and efficient cooling. The World Bank Group has committed to the development of a long-term strategy on sustainable cooling, as well as the Efficient, Clean Cooling Program within the Energy Sector Management Assistance Program (ESMAP) to develop necessary market infrastructure, financing mechanisms, policies, and regulations that support sustainable cooling, including cold chain. [lvii] The catalyst for many of the ongoing initiatives, including the ESMAP program and the Cool Coalition, has been K-CEP. By 2019, KCEP had allocated USD 48 million to projects in 44 countries, including technical assistance to 27 of those countries, for the inclusion of clean and efficient cooling in national cooling plans (or equivalent). Beyond funding provided by KCEP, it is important that host institutions sustain and scale up these efforts, launch new initiatives independently, and formalize coordination mechanisms to prevent the duplication of efforts.

THE COOL COALITION

Announced at the 2019 U.N. Climate Action Summit, the Cool Coalition is a global, multi-stakeholder network that connects 80 partners from government, the private sector, cities, international organizations, finance, academia and civil society to achieve a rapid transition to efficient and climate-friendly cooling. Partners will focus on turning commitments into action that leaves no one behind, including development of 26 national cooling plans, scaling up finance, installing cool roofs and driving technology pilots.


STOP

3. TRENDS IN COOLING ACCESS

As heat waves captured public attention in 2018 and 2019, access to cooling came into sharper focus. From Montreal, Canada to Karachi, Pakistan, those who suffered from the potentially deadly impacts from heat waves were largely the poor and the most vulnerable. Moreover, there is growing evidence that people living in poor countries with hot climates are those most negatively affected by their limited ability to build resilience against the intensifying impacts of climate change.[lviii] These trends reinforce the fact that access to cooling is not a luxury. It is an issue of equity that underpins the ability of millions of people to lead safe, healthy, and productive lives.

In *Chilling Prospects: Providing Sustainable Cooling for All*, an initial effort was made to quantify cooling access gaps, as our collective ability to track progress and refine methodologies is crucial to awareness building and planning. Among the issues identified were the data gaps pertaining to unmet cooling needs, and limited overlap in populations pertaining to different types of cooling needs across issues of human safety and comfort, food and nutrition security and agriculture, and health services. Across these types of needs and risks associated with unmet needs, access to sustainable cooling is considered across a spectrum, measured with national-level data points related to income, access to electricity, access to refrigeration, dwelling quality, and exposure levels of temperature-sensitive agricultural and medical products in cold chains.

Data limitations which hinder measurement of cooling access gaps and degrees of unmet human needs for cooling persist. In addition to data on the full spectrum of cooling access needs, critical disaggregated data on issues that increase vulnerability, such as socioeconomic status, gender, health, and education levels are needed for a complete understanding of risk. Moreover, individual tolerance to heat will vary based on factors other than temperature, including humidity, wind, activities, and clothing. What is tolerable in one location could cause heat stress in another. In urban areas, data on public cooling resources and the ability to both afford and run a fan during the hottest hours of the day, when power is most unreliable, are key to understanding risk and need. In rural areas, there is a critical data gap on the reliability of medical and agricultural cold chains, in addition to the issues of availability and affordability of off-grid systems capable of supporting fans, refrigerators and air conditioners. Both urban and rural settings, however, highlight the close relationship between access to cooling and access to reliable and affordable energy. The ability to run a fan, for example, in either an urban or a rural setting, requires a minimum of Tier 2 electricity access, as defined by the Multi-Tier Framework (MTF), while the ability to run an air conditioner or refrigerator reliably likely requires access between Tier 3 and Tier 5, depending on the efficiency of the device and income levels.[lix] A lack of access to electricity, particularly in rural settings, is therefore an important indicator of high risk of a lack of access to cooling, while enhanced access to cooling and reduced risk, in terms of the energy necessary to run certain cooling appliances, can be understood in part through the MTF framework. Such possible refinements, based on data where it is available, are included below.

Available data, including temperature, electricity access, vaccination rates, dwelling quality, food loss, and income, support an ongoing global quantification of cooling access gaps for **those who are at highest risk of a lack of access to cooling.** For

example, a lack of access to energy for rural populations living in a country projected to at least partially have mean monthly temperatures above 30°C between 2020 and 2039 is indicative of highest risk, which lowers as quality of energy access increases. While challenges in measuring enhanced access to sustainable cooling across a spectrum persist and point to a need to refine the model, the segmentation of risk groups, or potential markets, in terms of the rural poor, the urban poor, and the lower-middle income, and tracking them annually, remains crucial to building awareness and understanding the magnitude of the challenge and the actions that we need to take.

FIGURE 5: SPECTRUM OF RISKS IN HIGH TEMPERATURE ENVIRONMENTS

HIGH RISK

- No access to electricity
- Income below poverty line
- Poor ventilation and construction
- No access to refrigeration for food
- Farmers lack access to controlled cold chains
- Vaccines exposed to high temperatures

MEDIUM RISK

- Access to electricity
- Lower income levels
- Ability to run a fan, buildings constructed to older standards
- Food is refrigerated
- Farmers have access to intermittently reliable cold chains
- Vaccines may have exposure to occasional high temperatures

LOW RISK

- Full and stable access to electricity
- Middle income and higher
- Well built home, can include insulation, passive design, air conditioning
- Food is refrigerated reliably
- Farmers goods and vaccines have well controlled cold chains

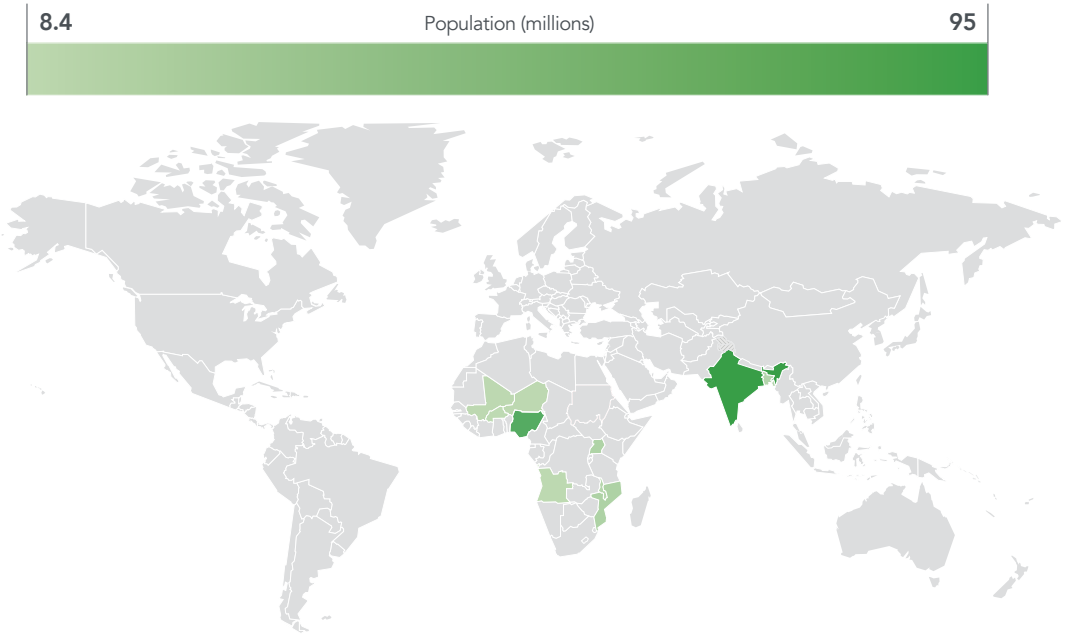
TABLE 1: RELATIONSHIP BETWEEN THE MULTI-TIER FRAMEWORK AND COOLING APPLIANCES

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Tier Criteria			Task lighting and phone charging	General lighting and phone charging, television, and fan (if needed)	Tier 2 and any medium-power appliances	Tier 3 and any high-power appliances	Tier 4 and very high-power appliances
Peak Capacity	Power capacity ratings (in W or daily wh)		Min 3 W	Min 50 W	Min 200 W	Min 800 W	Min 2 kW
			Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
	Or services		Lighting of 100 lmhr/day	Electrical lighting, air circulation, television and phone charging are possible			
Availability	Hours per day		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
	Hours per evening		Min 1 hr	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs
Cooling Appliances/ Systems Supported				Fan		Refrigerator and freezer	Air conditioner

THE RURAL POOR – APPROXIMATELY 365 MILLION PEOPLE

The Rural Poor lack access to electricity and are likely to live in extreme poverty. Many of them are likely to engage in subsistence farming and lack access to an intact cold chain enabling them to sell their products further afield at a higher price. Medical cold chains may also not be intact, putting lives at risk from spoiled vaccines.

