SUSTAINABLE COOLING FOR ALL IN GHANA:

MEETING COOLING NEEDS WHILE ACCELERATING A JUST AND EQUITABLE TRANSITION

SUSTAINABLE ENERGY FOR ALL

SEforALL SDG7 IMPACT GHANA

ACKNOWLEDGEMENTS

This report is based on a review of recent literature, industry reports, case studies and Sustainable Energy for All's (SEforALL's) insights from in-country access to sustainable cooling support to the public and private sectors in Ghana. Data were collected from various sources, including academic papers, SEforALL's Chilling Prospects series, the Ghana Energy Transition and Investment Plan, Ghana's National Cooling Plan and GIZ's Greenhouse Gas Inventory for the Refrigeration & Air Conditioning Sector (2022).

The report and analysis were developed by a team from SEforALL that includes Tilly Lenartowicz, Ben Hartley and Michael Abrokwaa. The SEforALL team was led by Brian Dean.

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Photo: Timothy Whitehouse

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ABBREVIATIONS

AC	Air conditioner
BAU	Business as Usual
CCS	Carbon Capture and Storage
CHPS	Community-based Health Planning and Services
ECREEE	Centre for Renewable Energy and Energy Efficiency
ECOWAS	Economic Community of West African States
EPI	Energy Performance Index
ESCO	Energy service company
ETIP	Energy Transition & Investment Plan
EUI	Energy Use Intensity
GDP	Gross Domestic Product
GHG	Greenhouse gas
GWh	Gigawatt house
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
HCFC	Hydrochlorofluorocarbons
KPIs	Key Performance Indicators
MEPs	Minimum Energy Performance Standards
NCAP	National Cooling Action Plan
NCCAP	National Climate Change Action Plan
NDC	Nationally Determined Contribution
NGO	Non-governmental organization
NZE	Net-Zero Emissions
ODP	Ozone Depletion Potential
PPP	Public-private partnership
RAC	Refrigeration and Air-Conditioning
RBF	Results-based financing
RCP	Representative Concentration Pathway
RFP	Request for proposal
SDG	Sustainable Development Goal
SME	Small and medium-sized enterprise
SRI	Solar Reflectance Index
UHIE	Urban Heat Island Effect

EXECUTIVE SUMMARY

Cooling and cold chains are crucial for healthcare, agriculture, thermal comfort and industrial processes. Affordable and sustainable cooling is essential for a thriving society and a healthy nation, sitting at the intersection of the Paris Climate Agreement, the Kigali Amendment of the Montreal Protocol and the UN Sustainable Development Goals (SDGS).

However, millions of people in Ghana lack access to affordable, reliable, sustainable cooling solutions, exposing them to severe health, well-being, and socioeconomic risks and consequences. According to Sustainable Energy for All's (SEforALL's) Chilling Prospects analysis, there are 12.9 million people at high risk due to a lack of access to cooling (including 4.17 million rural poor and 8.78 million urban poor) because they live below the international poverty line (less than USD 2.15 per day, as set by the World Bank) in substandard housing and do not have access to electricity. There are a further 16.6 million lower-middle-income people at medium risk due to a lack of access to cooling who also live without access to electricity and, although not impoverished, have limited financial resources to purchase cooling services. Given the significant power interruptions during 2024, commonly referred to as "*dumsor*", there could be more people at risk due to extreme heat as cooling appliances such as fans, air-conditioning units, fridges, etc. cannot operate without power.

Urban areas, such as Accra and Kumasi, are facing increased heat exposure due to the replacement of vegetation with heat-retaining surfaces, exacerbating the urban heat island effect (UHIE) that has caused city temperatures to be nearly 5°C higher than those of surrounding rural areas[1]. To combat the UHIE, the widespread adoption of passive cooling and nature-based solutions, especially for vulnerable populations (i.e., the 8.78 million urban poor living across Ghana), is essential.

Ghana's agricultural sector presents a significant opportunity to develop cold chain infrastructure for the fruit and vegetable sector, which offers a potential revenue of up to USD 900 million annually. The fisheries sector, employing 10 percent of the population[2], is also in critical need of sustainable cooling technologies. Women, who play a key role in post-harvest activities, often rely on solid ice for preserving fish. Introducing improved and sustainable cooling technologies could enable longer storage periods, increasing the income potential for women in this sector. Cold chain development could reduce post-harvest losses, improve food safety, quality and nutritional value, and enhance market access, ultimately improving the economic well-being of farmers and fishing people.

1 Cosmos S. Wemegah, Edmund I. Yamba, Jeffrey N.A. Aryee, Fredrick Sam, Leonard K. Amekudzi,Assessment of urban heat island warming in the greater accra region, Scientific African, Volume 8, 2020, e00426, ISSN 2468-2276, https://doi.org/10.1016/j.sciaf.2020.e00426

2 Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Country Profiles Ghana, URL: https://www.fao.org/fishery/en/facp/GHA

Reliable cooling is also crucial for vaccine and medicine storage, but healthcare facilities in Ghana struggle with a fractured healthcare cold chain and poor equipment maintenance. Coordinated efforts are necessary to develop and scale accessible cold chains for agriculture and healthcare that support socioeconomic development and strengthen food security and health outcomes in rural communities.

For Ghanaians with reliable access to electricity, refrigeration and air-conditioning (RAC) usage is increasing due to rising incomes, temperatures and heatwaves, and further growth expected in this sector will impact Ghana's energy systems and climate goals. The 2021 Ghana National Cooling Plan (NCP) projects that energy demand for the RAC sector will increase steadily from 7.04 TWh in 2015 to 20.9 TWh in 2050 with a corresponding increase in greenhouse gas (GHG) emissions from 5.05 mT CO2eq in 2015 to 12.8 mT CO2eq in 2050 under a business-as-usual'(BAU) scenario. To align with national energy and climate strategies such as the Ghana Energy Transition and Investment Plan (ETIP), these emissions need to be abated. Building on Ghana's leadership in promoting energy-efficient cooling and its commitment to the Global Cooling Pledge, now is an opportune time to reassess cooling needs to align with development, health and economic goals. Cooling plays a critical role in supporting Ghana's climate objectives and ensuring a just and equitable energy transition.

Ghana is positioned to achieve sustainable cooling for all by leveraging its national strategies and international commitments. Priority areas for policy interventions are recommended to strengthen the country's political landscape and enable sustainable cooling for all. The recommendations focus on integrating existing efforts, addressing policy gaps and enhancing information, awareness and capacity at both national and local levels.

1. Integrate cooling with national and county energy, climate and development policies.
2. Strengthen the mandate for the 'National Cooling Plan Committee' and governance system.
3. Enable 'Cool Cities' through a call to action, city networks and leading by example.
4. Increase the adoption of passive and nature-based cooling in buildings and cities.
5. Accelerate the transition to model Minimum Energy Performance Standards (MEPS) and participate in their regional harmonization.
6. Stimulate market demand for sustainable cooling and drive behavioural change with the government leading by example.
7. Enhance access to low climate-impact cooling and cold chain for agriculture and healthcare.
8. Promote sustainable cooling awareness.

To increase investment and finance for sustainable cooling for all in Ghana, key recommendations include improving climate finance tracking through tools like CLIMFINTRACK; establishing a climate finance baseline; leveraging innovative financing instruments such as green bonds; and fostering investable companies. Aligning Nationally Determined Contributions (NDCs) with investment flows and promoting case studies of adaptation finance will also help mobilize private capital and enhance investment readiness.

INTRODUCTION

PURPOSE OF THE REPORT

The purpose of this report is to provide Ghana's policymakers, investors and other cooling sector stakeholders with an overview, data, policy and financial recommendations to meet Ghana's cooling needs and accelerate a just and equitable transition while cutting emissions.

Cooling is crucial across Ghana for maintaining vaccine and medicine efficacy, preserving fresh food supplies, ensuring comfortable thermal environments in homes and workplaces, and supporting efficient transportation and industrial systems. Urgent action is required to address the energy and climate issues associated with cooling and to ensure equitable cooling access, particularly for the most vulnerable communities in heat-stressed regions of the country. Figure 1 illustrates how cooling is interconnected with all 17 UN Sustainable Development Goals (SDGs) in Ghana.

FIGURE 1: Sustainable Development Goals & Cooling in Ghana

Access to sustainable cooling technologies can enable longer storage periods increasing the income of farmers. Ghana' agricultural sector presents a significant opportunity to introduce cold chain infrastructure especially for the fruits and vegetable sector which has a potential revenue generation of USD 900 million annually.

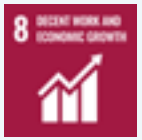
With 12.9 million out of 34 million people experiencing food insecurity sustainable cooling systems and cold chains have the potential to reduce 3.2 millions tons of food in Ghana's food supply chain

With only 14 temperature-controlled vehicles available across the country in 2021, sustainable mobile cold chains and efficient cold storage devices will improve Ghana's vaccination and response to health issues especially in rural areas

With temperatures soaring above 43°C in Ghana's hottest regions, schools can be too hot to learn. Passive cooling can increase comfort students, and have a direct effect on their learning outcomes

Women are most affected by extreme heat in Ghana and make up 50.1% of the population. Sustainable cooling can support women's economic empowerment and improve women's health outcomes.

Increasing the use of sustainable cold systems will ensure energy security and increase grid stability, consistent with Ghana's 2060 energy transition targets.



Ghana's unemployment rate stood at 13.4% in 2021. Sustainable cooling systems have the capacity to generate sustainable and decent jobs through more productive uses of energy, among others.

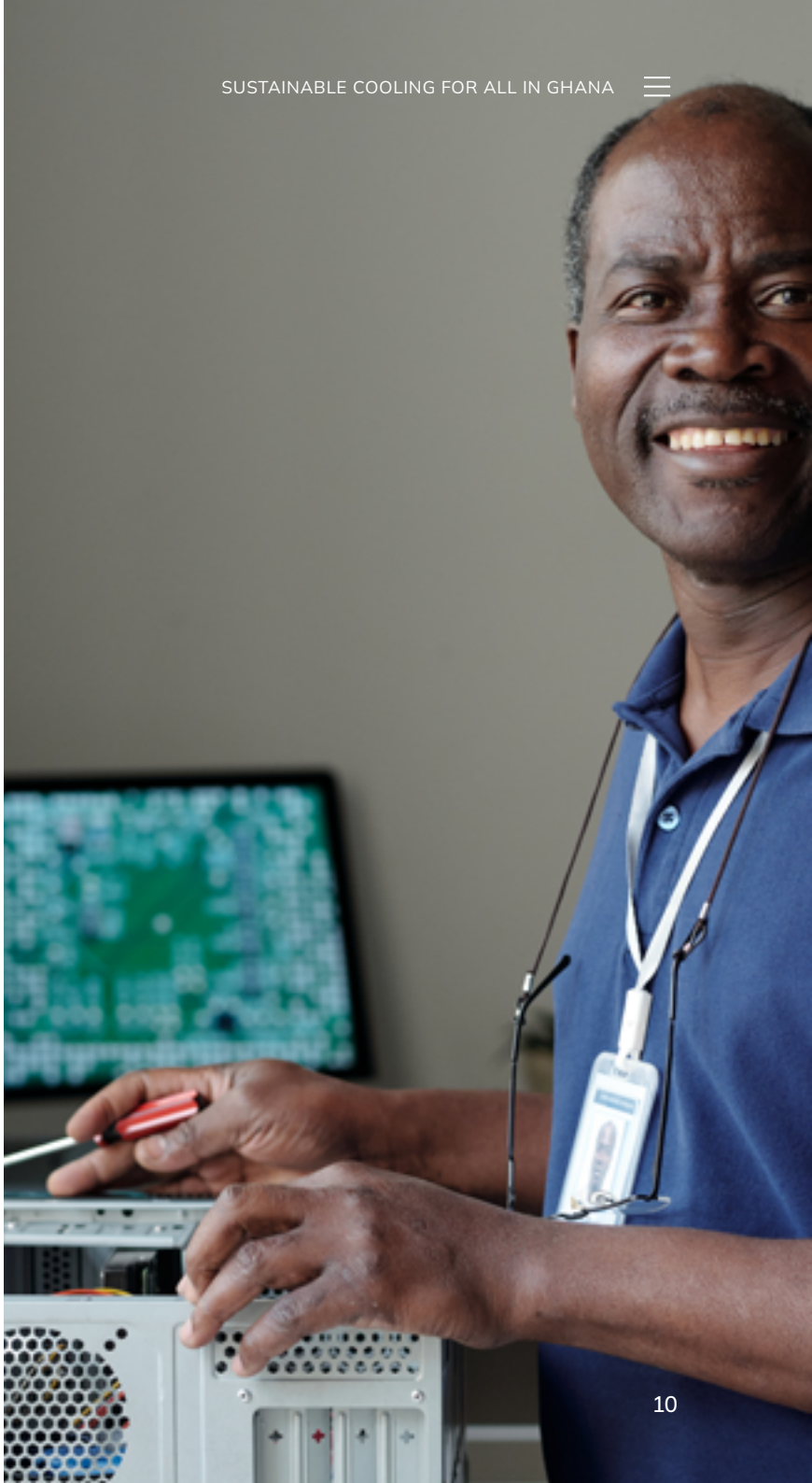
Ghana's youth have an unemployment disparity. With 22.3% of women between 15-35 unemployed, and 17.4% of men. Sustainable cooling systems can help increase gainful employment reducing inequalities such opportunities, access and pay disparity