FIGURE 6: RURAL POOR IN 2019



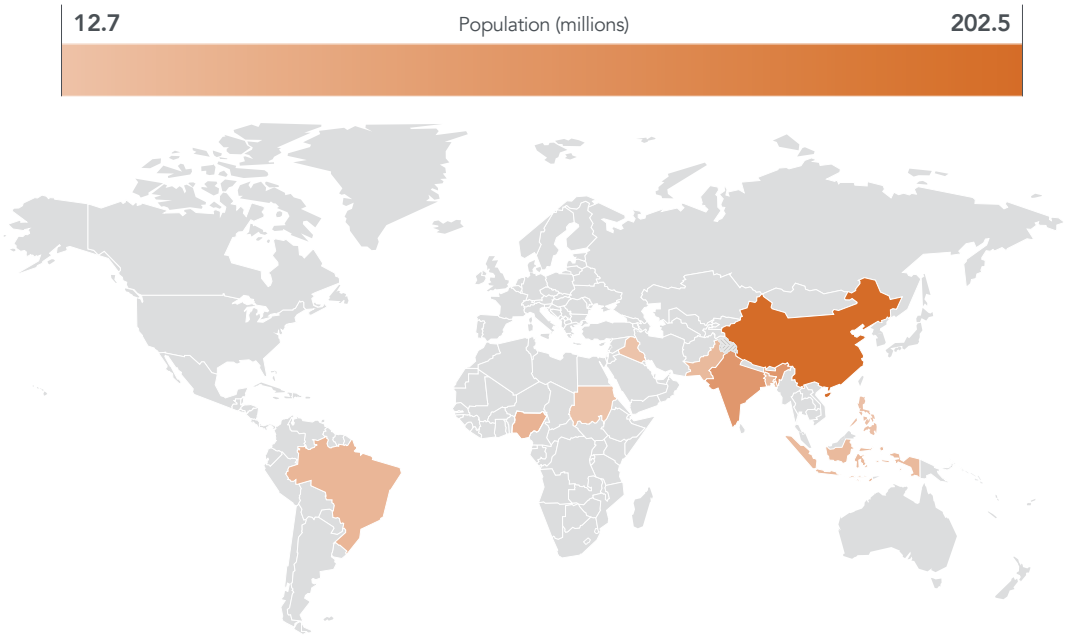
TOP 10 2019

01. India
02. Nigeria
03. Bangladesh
04. Mozambique
05. Uganda
06. Malawi
07. Niger
08. Mali
09. Angola
10. Burkina Faso

URBAN POOR – APPROXIMATELY 680 MILLION PEOPLE

The urban poor may have some access to electricity, but housing quality is likely very poor and income may not be sufficient to purchase or run a fan. They may own or have access to a refrigerator, but intermittent electricity supplies may mean that food often spoils and there is a high risk of food poisoning.

FIGURE 7: URBAN POOR IN 2019



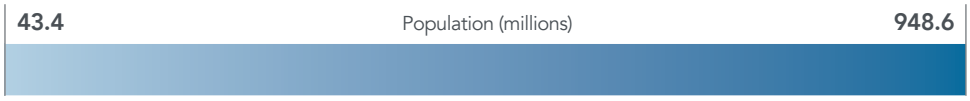
TOP 10 2019

01. China
02. India
03. Nigeria
04. Brazil
05. Pakistan
06. Bangladesh
07. Indonesia
08. Philippines
09. Sudan
10. Iraq

LOWER-MIDDLE INCOME – APPROXIMATELY 2.2 BILLION PEOPLE

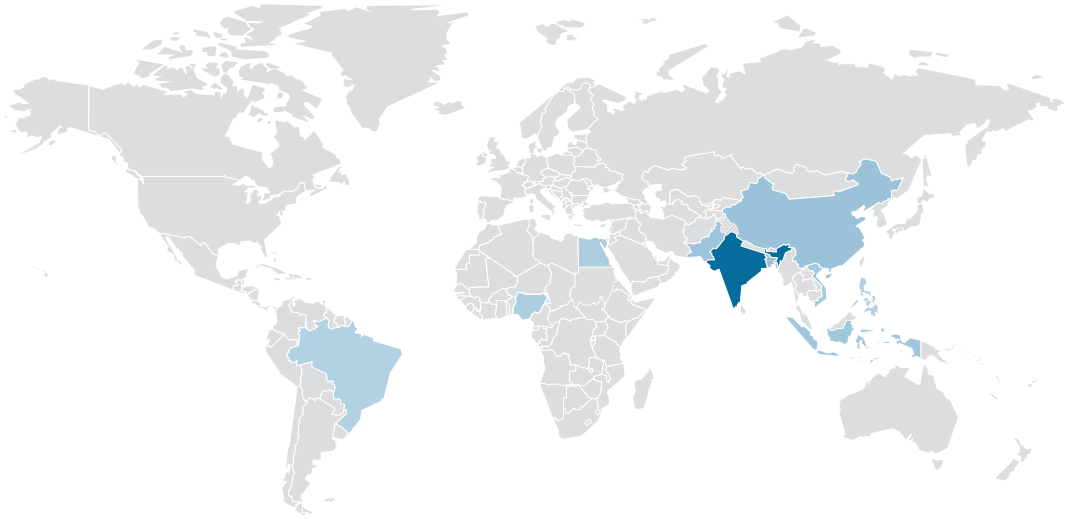
The lower-middle income group represents an increasingly affluent lower-middle class that is on the brink of purchasing the most affordable air conditioner or refrigerator on the market. Limited purchasing choices available to this group favor cooling devices that are likely inefficient and could cause a dramatic increase in energy consumption and associated GHG emissions.

FIGURE 8: THE LOWER-MIDDLE INCOME IN 2019



TOP 10 2019

01. India
02. China
03. Pakistan
04. Indonesia
05. Bangladesh
06. Egypt
07. Nigeria
08. Vietnam
09. Philippines
10. Brazil



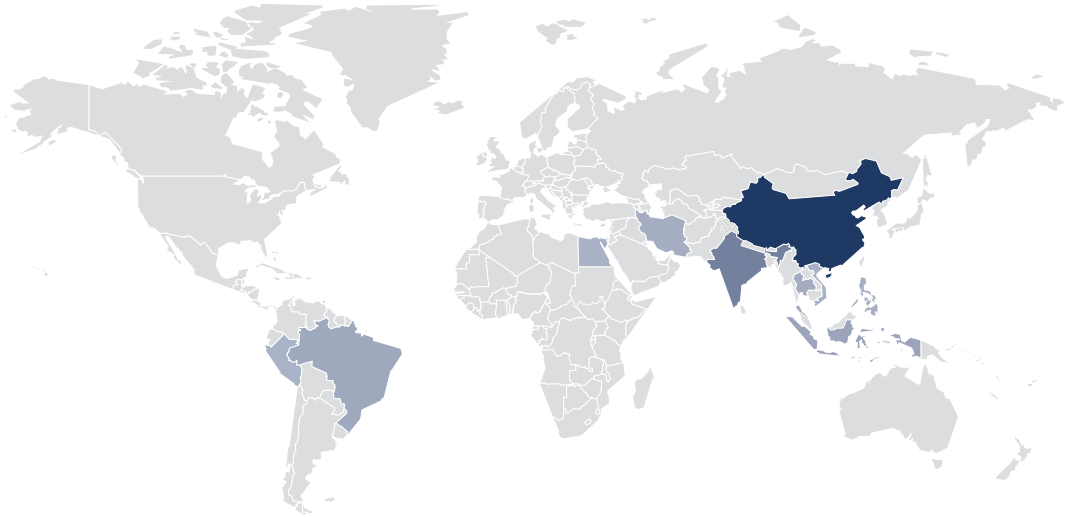
MIDDLE INCOME – APPROXIMATELY 950 MILLION PEOPLE

The middle income are people who have owned an air conditioner and may be able to afford a more efficient one. They might make conscious choices not to own an AC unit or minimize its use. They may represent the established middle class where affordability may also allow them to move to better designed, more efficient housing and working environments.

FIGURE 9: THE MIDDLE INCOME IN 2019

TOP 10 2019

01. China
02. India
03. Indonesia
04. Brazil
05. Thailand
06. Iran
07. Philippines
08. Egypt
09. Vietnam
10. Peru



COOLING ACCESS ISSUES FACED BY THE RURAL POOR

For rural people living in poverty, a lack of access to cooling threatens the ability of professionals, including doctors, to perform vital services, and of children to learn in classrooms.

In 2017, it was estimated that more than 90 million children in Sub-Saharan Africa attend a primary school that lacked electricity, a figure indicative of limited cooling access.[lx]

In its annual update on immunization coverage, WHO reported that global vaccination rates remain at a stubborn 86 percent, with no significant change over the last few years.[lxi] In 2018, 19.4 million infants, many of them in priority countries for cooling access: India, Indonesia, Nigeria, and Pakistan, were not reached with essential routine immunizations, including the temperature sensitive DPT vaccine.

FINDINGS AND TRENDS: 2018 TO 2019

The analysis shows that across the 52 high-impact countries 1.05 billion people among the rural and urban poor people remain at high risk from a lack of access to cooling. A further 2.2 billion lower-middle income people pose a different kind of risk: they will soon be able to purchase the most affordable air conditioner or refrigerator, but price sensitivity and limited purchasing options mean they favor devices that are likely to be inefficient, threatening energy systems and resulting in increased GHG emissions.