With increasing urban development there is the need for more green areas and sustainable building design, particularly in Accra and Kumasi.

The use of R290 active cooling devices will ensure Ghana demonstrates leadership in the phase down of HFC gases, supporting Ghana's NDC and commitment to the Kigali Amendment

With the release of Ghana's Energy Transition and Investment Plan (ETIP) that paves the way for the energy sector to meet net-zero emissions by 2060, and the government's commitment to the Global Cooling Pledge, this is a timely moment to develop a detailed roadmap for reducing carbon emissions from the cooling sector that firstly acknowledges the need to address Ghana's access issues. This includes increasing access to cold chains in the agriculture and healthcare sectors. Building on Ghana's National Cooling Plan (NCP) and other climate and development goals, this report aims to:

- Highlight the dual need to address energy and climate issues associated with the pressing access and development issues related to cooling to ensure a healthy nation and thriving society.
- Define and contextualize the key impact areas and interventions necessary for a holistic pathway to sustainable cooling for all.
- Encourage cross-sectoral collaboration across public and private sectors as well as multiple activity sectors to deliver sustainable cooling for all.
- Provide recommendations for priority action areas for policymakers and government officials to address current progress, gaps and opportunities, aiding in achieving sustainable cooling for all.
- Highlight key financial or investment mechanisms and recommendations to address challenges aimed at creating a robust financial ecosystem that supports sustainable cooling for all.



ORGANIZATION OF THE REPORT

The content is organized into five main sections:

01

Country background: This section provides information on Ghana's climate, heat exposure, demographics, economy, energy sector (including electricity for cooling), and heat risk and cooling access gaps.

02

Ghana's cooling challenges and opportunities: This section presents Ghana's context of cooling needs and data related to the challenges and issues associated with a lack of cooling. It covers three critical cooling sectors:

1) food, nutrition and agriculture,
2) health services, and
3) human comfort and safety

03

Sustainable cooling for all in Ghana: This section presents an overview of six key themes to achieve sustainable cooling for all in Ghana. The themes are:

1) passive cooling strategies;
2) higher cooling energy-efficiency standards,
3) the phasing out of climate-warming hydrofluorocarbon (HFC) refrigerants,
4) decarbonizing the power sector;
5) cooling equity and access, and;
6) accessible cold chains for agriculture and healthcare.

04

Policy interventions to achieve sustainable cooling for all in Ghana: This section outlines eight priority policy actions and interventions that can bolster Ghana's existing political landscape and enable equitable and sustainable cooling by strengthening existing efforts, introducing new efforts to close policy gaps, and increasing information, awareness and capacity.

05

Increasing investment and finance for sustainable cooling for all in Ghana: This section presents strategies tailored to the unique challenges of the cooling sector to drive investment and foster a more resilient and climate-conscious economy.

Supplementary information is provided in Annex 1.

The report is based on a review of recent literature, industry reports, case studies and Sustainable Energy for All's (SEforALL's) insights from in-country cooling support to the public and private sectors in Ghana. Data were collected from various sources, including academic papers, SEforALL's Chilling Prospects series, the ETIP, NCP, other policy documents and GIZ's Greenhouse Gas Inventory for the Refrigeration & Air Conditioning Sector.