Compared to 2018, the analysis shows a decrease of approximately 50 to 55 million people who are at highest risk of a lack of access to cooling, from 1.1 billion to 1.05 billion. The number of urban poor at highest risk grows by approximately 50 million from 630 to 680 million, while rural population decreases by approximately 105 million from 470 million to 365 million. The lower-middle income population has seen a reduction from 2.3 billion in 2018 to 2.2 billion in 2019. Across the 52 high-impact countries, at least 3.2 billion people face cooling access challenges in 2019.

Driving the change for rural people living in poverty is a significant increase in rural energy access, notably in India, Bangladesh and Indonesia, as well as continued urbanization trends in Africa and Asia. While energy access lowers risk exposure, it does not necessarily imply enhanced access to cooling, given the need for Tier 2 energy access to operate simple fans and the fact that poor people in rural areas face risks on multiple fronts. Significant concentrations of rural people at highest risk remain in Sub-Saharan Africa, particularly in Mozambique, Nigeria and Uganda.

In cities, the growth in the number of urban dwellers at highest risk between 2018 and 2019 is consistent with population growth and urbanization rates in the developing world, which have, in some instances, quadrupled during the last 50 years.[lxii] While the urban poor may have some access to electricity, unstable connections threaten food spoilage and the ability to run a fan during periods of extreme heat. Poor housing quality, exposure to the UHIE, and a relative lack of shading and vegetation contribute significantly as well. The urban poor are also likely to lack access to financing tools which would enable them to invest in a fan or fridge.

The lower-middle income population has seen a decline between 2018 and 2019, from 2.3 to 2.2 billion. Estimated as the segment of the population outside of rural and urban poverty, but living on less than USD 10.01 per day, the reduction is indicative of a growing

global middle class and lower prices for entry-level AC and refrigeration units. In Indonesia, which has seen a significant reduction in its lower-middle income population, the World Bank estimates that about 20 percent of the population are middle class and a further 45 percent of Indonesians are considered no longer vulnerable to poverty. Household consumption in Indonesia rose by 5.1 percent in 2018.[lxiii]

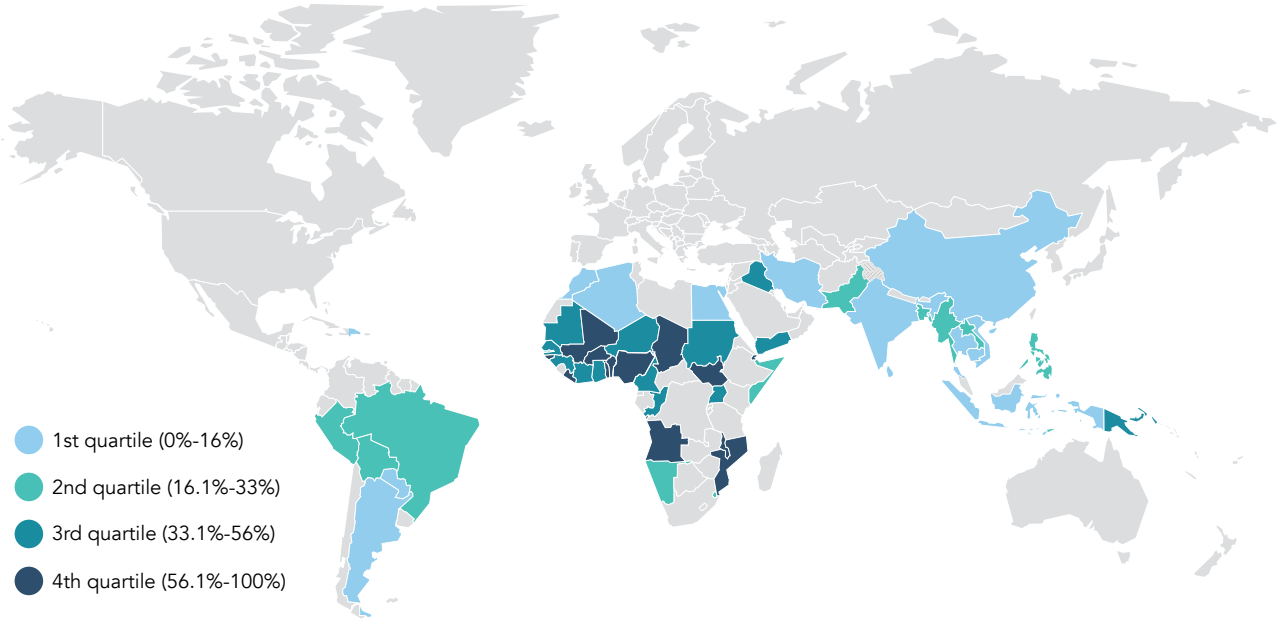
It is important to note that changes in numbers do not necessarily imply a transition from one segment of the population at risk to another. Given that the efficiency of cooling devices currently being purchased is significantly less than what is possible, it cannot be assumed that fewer people in the lower-middle income group automatically translates to an increase in the number of people in the middle income group.[lxiv]

The analysis also allows for geographic comparison, and for an understanding of where those at highest risk are concentrated. In Africa, the rates of growth for those at high risk, the rural poor and the urban poor, have increased beyond the rate of population growth (5.7 percent), with increases of 28.7 percent and 19.1 percent respectively. **More worrying is the concentration of countries in Africa that exhibit high concentrations of populations at risk. Of the African countries identified as high impact, 12 have over 60 percent of their populations at highest risk – Angola, Benin, Burkina Faso, Djibouti, Guinea-Bissau, Liberia, Malawi, Mali, Mozambique, Nigeria, South Sudan, and Togo.** Overall, of the high impact countries in Africa, 47 percent of their total populations is categorized as highest risk, up from 40 percent in 2018.

TABLE 2: CHANGES IN VULNERABILITY BETWEEN 2018-2019

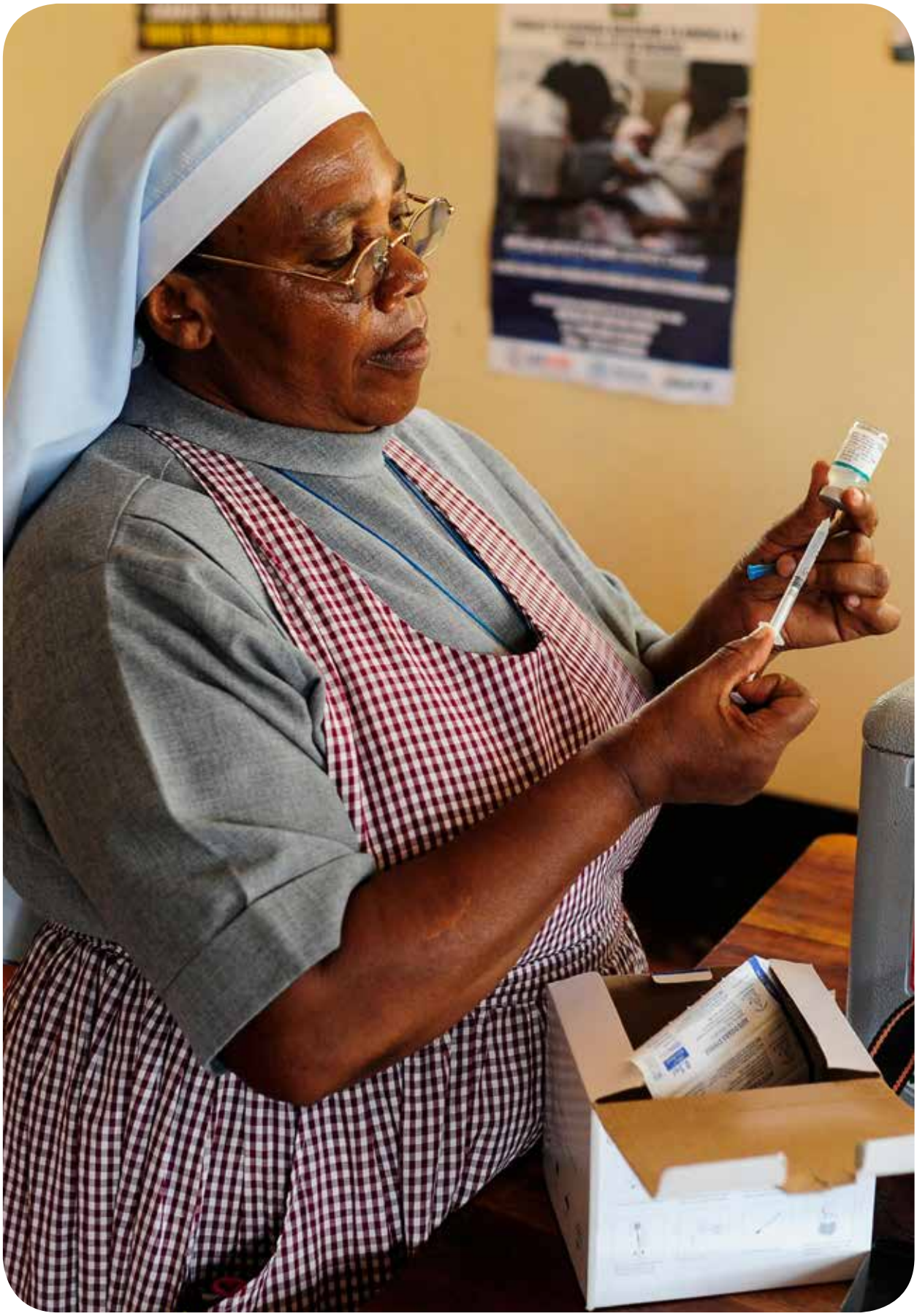
POPULATIONS AT RISK	HIGH RISK		MIDDLE RISK	LOW RISK
	RURAL POOR	URBAN POOR	LOWER-MIDDLE INCOME	MIDDLE INCOME
RISK INDICATORS	• Lack of access to energy • Proportion of rural population living in poverty	• Lack of access to energy • Proportion of population living in urban slums	• Proportion of population living on less than USD 10.01 / day outside of rural or urban poverty	• Proportion of population living between USD 10.01 and 20.01 / day
2018 ACCESS GAP	470 million	630 million	2.3 billion	1.1 billion
2019 ACCESS GAP	365 million	680 million	2.2 billion	950 million
CHANGE	-105 million	+50 million	-100 million	-150 million
FINDINGS AND TRENDS	• Significant increase in rural energy access, notably in India • Continued urbanization trends in Africa and Asia	• Continued urbanization and fast-growing cities in Africa and Asia	• Purchase of cooling devices associated with income growth, notably in Indonesia • Lower prices for entry-level AC and refrigeration units	• Increased purchasing power and growth of an established middle class
NOTE	• 1.05 billion remain at highest risk, compared to 1.1 billion in 2018. • While energy access lowers risk exposure, it does not necessarily imply enhanced access to cooling, given the need for Tier 2 energy access to operate simple fans. • Changes in volume do not necessarily imply a transition from one population at risk to another.			

FIGURE 10: SHARE OF POPULATION AT HIGH RISK (RURAL AND URBAN POOR COMBINED)



Note: Each quartile includes one fourth of the countries. The % represents the range of the share of population at high risk for each quartile.

The situation remains critical in Asia, with approximately 615 million people at highest risk. The region saw a slight decrease in its populations at highest risk, from about 20 percent (19.4 percent) in 2018 to 16 percent in 2019, driven by electricity access gains in India, but this figure does not take into consideration electricity reliability.



4. THE COOLING FOR ALL NEEDS ASSESSMENT

The previous chapter provided an assessment of cooling access gaps, and the progress and challenges identified over 2018 and 2019, highlighting the need for refinement of the model used to measure those gaps and significant ongoing data challenges. This section will detail data points to supplement those measurements and provide a new tool to adequately measure economy-wide cooling needs, such that aggregated policy, finance and technological solutions can be implemented to deliver sustainable cooling for all.

CHALLENGES IN MEASURING DEMAND FOR COOLING FOR ALL

Defining cooling access gaps at a global scale is critical to understanding progress and building momentum to provide sustainable cooling for all. From data available at a global level, those who are at the highest risk of a lack of access to cooling at the base of the pyramid can be derived first based on heat exposure, and then from indicators that include electricity access, urban slum populations, and income. But these indicators have limitations, notably with respect to dwelling quality, relative poverty, access to cold chains, and reliability of electricity supply, and likely underestimate the size of the need. To date, projections and discussion of possible solutions have also tended to focus on equipment sales projections as well as GDP and population growth, without considering the full diversity of cooling needs that are necessary to provide access to sustainable cooling for all.

The implications this demand has for energy systems, new build generation requirements, climate change, clean air, economic diversification and growth, health and wellbeing, and workforce development are therefore poorly understood. **An underestimation of the scale of the cooling demand, and its impact on energy demand risks may contribute to a lack of ambition in policy, infrastructure and technology development, and could ultimately have far-reaching social, economic and environmental consequences.** By contrast, accurate measurement and planning can help enable new economic and social opportunities, including a better sense of market opportunities within a clean energy transition that may not have been evident or possible before.

A NEEDS-DRIVEN DEMAND MEASUREMENT

In response to this, the Cooling for All Secretariat at SEforALL and Heriot Watt University have partnered to create the Cooling for All Needs Assessment, a tool recommended for governments, development institutions, and NGOs to measure the full spectrum of cooling needs and aggregate policy, technology, and finance measures to address them.

The needs assessment works as a tool to overcome data limitations at a local or country-level, understand the dimensions of risk, and develop solutions that are targeted at vulnerable groups and meet their cooling needs. It is based on the principle that **in order for a country, city or community to ensure that the cooling needs of their population are met, they must first understand what those needs are. Through assessment across human comfort and safety needs, health service needs, and food and nutrition security and agricultural needs, demand can be understood systemically and measured fully. A roadmap to delivering access to sustainable cooling for all can then be developed.** Such assessment is crucial to the planning and investment required to minimize demand, aggregate services, and harness

LIMITATIONS OF EQUIPMENT-BASED PROJECTIONS FOR BASE OF THE PYRAMID POPULATIONS

Equipment based projections of cooling demand are an essential element of producing meaningful emissions and energy consumption data and have generally been used in all cooling demand projections. However, in terms of protecting vulnerable populations, they suffer from three significant weaknesses:

i) **Poor quality data** – data in relation to unit stocks in each of the cooling categories are somewhat unreliable as verified sales, disposal figures, and second-hand transfers of equipment are not universally available. As a result, the equipment stock is genuinely difficult to estimate and projections can be uncertain.

ii) **Failing to capture needs** – equipment-based projections do not start from a position of understanding community needs, and how cooling demand and solutions will be shaped by these needs.

iii) **Pre-supposing a solution** – a focus on per capita equipment penetration rates risks pre-supposing a solution to specific cooling needs and could ignore additional opportunities of electricity demand mitigation by redesign of systems, demand aggregation, modal shifts, and use of waste or currently untapped resources.

new and renewable technologies, whether through a national cooling plan or an equivalent set of measures. It is also necessary to deliver on the SDGs, the Paris Agreement, and the Kigali Amendment. Without such an assessment, planning processes are likely to underestimate the full scope of demand and be inadequate in the long term.

For rural poor, urban poor, and lower-middle income[8], increased access to cooling exists across a spectrum that includes three general areas of need: human safety and comfort; food and nutrition security and agriculture; and health services. These needs anchor the framework of analysis to measure present and future community, regional, and national access to cooling requirements. Each has a series of guiding questions that inform next steps for demand measurement.

Human comfort and safety: for living, learning, working, and mobility

- To what extent does the population have access to the space and mobility cooling that is adequate to maintain safety and productivity, at home, in places of education and in the work environment and while moving between each?

Food and nutrition security and agriculture: for nutrition, rural incomes, and connectivity

- To what extent does the population have access to the food they need to maintain a healthy (and socially acceptable) diet?

- Is income from agriculture and fisheries sufficient to keep workers out of absolute and relative poverty?

[8] The Middle-Income are considered to be outside of direct exposure to lack of cooling access risks and are not included in the framework.

Health services: for safe medical clinics and hospitals and the secure transport and storage of vaccines and medical products

- Are national vaccine programs reaching their target population?
- Is there sufficient unbroken cold chain to ensure provision of medicines and healthcare products?
- Are health infrastructure buildings equipped with the cooling they need to deliver adequate and reliable health services at affordable costs?

The indicators identified in Table 7 represent a starting point to collect the relevant information to address access to cooling gaps. **The needs assessment tool, accompanying methodology, and guidance on how to include the needs assessment in a national cooling plan are freely available to interested parties through the Cooling for All Secretariat,** which is hosted by SEforALL and serves as a platform to connect governments, development institutions, and NGOs to resources that enable its use in programs or interventions that enhance access to sustainable cooling for all.

CONSIDERATIONS FOR POLICYMAKERS

The value in a needs assessment lies in defining the scale of the access to cooling challenge. Utilizing the needs assessment, through a national cooling plan or an equivalent planning mechanism, will allow countries and communities to apply aggregated policy and technology options to vulnerable communities and allow for the development of time-bound targets for reducing vulnerability. There are a number of issues to consider.

Establishing a baseline: The needs assessment serves as a basis to establish a critical baseline for access to sustainable cooling, through which to set targets and measure progress. By establishing a baseline, it also becomes possible to derive the consequences of meeting these needs with current technologies, energy resources and infrastructure tools, and determine the associated environmental impacts.

Outcome-based decisions: Planning decisions made on the basis of the needs assessment must be outcome-based as far as possible, taking national, regional and community circumstances into account. The data serve as a basis to understand how to aggregate policy, finance, and technology choices towards desired outcomes, and allow for system-level and service aggregation approaches to be considered to deliver both energy and economic efficiencies.

Implications of cooling demand for energy services and climate change: Needs-driven assessments must consider the implications of increasingly hotter temperatures, the climate implications of cooling demand driving peak loads, and ways of meeting those capacity requirements with sustainable energy. Understanding available energy resources enables optimum and needs-based choices for energy systems that encompass demand mitigation and adaptation measures, harnessing traditional cooling methods, and renewable energy. We also need to understand the additional stress that growth in universal access to cooling will place on energy systems in the context of the broader fundamental structural changes to these systems driven by targets to mitigate emissions and adapt to climate change.

Industrial cooling and transport: While not included in the needs assessment for vulnerable populations, industrial cooling, as well as personal transportation methods, are also critical factors to consider in assessing cooling needs.