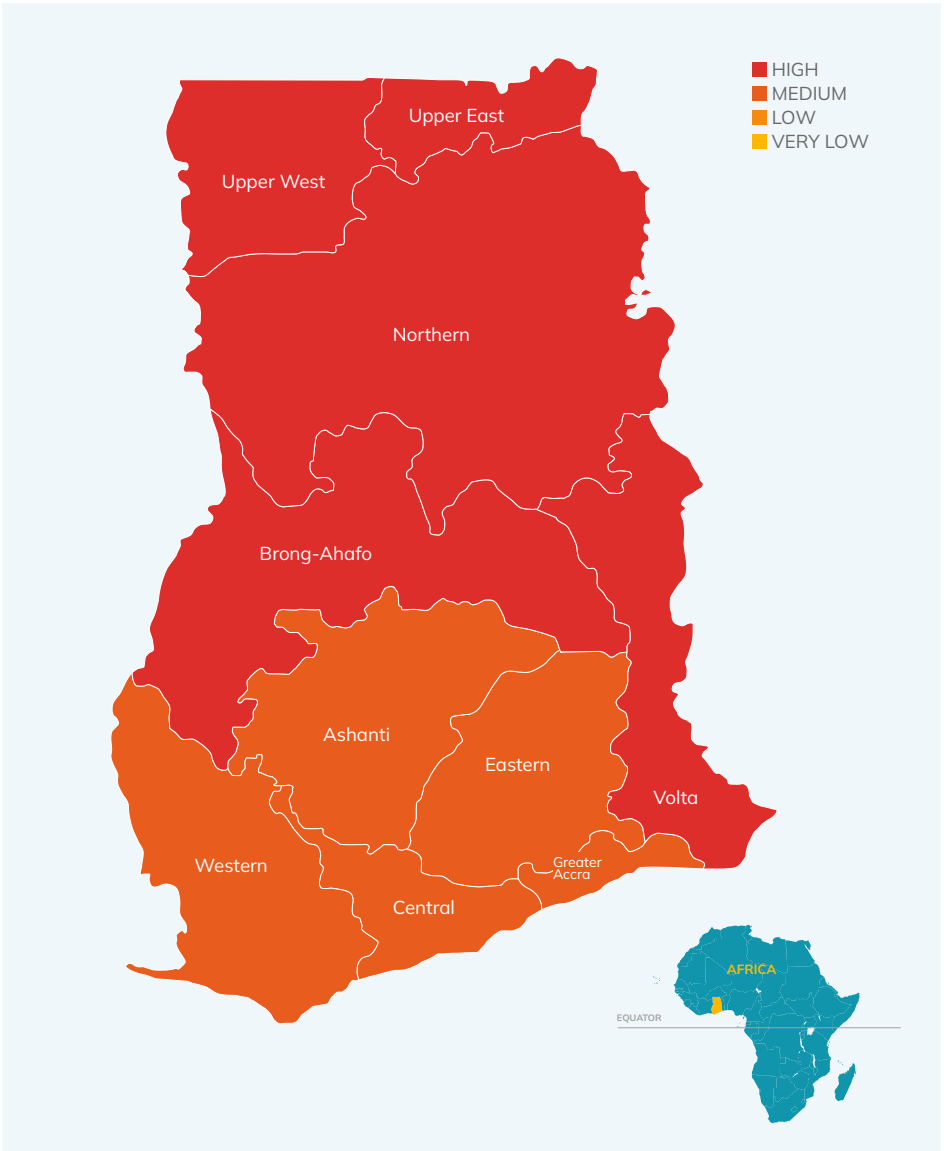
01 COUNTRY BACKGROUND

CLIMATE

Ghana is in West Africa and 540 km of its coastline are along the Gulf of Guinea. Generally, the country has a warm tropical savanna climate though this varies across geographical zones according to latitude (4° to 12°N), varying elevations and proximity to the ocean. Ghana's mean annual temperature is 27.3°C and the mean minimum and maximum annual temperatures are 22.1°C and 32.5°C, respectively. The highest recorded temperature is 43.8°C in the Upper East region of Navrongo[3]. Northern Ghana typically experiences one rainy season from May to September, while southern Ghana has two rainy seasons, the major one from April to July and a minor one from September to November. Humidity levels are high throughout much of the year, particularly in coastal and forest regions, ranging from 70 percent to 100 percent, depending on the season and region.[4]

Ghana is expected to face significant changes in its climate, with mean temperatures projected to rise by 1.0°C to 3.0°C by the middle of the century, and 2.3°C to 5.3°C by the end of the century (dependent on four Representative Concentration Pathways (RCPs), i.e., RCP2.6, RCP4.5,

FIGURE 2: Map illustrating risk of extreme heat in Ghana[5]

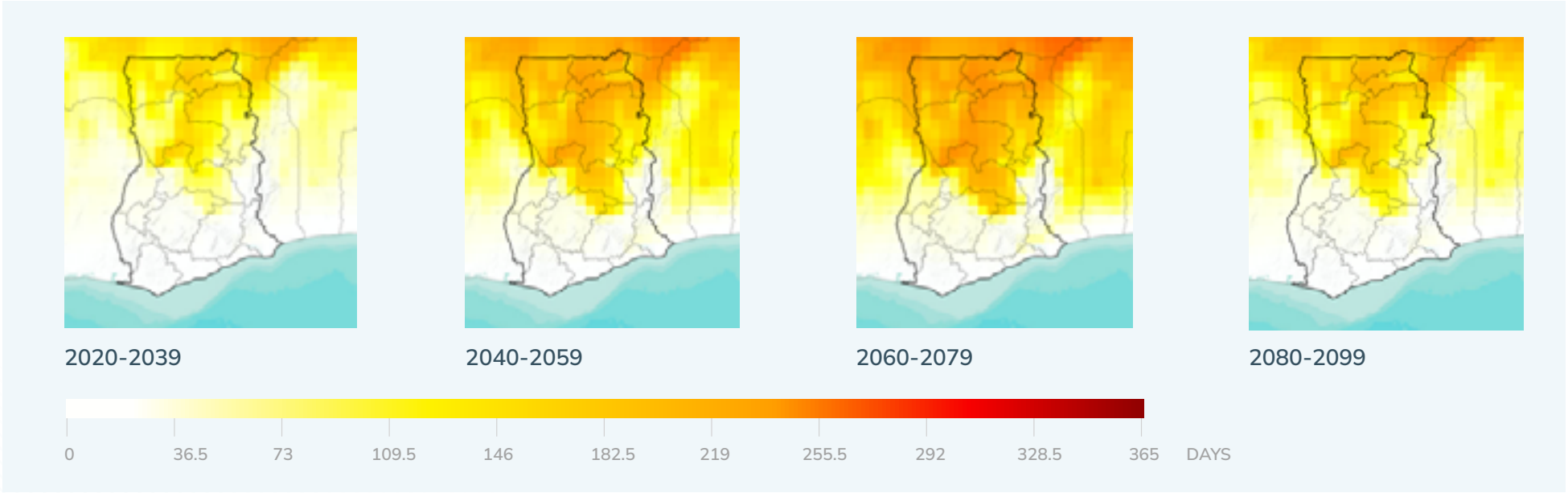


3 Masters, Jeff (18 January 2018). "NOAA: Earth Had Its Third Warmest Year on Record in 2017". Wunderground. Archived from the original on 30 April 2018. Retrieved 27 October 2023.