TABLE 3: A NEEDS-BASED TEMPLATE FOR COOLING DEMAND AT THE BASE OF THE PYRAMID

ACCESS TO COOLING NEED	Human comfort and safety: for living, learning, working, and mobility	Food, nutrition security and agriculture: for nutrition, rural incomes, and connectivity	
GUIDING QUESTIONS	 To what extent does the population have access to the space and mobility cooling that is adequate to maintain safety and productivity, at home, in places of education and in the work environment and while moving between each?	 Is income from agriculture and fisheries sufficient to keep workers out of absolute and relative poverty?	 To what extent does the population currently have access to an affordable, nutritious and safe diet?
INDICATORS	 **SDG 7.1.1** Access to reliable, sustainable energy supply **SDG 1.1.1** Population below the international poverty line **SDG 8.8.1** Proportion of the population potentially at risk of heat stress, including through UHIE Morbidity and mortality related to heat stress **SDG 11.7.1** Proportion of the urban population with access to public green spaces **SDG 11.5.2** Proportion losses attributable to heat stress-related disasters Proportion of learners taught in buildings where temperatures impede cognitive function and number of days per year Population working inside at risk of heat stress in the workplace Work days lost each year due to heat stress	 **SDG 1.1.1** Proportion of the population below the international poverty line **SDG 1.2.1** Proportion of the population living below the national poverty line **SDG 1.2.2** Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions **SDG 2.3.2** Average income of small-scale food producers **SDG 2.C.1** Extent of food price anomalies **SDGs 9.1.1 and 9.C.1** Connectivity to markets (local, short, medium and long distance) farmers currently have – in terms of information flow (farm-to-fork and fork-to-farm) and physical access. Price differential achieved for the same product at different markets	 **SDG 2.1.1** Prevalence of undernourishment **SDG 2.1.2** Prevalence of moderate or severe food insecurity **SDG 2.2.1** Prevalence of stunting among children <5 **SDG 2.2.2** Prevalence of malnutrition among children <5 Proportion of the population that achieves a healthy, nutritionally sufficient diet **SDG 2.3.1** Volume of production per labor unit by farming enterprise size **SDG 12.3.1** Volume and proportion of food loss and waste at each stage along the cold chain **SDG 7.1.1** Proportion of the population with access to reliable, sustainable energy supply Morbidity and mortality rates related to food poisoning Proportion of the population with access to refrigeration for domestic use

ACCESS TO COOLING NEED	Health services: for safe medical clinics and the secure transport and storage of vaccines and medical products		
GUIDING QUESTIONS	 Are national vaccine programs reaching their target population?	 Is there sufficient unbroken cold chain to ensure provision of medicines and healthcare products in everyday and natural disaster scenarios?	 Are health infrastructure buildings equipped with the cooling they need to deliver existing health services?
INDICATORS	**SDG 3.B.1** Proportion of the target population covered by all vaccines included in the national program **SDGs 3.3.2 and 3.3.4** Prevalence of vaccine preventable diseases Mortality from vaccine preventable diseases	Proportion (and total number) of vaccines, medicines and medical products lost each year due to cold chain failures and associated economic costs Number, volume, and geographic distribution of cold storage facilities for health **SDG 3.B.3** Proportion of health facilities with a core set of relevant essential medicines available and affordable on a sustainable basis Number and location of communities not served by cold storage facilities for health Community level of risk due to natural disasters based on the number of deaths, missing persons and affected persons attributed to disasters per 100,000 of the population	Number of health infrastructure buildings in the community, region, or country Current demand and utilization of cooling services for effective and safe use of equipment, or safe and comfortable air temperature control for patients Levels of morbidity and mortality associated with power loss at health facilities

5. A FOCUS ON FINANCE

The very limited funding for access to cooling, as noted in *Chilling Prospects: Providing Sustainable Cooling for All*, "is a key part of the challenge in developing solutions." Identifying investment flows going to the various cooling access needs remains difficult, a reflection of an absence of recognition for these issues until very recently. The diversity and complexity of cooling needs is a central part of the challenge in developing finance tools that reduce vulnerability. By understanding these needs however, we can begin to identify financing challenges, and aggregate the most appropriate options towards vulnerable groups.

Human comfort and safety: affordable, efficient cooling for the poor is the largest and, in many respects, most complicated financing challenge. For the many millions of families marginally able to afford a cooling device, the initial cost is a dominant consideration. Finding ways to make more efficient systems affordable to this segment of the population is a major challenge. Evolving solutions include consumer awareness and policy reforms as well as innovative approaches to consumer financing products that include options and provide incentives for more efficient cooling systems.

In cities, urban design and planning for heat extremes are key issues for both building and construction as well as for public spaces. Technical assistance from international organizations, including NGOs, has provided an important foundation for such efforts along with support for sharing learning and experience among city leaders. MDBs and philanthropies are also actively supporting policies to implement more effective building codes, green building and construction, cool roofs, and similar measures. The issue is urgent. By 2030, the number of urban residents is expected to grow to 40 percent in India, 55 percent in Southeast Asia, and to nearly half the population of Sub-Saharan Africa.[lxv] Preventing dangerous lock-in effects of unsustainable building expansion is vital in the short term and measures must include those that promote sustainable cooling.

Food and nutrition security and agriculture: supporting cold chains and cold storage that both enable healthier diets and improve agricultural incomes remains a complex challenge. These technologies are critical for development, but technical solutions are difficult to identify given that low agricultural incomes likely necessitate grants or highly concessional finance to initiate market development. In India, incentives that include subsidies, grants, and loans have resulted in a 50-fold increase in cold storage projects approved by the government.[lxvi] In developing these strategies however, a key concern is that producers see an equitable financial return. Local capacity building, pay-as-you go models, and Community Cooling Hubs are examples of ways to address these issues.

Health services: finance solutions generally encompass the cold chain that supports delivery of vaccines and temperature-sensitive medical products, and the functioning of health infrastructure to deliver medical care. By virtue of these being public goods, both products and services are, and will continue to be, areas where we need public and highly concessional finance to deliver enhanced access to sustainable cooling in high-impact countries. Financing of cold chain technology innovation and dissemination for those health care centers that are accessed by populations at the base of the pyramid as well as financing of technologies that provide reliable, uninterrupted power to health clinics that are currently not equipped to provide reliable health care service to the resident population will be critical. As discussed in the *Chilling Prospects: Providing Sustainable Cooling for All* report, new technologies for effective delivery of vac-

cines and medical supplies are the focus of a WHO program – a program largely dependent on public and philanthropic support.[lxvii]

Utilized in a national cooling plan or equivalent set of measures, a needs-based approach can inform finance by identifying what is achievable with private investment and blended finance and what is only achievable through public support. It can create a foundation for financing strategies that complements investment plans (where investment plans will indicate what the investment needs are, financing strategies will indicate what type of financing is needed). Incipient initiatives, such as the Global ESCO Network, have the potential of filling an important knowledge gap for standards and financing instruments that are being introduced in different parts of the world.

INNOVATIVE APPROACHES: PRIZES, COMMUNITY COOLING HUBS, AND COOLEASE RWANDA

Growing recognition of the importance of cooling generally, and access to cooling more specifically, has been a spur to several recent initiatives directly and indirectly related to financing.

The *Chilling Prospects: Providing Sustainable Cooling for All* report references the use of competitions to spur innovative technologies for small refrigerators and transport of vaccines. The Global Cooling Prize, led by the Rocky Mountain Institute, offers a prize of USD 3 million for a residential cooling system that is five times more efficient at no more than two times the cost, and, as discussed previously, has attracted significant support. Winners and finalists of the-grid refrigeration competition led by CLASP, will be eligible to participate in a results-based financing that will make available USD 2.5 million in procurement incentives.

In June 2019 experts in "clean cold" from the University of Birmingham announced a collaboration with the National Centre for Cold Chain Development and the Shakti Sustainable Energy Foundation in India to develop the concept of Community Cooling Hubs.[lxviii] Central to the approach is aggregating demand so as to enable serving a range of needs and larger populations more efficiently and affordably. The potential for this approach lies in reducing food waste, removing barriers farmers face to accessing higher value markets by providing cooling, and providing a community resource during extreme heat. Examples of such scenarios include using the hubs to support infants or the elderly, as a classroom for schools on the hottest days of the year, or to store vaccines and medicines safely for local health care services.

The Government of Rwanda also announced the 'Coolease' financial mechanism in June of 2019, a first-of-its kind program that aims to overcome the challenge of high initial costs of energy efficient air conditioners and refrigerators. A positive list dictates which technologies are eligible for the program, which operates on the principles of cooling as a service (CaaS) whereby the technology is effectively leased and the provider commits to maintenance (see text box).[lxix] While the approach is primarily aimed at enterprises, it has potential for scale across African markets and penetration into the individual consumer market. As of its launch, it had mobilized a reported USD 4 million in initial funding.[lxx]

The CaaS model involves a building owner paying for the cooling service for every metered unit of cooling instead of investing in the infrastructure that delivers the cooling. The technology provider owns the cooling system, maintains it, and covers all operational costs including electricity. The periodic payments made by the customer are fixed-cost-per-unit; as such the client does not bear any risk related to the performance of the cooling equipment and the technology provider has the incentive to install the equipment offering the lowest life cycle cost to make the service more cost-effective. A key component of Energy Performance Contracts is that payments are not based on savings, which avoids yearly negotiations around the achieved savings between the customer and the provider.

The provider can be recapitalized through sale-lease-back mechanisms or dedicated special purpose vehi-

COOLING AS A SERVICE

Cooling as a service (CaaS) is a pay-as-you-go model for cooling that enables customers to base their investment decision on life-cycle cost rather than on the purchase price of the equipment. Although it has been utilized in district cooling, providing CaaS to individual buildings and businesses is still a relatively nascent business model in low-income countries. It has also been more recently assessed to support new technology deployment, including through a partnership between K-CEP and the Basel Agency for Sustainable Energy (BASE) that supports CaaS as a disruptive business model capable of overcoming key market barriers to clean and efficient cooling, without upfront investment, integrating financial tools to recapitalize technology providers. CaaS was also selected by the Global Innovation Lab for Climate Finance as one of the most innovative, actionable, and scalable financial instruments of 2019.[lxxi]

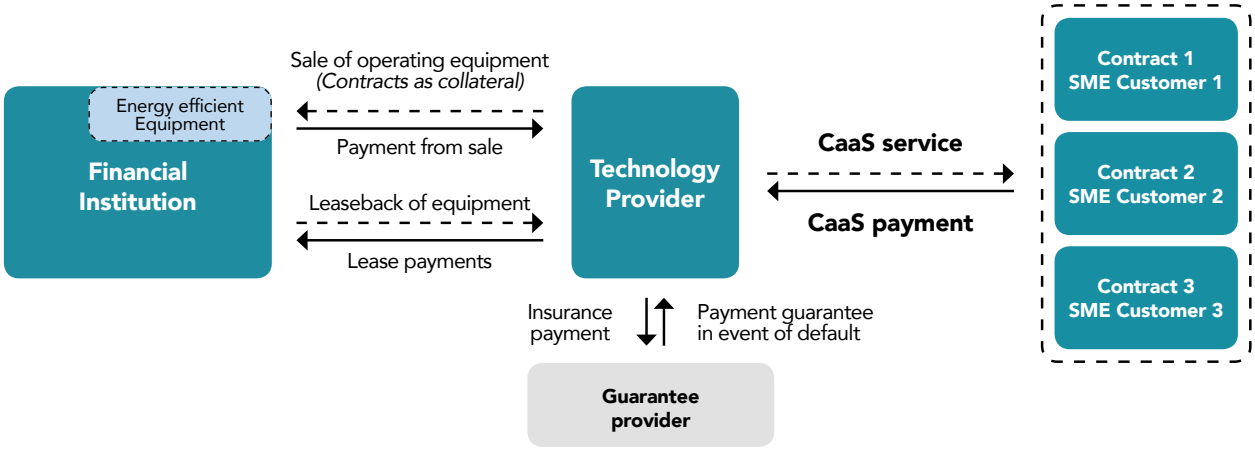
cle (SPV) structures. In the sale-leaseback mechanism, the technology provider sells the equipment to the bank and leases it back, with the CaaS contracts serving as an additional collateral. Payment guarantees reducing the default risk to which technology providers are exposed can then be provided by, for example, insurance companies or a development finance institution.[lxxiii]

INTERNATIONAL PROCESSES AND THEIR POTENTIAL FOR ACCESS TO COOLING FINANCE

The *Chilling Prospects: Providing Sustainable Cooling for All* report describes some of the challenges associated with obtaining funds for access to cooling from multilateral ozone and climate funds; to date funds have been very limited, with the exception of those for a few projects promoting more efficient appliances and more efficient buildings. There are some indications that show awareness of the importance of cooling issues within these funds may be increasing, particularly within the Montreal Protocol community. The Green Climate Fund, for example, proposed strategic priorities as background for replenishment negotiations in 2019 that include funding innovative technologies for energy efficiency, including refrigeration and cooling, and support to embed urban greening and resilience actions into national adaptation plans.[lxxiii] The GEF has adopted a Sustainable Cities Impact Program offering support for cities to pursue sustainable urban planning, energy efficiency in buildings, and utilization of green space and infrastructure.[lxxiv] The World Bank's Sustainable Cooling Program has also recognized the need to promote holistic approaches, including support for national cooling plans and city heat action plans, in addition to the opportunity to provide technical assistance.

Nationally Determined Contributions (NDCs) are the formal reporting requirement adopted as part of the 2015 Paris Agreement as the mechanism for countries to report their climate commitments and the agreement contains provisions designed to steadily increase the ambition of NDCs over time. While much of the focus has been on the level of

FIGURE 11: BASE AND K-CEP COOLING AS A SERVICE MODEL



Source: The Basel Agency for Sustainable Energy

GHG reduction promised in the NDCs, many also include adaptation elements as well as a focus on finance.[lxxv] While energy efficiency is referred to in most NDCs, most only include a broad intention to improve, and few include new policies, measures, or targets.[lxxvi] The high level and broad scope of such reports has also meant few NDCs have addressed issues related to access to cooling. One bilateral initiative of the German Environment Ministry, "Cool Contributions fighting climate change" is working with six countries to include climate friendly cooling in NDCs.[lxxvii] National Cooling Plans and commitments to undertake them are another promising mechanism through which to integrate cooling into the NDCs, with opportunity existing for sufficiently advanced plans to include these measures in 2020 NDC updates.

In 2010, the UNFCCC created the process of National Adaptation Plans (NAPs) with a primary focus on least developed countries, but open to other developing countries as well, with the intent to identify priority adaptation needs, projects, and programs. As of November 2018, only 11 developing countries had produced a completed NAP but 91 had at least launched the process.[lxxix] More technical support and funding is being provided through the GEF and GCF. A recent report by the NAP Global Network formed to provide technical support for NAP preparation focuses on how the process can be used to engage the private sector.[lxxix] The report details instruments and strategies for working with the private sector to mobilize greater investment in adaptation.

Emerging recognition and opportunity to finance sustainable access to cooling also brings the need for coordination. One of the major challenges for using climate financing for policies and programs to improve cooling efficiency has been the lack of coordination between the source of funds for refrigerant replacement, the Multilateral Fund for the

The Government of the United Kingdom has committed ~GPB 26 million (~USD 32 million) of Official Development Assistance (ODA) for sustainable cooling. To date the funding has primarily supported innovation, research, development, demonstration and technical assistance for sustainable cooling in ODA-eligible countries.

Implementation of the Montreal Protocol (MLF), and the multilateral climate funds which support improving the energy efficiency of appliances.

The need for coordination has increased since the adoption of the Kigali Amendment to the Montreal Protocol. The MLF supports developing country reduction and replacement of substances regulated under the Montreal Protocol. The regulated substances are substances that deplete the ozone layer and with the recent Kigali Amendment, substances that are powerful greenhouse gases. Though a request to the MLF for access to consider flexibility for energy efficiency financing has been made, the Montreal Protocol has not yet had a mandate to consider energy efficiency issues.[lxxx] This may be considered as a lost opportunity, in that the power used for refrigeration and AC equipment can, over the life of the system, generate far greater greenhouse gas emissions than the reduction from HFC replacement.[9]

This lack of coordinated funding, and options to fix it, is the focus of a recent paper prepared by the Natural Resources Defense Council (NRDC) and Climate Finance Advisors (CFA) with support from K-CEP.[lxxxi] The paper succinctly describes the problem:

> *"Cooling efficiency, however, has no equivalent international institution or fund dedicated to it; it is but one of many issues on the agendas of the multilateral climate funds. Cooling efficiency support has therefore been provided mostly in an ad hoc, uncoordinated manner, failing in particular to capitalize on the Montreal Protocol's work phasing out ozone depleting substances (ODSs) from appliances whose energy use is significant".*

The NRDC/CFA paper offers four generic institutional arrangements, or models, for collaboration among institutions, two based on the creation of new dedicated funds and two more modest initiatives based on greater coordination among existing programs and institutions:

- an energy efficiency 'sidecar' to the MLF.
- a dedicated donor facility housed at a multilateral climate fund or development financial institution.
- a formal mechanism of inter-institutional coordination.
- an increase in disparate, ad hoc activities.

The relative strengths and limitations of each of the four models are explored in the paper. Ultimately the models are complementary and non-exclusive.

THE TRACKING CHALLENGE

The *Chilling Prospects: Providing Sustainable Cooling for All* report identified the limits of knowledge of tracked financial flows for access to sustainable cooling and stressed that more effort was needed to understand the trends in sustainable cooling options, where gaps exist, and where efforts need to be reinforced or redirected. Tracking finance is an important issue first and foremost because it provides a baseline for identifying the level of existing investments to address the needs and corresponding sectoral and geographic gaps of highest priority for more support. Yet it remains challenging given that the issue is nascent and extremely varied.