4 Climate Risk Profile: Ghana (2021): The World Bank Group, https://climateknowledgeportal.worldbank.org/sites/default/files/2021-06/15857-WB_Ghana%20Country%20Profile-WEB.pdf

5 ThinkHazard! (2020). Ghana – Extreme Heat. URL: http://thinkhazard.org/en/report/94-ghana/EH

FIGURE 3: Projected number of annual hot days above 35°C in Ghana under climate scenario SSP2-4.5; 50th percentile



Source: https://climateknowledgeportal.worldbank.org/country/ghana/heat-risk

RCP6.0 and RCP8.5)[6]. Northern and inland areas will be the hottest, and the frequency of hot days and nights in all areas is expected to increase by 18-59 percent by the middle of the century, accompanied by a decrease in the frequency of cooler periods. These changes underscore the need for climate adaptation strategies, particularly in northern regions.[7]

The five northern regions (Upper West, Upper East, Northern, Brong Ahafo, Volta) have a high heat hazard classification, whilst the four coastal regions (Western, Ashanti, Eastern, Central, Greater) have a medium heat hazard classification. (See Figure 2.) However, in 2024, the coastal zone of Western Africa (including parts of Ghana) experienced abnormal early season heat with a combination of high temperatures and relatively humid air that put people in extreme danger of heat cramps, heat exhaustion and heat stroke.

6 Ibid. RCPs are defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. For simplification, these scenarios are referred to as a low (RCP2.6); a medium (RCP4.5) and a high and business-as-usual (RCP8.5) emission scenario in this profile. More information about RCP at: https://iiasa.ac.at/web/home/research/researchPrograms/TransitionstoNewTechnologies/RCP.en.html

7 Ibid.

POPULATION & ECONOMY

Ghana has a population of approximately 34 million people, 59 percent of whom reside in urban areas (2023), including major cities like Accra and Kumasi. About 25.2 percent of the population live below the poverty line (2016), and 33 percent of the total population (8.8 million) reside in informal or slum housing (2020).[8]

Ghana's economy is robust and diverse, with key sectors including agriculture (20.9 percent of GDP), industry (34.2 percent) and services (44.9 percent) (2022).[9] Ghana is Africa's largest gold producer, and the economy has significant contributions from the mining and minerals sector, as well as growing oil and gas industries. The manufacturing and services sectors are also vital to the nation's economic landscape.

8 World Bank Development Indicators (2024) https://data.worldbank.org/country/ghana

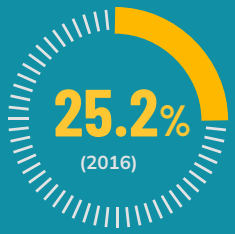
9 Ghana Statistical Service, Sectoral Share of GDP 2022. https://statsghana.gov.gh/gdpgraph.php?graphindicators=MTE4NzYxMzkxNi45NDI1/gpdgraph/49pp7266p8

10 World Bank Development Indicators (2024) https://data.worldbank.org/country/ghana; World Population Review (2024), https://worldpopulationreview.com/cities/ghana

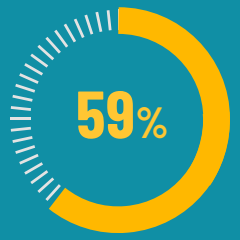
BOX 1

DEMOGRAPHIC DATA[10]

TOTAL POPULATION: **34,121,985** (2023)



POPULATION LIVING BELOW THE POVERTY LINE



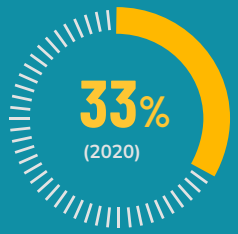
URBAN POPULATION

LARGEST CITIES BY POPULATION:

ACCRA
~ 1.6 million

KUMASI
~ 1.5 million

TAMALE
~ 361,000 (2023)



URBAN POPULATION LIVING IN INFORMAL OR SLUM HOUSING

POWER & EMISSIONS PROFILE

Access to electricity has improved considerably; 95 percent of urban populations now have access, though the figure is lower for rural populations (72 percent). This means the average rate of electrification is 85.1 percent (as of 2022).[11] Ghana is aiming for universal electrification by 2030.

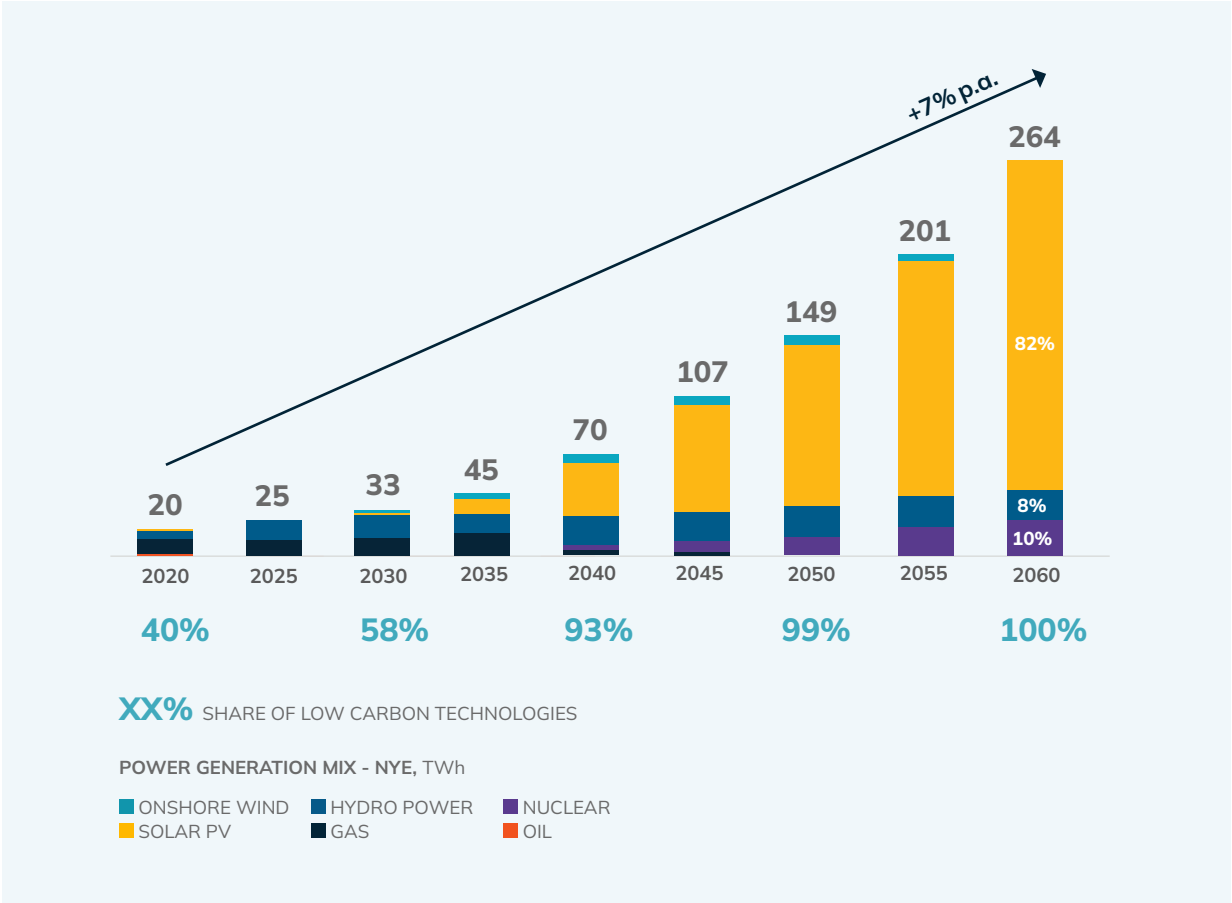
Ongoing power interruptions, known as "*dumsor*," resulting from maintenance issues, financial constraints and gas supply difficulties, have been a significant challenge in 2024. Load-shedding schedules have been implemented to manage these disruptions.

According to Ghana's Energy Transition and Investment Plan (ETIP), in 2020, Ghana's power generation totalled 20.45 TWh, with a source mix of gas (56.68 percent), hydro (39.28 percent), oil (3.79 percent) and solar (0.31 percent), resulting in carbon emissions of 6.23 Mt CO2e.

11 IEA, IRENA, UNSD, World Bank, WHO. 2024. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. https://trackingsdg7.esmap.org/data/files/download-documents/sdg7.1.1_-_access_to_electricity.xlsx

Looking ahead to 2050 under the ETIP net-zero pathway, Ghana plans to shift its energy mix dramatically towards renewables, with solar energy expected to account for 71.4 percent of generation capacity, complemented by nuclear (10.24 percent), hydro (13.87 percent) and onshore wind (3.86 percent). Gas use will drop to 0.72 percent, with a portion using carbon capture and storage (CCS). The total power generation required is expected to reach 148.97 TWh, but associated carbon emissions will decrease significantly to 0.4702 Mt CO2e, aligning with Ghana's target of achieving net-zero emissions by 2060. The transition will involve a massive scale-up of solar PV, beginning in 2020 and accelerating from 2040, alongside the introduction of nuclear power by 2045.

FIGURE 4: Power generation mix and capacity from 2020-2060 under the ETIP Net Zero by 2060 pathway (Data source from the Ghana ETIP)



COOLING POWER & EMISSIONS

Refrigeration and air-conditioning (RAC) systems contribute to both direct and indirect carbon emissions. Indirect emissions stem from the electricity generation required to power RAC systems, while direct emissions result from the release of refrigerants used in these systems. The overall environmental impact is determined by factors such as the efficiency of the appliances, the type of refrigerant used and the source of electricity generation. The global warming potential (GWP) and ozone depletion potential (ODP) of refrigerants play a major role in determining their direct emissions, which can occur during operation and installation, and at the end of the equipment's lifecycle.

In Ghana, the rising demand for cooling is driven by increasing temperatures, growing incomes and expanding urbanization. According to the Ghana National Cooling Plan (NCP), energy demand for the RAC sector is projected to rise from 7.04 TWh in 2015 to 20.9 TWh by 2050 under a business-as-usual (BAU) scenario.

TABLE 1: Power generation mix & generation for 2020 and 2060 under the ETIP Net Zero by 2060 pathway (Source: ETIP)

POWER SOURCE	2020 POWER GENERATION MIX	2060 POWER GENERATION MIX
Hydro	36.2%	8%
Solar PV	0.8%	82%
Nuclear	0%	10%
Onshore Wind	0.02%	0%
Oil	0%	Phased Out
Gas	62.98%	Phased Out

Correspondingly, greenhouse gas (GHG) emissions from the RAC sector are expected to increase from 5.05 million tonnes (mT) of CO2 equivalent (CO2eq) in 2015 to 12.8 mT CO2eq by 2050. Unitary air conditioners (ACs), mobile ACs and domestic refrigeration have been identified as the largest contributors to these emissions. Reducing cooling demand, improving appliance efficiency, and reducing harmful refrigerants is crucial to Ghana's energy and climate strategies.

Ghana's ETIP outlines a path to net-zero carbon emissions across the energy sector by 2060, with key targets for renewable energy deployment, particularly solar PV and nuclear power. This plan will help decarbonize the grid, which is essential for reducing indirect emissions from the RAC sector. Addressing direct emissions also requires phasing out harmful refrigerants in line with global agreements, such as the Kigali Amendment to the Montreal Protocol. Ghana has committed to phasing out hydrofluorocarbons (HFCs) by 2024 and reducing their use to 80 percent of the baseline by 2045, as well as replacing hydrochlorofluorocarbons (HCFCs) with environmentally friendly alternatives.

To ensure the RAC sector supports Ghana's climate and energy goals, updated data on RAC usage, energy demand and refrigerant consumption are needed. By aligning with the Ghana ETIP, the country can develop a roadmap for sustainable cooling that contributes to its Nationally Determined Contributions (NDCs) under the Paris Climate Agreement, ensuring that cooling supports a just and equitable energy transition.

HEAT RISK & ACCESS TO COOLING GAPS

Sustainable Energy for All's (SEforALL's) Chilling Prospect series[12] analyzes risk factors in high-temperature countries and regions to determine how many people are likely to be at high, medium and low risk to heat exposure due to a lack of access to cooling services.