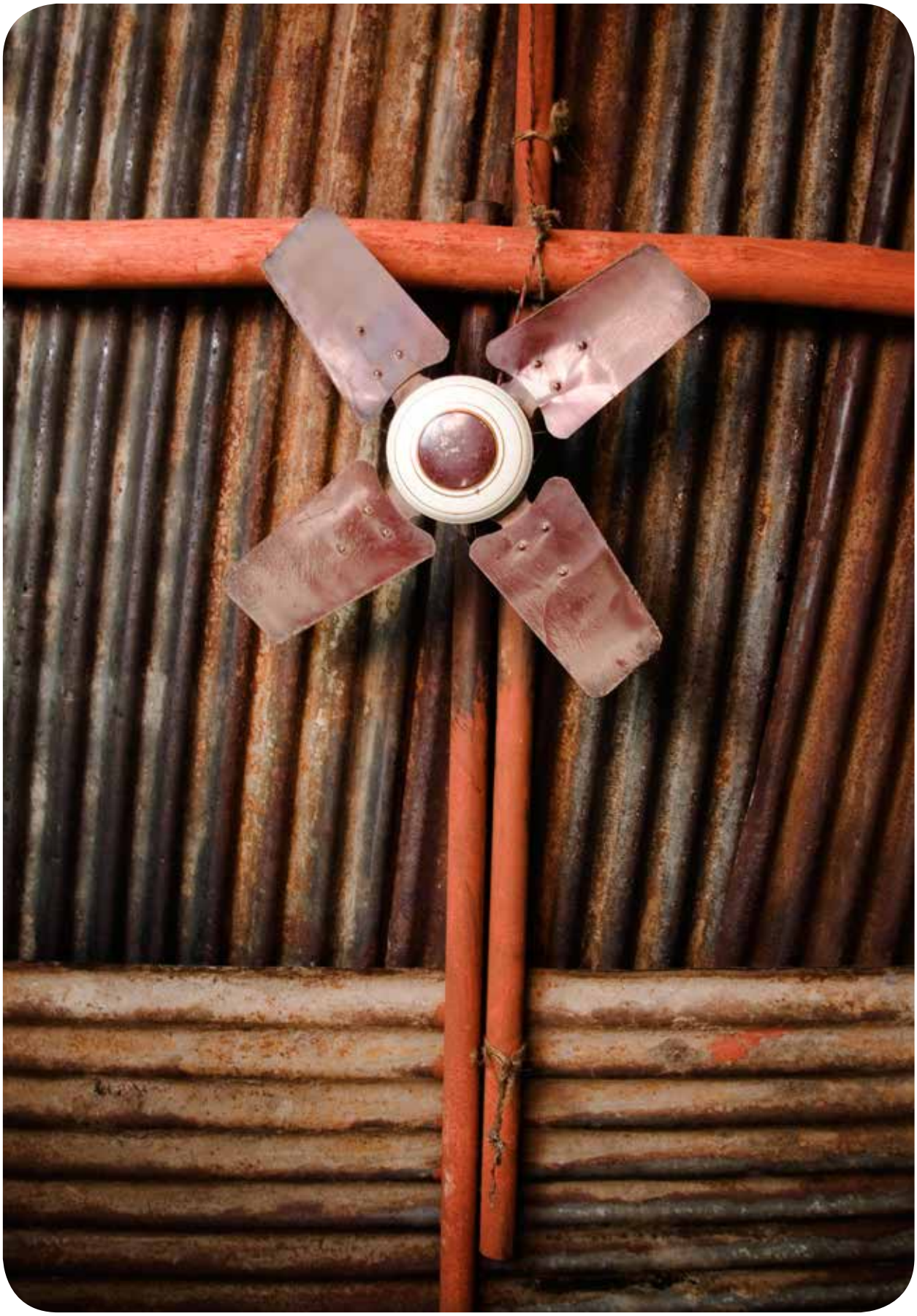
Finance for access to cooling can entail investment related to energy efficiency in the RAC sector, as well as measures aimed at decreasing the demand for cooling, such as cool roofs, building codes, and nature-based solutions. It also includes financial flows that support cold chain infrastructure in the health and agricultural sectors, as well as those measures designed to protect vulnerable groups during extreme heat, such as heat sensors and local heat action plans. It is also closely related to flows into increased access to affordable and reliable energy, as access to energy is a necessity to run electrical cooling devices.

[9] IEA, The Future of Cooling (2018). Improvements in the efficiency of AC equipment reduce GHG emissions in several ways. First, by reducing demand for power generated using fossil fuels. Second, by reducing peak demand, which is dominated by AC in many countries and typically supplied at the lowest system efficiency and therefore greatest emissions. And third, by reducing total system requirements enabling a greater proportion of total demand to be met from wind, solar, and other non-fossil sources of energy.

Conclusions can be drawn from efforts to identify finance flows towards access to energy. Finance commitments for off-grid electricity solutions, including mini-grids and stand-alone systems, stood at USD 430 million in 2017 across 20 high impact countries with large electricity access gaps, a marginal increase of only 12 percent compared to the annual average in 2015-16. However, the aggregate investment still represents a mere 1.2 percent of the total tracked finance commitments for electricity access in these countries. At the same time energy efficiency accounted for USD 740 million of all finance commitments tracked for electricity access in 2017, growing from USD 260 million in 2015-16. These commitments came primarily from public international sources and were directed towards energy conservation and demand reduction. [lxxxii] A complete understanding of energy efficiency investment, and investment related to cooling is inhibited by sufficient details to separate efficiency investments from those related to energy, and points to a need to refine the methodology to track energy efficiency investments and disaggregate for those related to access to cooling. However, it can be inferred that finance for access to sustainable cooling represents only a portion of this.

A 2018 paper by GIZ on coordinating finance in the RAC sector provides a useful basis on which to consider tracking finance in access to cooling.[lxxxiii] For the RAC sector, the paper considers the differentiated roles of public national budgets, private sources, and from public international funds, and cites crossover opportunities that include bi- and multilateral funds that target private sector engagement specifically. It further differentiates funding sources into private investments, ODA, or specific climate funds, the latter of which includes specific climate funds such as GEF, GCF, and MLF, bilateral funding, and non-state actors such as K-CEP. Expanding this frame beyond the RAC sector to consider investments in the broad scope of cooling needs defined by the needs assessment could serve as a basis on which to track finance commitments and ultimately flows.


REFRIGERATED
COLD WATER
1 रुपये 2 गिलास



6. RECOMMENDATIONS AND NEXT STEPS

The importance of providing access to cooling is beginning to be understood by governments, health care companies, food manufacturers, real estate firms, air conditioning and refrigerant manufacturers, and development institutions alike, and this report highlights key areas of progress over 2018 and 2019. It also demonstrates that over 1 billion people remain at highest risk from a lack of access to cooling, and that a further 2.2 billion need access to sustainable and affordable cooling to ensure energy systems remain modern and sustainable in response to a rapid increase in cooling demand. Providing access to sustainable cooling to serve the thermal comfort, nutritional, and health needs of over 3 billion people at prices they can afford must be treated as an urgent development challenge that underpins our ability to achieve both the Kigali Amendment and the Paris Agreement.

To support this challenge, this report identifies the need to measure the full scope of cooling needs when developing national cooling plans or access to cooling strategies at the sub-national or local level and provides a tool for governments (national, sub-national, and local) to conduct these assessments. Moving forward, there are key next steps that stakeholders can take to accelerate the urgent action that is crucial. These are highlighted below.

FOR GOVERNMENT POLICYMAKERS

Comprehensive cooling plans that protect the vulnerable: Countries with significant cooling access gaps have an important opportunity to integrate access to sustainable cooling into economic, energy, and climate-related planning processes in a manner consistent with growth priorities and the SDGs. Many countries have taken a first step, initiating the development of national cooling plans that address the transition envisioned in the Kigali Amendment and the expected increase of demand for comfort cooling as temperatures increase and economic growth accelerates. A key step within, or subsequent to these efforts, is the development of measures and targets that address cooling needs across the spectrum of risks faced by vulnerable groups in terms of human comfort and safety, agriculture, nutrition, and health. By utilizing the needs assessment for this purpose, countries can collect the data necessary to understand risks, set targets for reducing them, and begin to aggregate policy and technology options that are targeted at vulnerable groups. The results of the needs assessment will be critically important to provide a baseline and to identify opportunities for partnerships with the private sector as a means of achieving market development.

- Initiate a National Cooling Plan: As detailed in *Chilling Prospects: Providing Sustainable Cooling for All*, the initiation of a national cooling plan is a critical first step in addressing cooling access gaps, and countries working on HFC reduction measures under the Kigali Amendment will already have a basis upon which to build. Several multilateral agencies, including UNDP, UN Environment, and the World Bank are providing technical assistance based on guidance documents to develop these plans. Resources exist to assist countries in framing the energy savings and co-benefit potential, including:
    - Principles for National Cooling Plans, K-CEP[lxxxiv]
    - Country Energy Savings Assessments, United for Efficiency[lxxxv]

- Model regulations for cooling products and MEPS guidance, UN Environment.[lxxxvi]
- Modernizing Building Energy Codes, IEA and UNDP[lxxxvii]

- Conduct a Needs Assessment: In countries with populations vulnerable to a lack of access to sustainable cooling, conducting a needs assessment within a national cooling plan process, or subsequently, is a necessary step to understanding the full scale and geographic spread of cooling demand. Understanding this demand also enables an understanding of how it will impact sustainable energy priorities and programs. Tools and resources available include:
  - The Cooling for All Needs Assessment: Template and Guidance for National Cooling Plans, SEforALL.