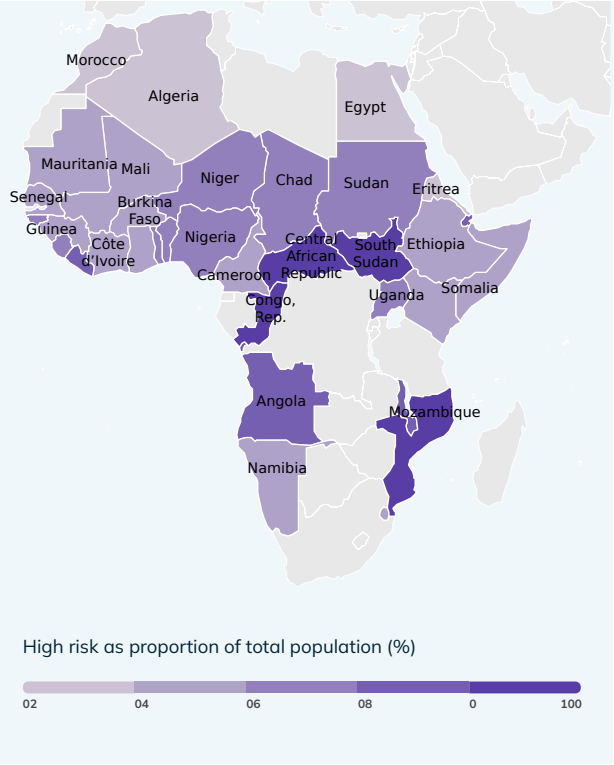
The risk spectrum is based on the premise that heat disproportionately affects impoverished individuals or those with limited access to services. People without electricity, and those living in inadequate housing or residing in rural areas without food or medical cold chains are especially vulnerable. Similarly, those working outdoors or in the informal sector face heightened risks due to limited cooling access.

An estimated 12.9 million people in Ghana are at high risk due to a lack of access to cooling, nearly 40 percent of the population. They include:

- 4.17 million rural poor people who lack access to electricity and live in extreme poverty. Many are likely to engage in subsistence farming but lack access to an intact cold chain that would enable them to sell their products further afield at a higher price. There may also be a lack of medical cold chains in rural poor communities, putting lives at risk from spoiled medicines and vaccines. 47 percent of the rural poor at high risk are women.
- 8.78 million urban poor people who have limited or no access to electricity, and whose quality of housing is likely too poor to protect them from extreme heat. Their 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 poor nutrition or food poisoning. 50 percent of the urban poor at high risk are women.

The proportion of the population at high risk in Ghana is like that of neighbouring countries. In Togo and Burkina Faso 41 percent and 39 percent of the population are at high risk, respectively. The proportion of the population at high risk in neighbouring Cote d'Ivoire is slightly less at 32 percent.

FIGURE 5: Proportion of the population at high risk among 31 high-impact countries in Africa (SEforALL Chilling Prospects, 2023)



12 https://www.seforall.org/our-work/research-analysis/chilling-prospects-series

In addition, there are **16.6 million people at medium risk due to a lack of access to cooling across Ghana**, 51 percent of whom are women. The population at medium risk represents an increasingly affluent lower-middle-income class that is on the brink of purchasing the lowest-cost air conditioner or refrigerator on the market. Limited purchasing choices available to this group means cooling devices that are likely inefficient and could cause a dramatic increase in energy consumption, energy costs and associated greenhouse gas (GHG) emissions. The lower-middle income segment of the population lives outside of rural and urban poverty, though on less than USD 10.01 per day.

The following section delves more into the specific needs and challenges for those at risk due to a lack of access to cooling. The solutions and actions necessary to ensure a just and equitable cooling transition are given in the final three sections of this report.

Photo: Timothy Whitehouse

FIGURE 6: Risk indicators for a lack of access to cooling (SEforALL, *Chilling Prospects* 2023) & & access figures for Ghana

RISK SPECTUM	HIGH RISK		MEDIUM RISK	LOW RISK
	• No access to electricity • Income below poverty line • Poor ventilation and construction • No access to refrigeration for food • Farmers lack access to cold chains • Vaccines exposed to high temperatures		• Access to electricity • Lower income levels • Ability to run a fan, buildings constructed to older standards • Food is refrigerated • Farmers only have access to intermittently reliable cols chains • Vaccines may have exposure to occasional high temperatures	• Full and reliable electricity • Middle income and higher • Well-built homes can include insulation, passive design, air conditoning • Food is refrigerated reliably • Farmers' goods and vaccines have well-controlled cold chains
RISK POPULATIONS	RURAL POOR	URBAN POOR	LOWER-MIDDLE INCOME	MIDDLE-INCOME
RISK INDICATORS	Lack of access to energy Population living in rural areas on less than $2.15/day	Lack of access to energy Population living in urban slums on less than $2.15/day	Population living on less than $10.01/day outside of rural or urban poverty	Population living on between $10.01 and $20/day
Ghana 2023 access gaps	4.17 million	8.78 million	16.6 million people	3.18 million

Source: https://www.seforall.org/chilling-prospects-access-to-cooling-gaps-2023/summary

02 GHANA'S COOLING CHALLENGES AND OPPORTUNITIES

This section offers an overview of the three critical sectors where cooling and cold chain systems are essential in Ghana, along with the challenges currently faced and potential opportunities in each sector:

- Food, nutrition and agriculture
- Health services
- Human comfort and safety in the built environment (encompasses cities and buildings)

Other significant cooling needs in Ghana are also highlighted.

FOOD, NUTRITION AND AGRICULTURE

Sustainable cooling systems and cold chain infrastructure are vital for reducing food waste, enhancing agricultural productivity and incomes, and combating hunger. Each year, Ghana loses or wastes 3.2 million tons of food in the supply chain, costing the country around GHS 762.32 billion[13]. This food loss exacerbates food insecurity, with around 12.9 million people in Ghana affected by moderate or severe food insecurity in 2022[14]. Developing cold chain infrastructure could significantly reduce post-harvest losses, ensuring that perishable, nutritious crops and fresh produce are stored and transported effectively. This would not only increase food availability and improve nutrition, but also boost incomes for those dependent on agriculture and food production, including the approximately 7 million smallholder farmers who produce more than 90 percent of the food consumed in Ghana[15].