- Set targets and aggregate policy and technology options: The wide variety of cooling needs and associated risks implies an equally diverse set of solutions. With an understanding of need based on data and demand, policy and technology options can be aggregated in order to reduce costs and ensure the most energy efficient solutions are applied. In principle, this implies a holistic approach that prioritizes energy demand reduction for cooling loads and ensures the remainder of demand is met with sustainable energy. Targets for success, by sector or geography, are also critical to ensuring policy and technology choices are suitable for national circumstances.

FOR DONORS, DEVELOPMENT PRACTITIONERS AND FINANCIERS

Prioritize the most vulnerable: There is an urgent need to prioritize interventions that support human safety, nutritional outcomes and agricultural incomes, and medical services alongside the better understood finance and assistance models related to energy efficiency. The application of a cross-sectoral, multi-stakeholder approach is a crucial first step for donors and the development community to maximize finance and impact for access to sustainable cooling at the base of the pyramid. Communities of practice in agriculture, health, and access to energy are key partners and must be engaged early in project design and implementation. The private sector has also demonstrated its capability to be part of such efforts, and PPPs must be utilized to ensure the demonstration of technology and new business models can reach scale.

Harness a diverse set of financing tools to deliver Cooling for All: Cooling needs exist across multiple sectors, including buildings, urban environments, transportation, agriculture and health, and addressing vulnerability will require a diverse set of financing mechanisms, including PPPs, and a holistic, multi-stakeholder approach. Philanthropy, bi- and multilateral donors, and development institutions are in a position to initiate and leverage investments that address these needs, in alignment with the Paris Agreement, Kigali Amendment and the SDGs. A first step is to use the needs assessment to identify desired outcomes and determine what can be achieved with private and blended finance, and what can only be achieved with public finance.

FOR INDUSTRY AND BUSINESS

Efficiency and Affordability at the Base of the Pyramid: While MEPS for cooling equipment constitute a baseline, average market efficiencies and the range of products that are typically available are significantly less energy efficient than the best available technologies. Rapidly expanding markets, particularly for air conditioners, mean better data and a foundation to understand the potential impact on energy systems in a business-as-usual approach. Industry and manufacturers of refrigeration and air-conditioning equipment have a crucial role in delivering sustainable cooling for all and may play a potentially transformative role in ensuring the highest efficiency devices are affordable at the base of the pyramid. Achieving this will require sustained technological innovation that drives price reductions and a concerted effort to overcome issues associated with higher up-front costs. By working with

vendors and local financial institutions, the expansion of cooling as a service, pay-as-you-go, or installment payment plans are clear areas where industry can play a role in making efficient devices more affordable at the base of the pyramid.

Skills Development, Maintenance, and Technician Training: Enhancing local capacity to maintain cooling equipment is crucial to lowering household costs, while creating jobs and benefitting corporate bottom-lines. Existing programs, such as UN Environment's OzonAction twinning program, have had considerable success, but tend to be developed by public actors for the benefit of public officials and governments. While manufacturers certainly engage in this type of capacity building, it is likely not yet at scale in markets where cooling demand is growing fastest. Opportunity exists for industry to play a central role in measuring the need for trained technicians, and to use its resources to expand training opportunities, including through public-private partnerships.

FOR CITIES AND LOCAL AUTHORITIES

In addition to supporting policy planning at the national level, cities and local authorities should use the needs assessment to identify priority actions to protect vulnerable populations. Regardless of whether the area is a major city or a rural municipality, local authorities are typically on the frontlines of managing the effects of heat stress, and their interventions can mean the difference between life or death in extreme events. As detailed in *Chilling Prospects: Providing Sustainable Cooling for All*, priority near-term actions include the development of heat action plans and expanding passive cooling in the form of green spaces and white roofs. For information on how cities and local authorities can implement passive cooling, please see:

- Unlock the Benefits of Reflective Cool Roofs, Global Cool Cities Alliance[lxxxviii]

To address longer term issues associated with urbanization and growing energy demand for cooling, other priority actions include:

- Taking a holistic approach to energy planning that supports the development of smart thermal networks and micro-grids
- Using urban designs to create natural cooling that reduce overall cooling demand and reduce the UHIE
- Developing and enforcing building energy codes that mitigate cooling demand.

In addition to actions within the control of specific actors or institutions, there are a number of cross-cutting issue areas in need of further action to accelerate progress in delivering sustainable cooling for all.

TO RAISE AWARENESS AND GENERATE KNOWLEDGE ACROSS SECTORS

Data and Evidence to Support Investment in Agriculture: Better data on the sufficiency of agricultural cold chains in high-impact countries is desperately needed to inform finance and business models that support enhanced nutritional outcomes and agricultural productivity. The current data gaps on the location, frequency, and impacts of cold chain breakdowns inhibit new investments, in particular from the private sector. Given the potential market size, the private sector is well-placed to fill this gap with data collection efforts that identify agricultural cold chain breakdowns by stock, location in the value chain, and commodity value. Identification must occur in a systematic fashion that supports government policy-making and near-term investment and enables cross-jurisdictional comparability and replication.

Engaging the health community: Access to reliable energy to power refrigeration and clean and unbroken cold chains is a critical enabler of the global goals related to both health and energy. Despite this, it is estimated that 56 percent of cold chain equipment in low to middle income countries is poorly or non-functioning,[lxxxix] and tens of thousands of health facilities in those same countries either lack electricity or suffer from frequent power outages.[xc] With a growing recognition of the nexus issues, improved collabo-

ration between the energy and health sectors must be a priority for both communities, extending from development practitioners to responsible health and energy ministers. The private sector must also be engaged, particularly where public resources may not be adequate to finance high initial costs, and projects must demonstrate how access to sustainable cooling can improve medical outcomes, particularly in rural and off-grid settings. The recently established global Health and Energy Platform of Action led by the WHO could serve as a basis upon which to mobilize investment and initiate new partnerships dedicated to access to cooling and improved health services.

A focused analysis of gender-based impacts: As is the case with energy access, women, girls, men and boys face different barriers and experience different benefits of access to cooling. The gender risks are evident but a lack of data and evidence on the barriers and benefits of access to sustainable cooling is a key weakness that may prevent finance and assistance programs from delivering the full range of programs that recognize these gender differences. While the needs assessment recommends collection of disaggregated data based on gender at the project or national level, a gender-based analysis as a resource alongside the assessment tool can aid in characterizing how the project design and implementation will have different impacts on women, girls, men, and boys. SEforALL's People-Centered Accelerator and the Cooling for All Secretariat are well-positioned to develop this resource.

TO BUILD CAPACITY AND DEVELOP SKILLS

Efforts by K-CEP, GIZ, and the OzonAction and development organizations assisting with national cooling plans have laid a strong foundation which can be expanded on to build the global capacity necessary to deliver cooling for all. As highlighted in *Chilling Prospects: Providing Sustainable Cooling for All,* training capacity and centers for promoting focused work on access to cooling in vulnerable countries, either at the country or regional level, should be established as a means to scale up current efforts. One model worthy of consideration is that of the Global Network of Regional Sustainable Energy Centres, led by the UNIDO, that provide a network and resources for regional practitioners. Thematically, such efforts should focus on innovations, policy, and business models that are ready for scale and accelerate the transition in a way that requires the least economic cost and is consistent with the clean energy transition envisioned by the Paris Agreement and the SDGs.

TO BENCHMARK PROGRESS AND TRACKING FINANCE

This report serves as a basis upon which to benchmark and monitor progress towards delivering sustainable Cooling for All. While there are clear and acknowledged gaps in the data that preclude a complete understanding of risk across the spectrum of access to cooling, globally available data will continue to support tracking of cooling access gaps for those at the highest risk.

As greater emphasis is placed on cooling by development finance institutions and bi- and multilateral donors, there will be a clear need to track financial flows directed towards access to cooling for vulnerable populations. Understanding the amount, geography, finance type and the rate of distribution and absorption is critical to prioritizing new investments. Such an effort requires on ongoing process that accounts for changing technologies and policy frameworks, as well as the emergence of new markets and business opportunities. Major financiers such as multilateral banks can contribute by clearly self-reporting project investments directed towards vulnerable populations, for example by categorizing them across human comfort and safety needs, agricultural and nutritional needs, and medical services.

As populations grow, heatwaves intensify, and the global middle class expands, the role of cooling in the productivity of developed economies and the safety of people has never been easier to appreciate. The developed world has also grown to appreciate how cooling made the transition from a luxury in the mid-19th century to a necessity today.

It is the responsibility of governments, industry, civil society, and the development community to internalize the lesson that delivering access to sustainable cooling to vulnerable populations is an issue of equity, and to apply it with urgency. With solutions at hand, growing interest, and ambitious commitments, ensuring we deliver results for those at the base of the pyramid requires a clear road map based on cooling needs, which moves beyond equipment-based projections, and that places equity at the heart of our efforts.

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