The economic potential of cold storage and refrigerated transport is particularly acute in Ghana's fruit and vegetable sector, which offers a potential revenue of up to USD 900 million annually[16]. The country's 2021 National Cooling Plan (NCP) emphasizes the need for refrigeration to support the "Planting for Food and Jobs" campaign, which aims to increase food production and job creation. Additionally, Ghana's industrial transformation programme, which focuses on adding value to agricultural products, underscores the importance of process cooling, particularly in local cocoa bean processing. Ghana, a major cocoa producer, benefits from cooling systems in warehouses and processing plants to prevent cocoa beans from spoiling in the humid climate.

Photo: Timothy Whitehouse

13 The Global Food Banking Network, 2022, URL: https://www.foodbanking.org/news/new-harvard-research-shows-how-ghana-can-help-combat-food-waste-hunger-and-climate-change/

14 Care, 2023, Ghana: Inequalities in Food Insecurity, URL: https://reliefweb.int/report/ghana/ghana-inequalities-food-insecurity#:~:text=As%20per%20the%20Food%20and,population%2C%20were%20affected%20in%202022

15 Corteva, 2022, "Working Together to Support Smallholder Farmers in Ghana", URL: https://www.corteva.com/resources/blog/working-to-support-smallholder-farmers-in-ghana.html#:~:text=Approximately%20seven%20million%20smallholder%20farmers,the%20food%20consumed%20in%20Ghana.

16 International Trade Administration, 2022, Ghana Cold Chain, URL: https://www.trade.gov/market-intelligence/ghana-cold-chain#:~:text=Just%20in%20Ghana%2C%20the%20need,this%20opportunity%20remains%20largely%20untapped.

Photo: Timothy Whitehouse

Ghana's fisheries sector, employing 10 percent of the population, is also in critical need of sustainable cooling technologies, services and financing.[17] Women, who play a key role in post-harvest activities, often rely on solid ice for preserving fish. Introducing improved and sustainable cooling technologies could enable longer storage periods, increasing the income potential for women in this sector.

However, the development of Ghana's agricultural cold chain faces several challenges, including financial constraints for farmers and agribusinesses, limited access to capital and inadequate infrastructure. The lack of refrigerated transport vehicles and logistical support further hampers progress. To address these challenges, investments in infrastructure, capacity building and financial support are needed. Public-private partnerships and targeted policy interventions will be essential to building a robust and efficient cold chain system, ensuring that Ghana can fully realize the economic and social benefits of sustainable cooling.

17 Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Country Profiles Ghana, URL: https://www.fao.org/fishery/en/facp/GHA

HEALTH SERVICES

Cold chains are crucial for the safe transport and storage of vaccines, blood products and other temperature-sensitive medical supplies, ensuring they remain effective. In Ghana, the healthcare sector faces significant challenges due to unreliable electricity, particularly in rural areas, which hinders the operation of cooling systems. This issue is especially problematic for national Community-based Health Planning and Services (CHPS) facilities.

Ghana's fractured healthcare cold chain became particularly apparent during the COVID-19 pandemic, with only 14 temperature-controlled vehicles available across the country in 2021, severely limiting the distribution of vaccines and other critical supplies to rural populations.[18] The pandemic underscored the urgent need for a robust healthcare cold chain in Ghana. As the first African country to receive COVID-19 vaccines through the COVAX initiative, Ghana received an initial delivery of 600,000 doses of the AstraZeneca/Oxford vaccine in February 2021, but vaccination progress was slow. The challenges of frequent power outages, insufficient ultra-cold storage facilities and limited refrigerated transportation hampered efforts to vaccinate the population, with only 2.8 percent vaccinated by July 2021 despite the aim to vaccinate 87 percent of the population. This highlighted the need for significant investments in infrastructure, energy solutions, and comprehensive training for healthcare workers to expand storage capacity and improve vaccine distribution.[19]

Ghana's Dokrochiwa Health Centre faced challenges, with a 31-year-old refrigerator frequently failing to maintain the necessary 2-8°C for vaccines, causing missed immunization targets and patient mistrust. With support from UNICEF and Gavi, the centre received new cold chain equipment, including solar-powered units, significantly improving vaccine storage and allowing the centre to meet and exceed its immunization objectives. This support is part of a broader initiative that has delivered over 100,000 vaccine refrigerators to 100 countries, enhancing global vaccine distribution and storage.[20]

Enhancing Ghana's healthcare cold chain is essential for maintaining the efficacy of vaccines, medications and other medical supplies. Addressing the challenges of unreliable electricity supply, inadequate infrastructure and limited training requires targeted investments, capacity building and supportive policies. By fostering innovation and public-private partnerships, Ghana can develop a more robust and efficient healthcare cold chain system, improving health outcomes and ensuring the availability of vital medical supplies.

18 International Trade Administration, 2022, Ghana Cold Chain, URL: https://www.trade.gov/market-intelligence/ghana-cold-chain
19 GAVI The Vaccine Alliance, 2021, COVAX vaccine roll-out Ghana, URL: https://www.gavi.org/covax-vaccine-roll-out/ghana
20 UNICEF, URL: https://www.unicef.org/ghana/stories/ghana-strong-cold-chain-makes-all-difference

HUMAN COMFORT & SAFETY

Heat mitigation and cooling are increasingly critical in Ghana as rising temperatures, heat waves and the urban heat island effect (UHIE) impact vulnerable populations, including the elderly, young children and low-income communities. In cities such as Accra, temperatures are nearly 5°C higher than those of surrounding rural areas due to heat-absorbing urban surfaces like concrete and asphalt, combined with the effects of human activities[21]. This exacerbates heat stress, particularly in informal settlements where poor housing construction leads to higher indoor temperatures, posing significant health risks.

Ghana faces substantial economic and health challenges due to heat stress. By 2030, it is projected that approximately 12 percent of working hours in the agriculture and construction sectors will be lost due to heat stress, significantly affecting productivity.[22]

21 Cosmos S. Wemegah, Edmund I. Yamba, Jeffrey N.A. Aryee, Fredrick Sam, Leonard K. Amekudzi,Assessment of urban heat island warming in the greater accra region, Scientific African, Volume 8, 2020, e00426, ISSN 2468-2276, https://doi.org/10.1016/j.sciaf.2020.e00426.

22 International Labour Office, Geneva, 2019 Working on a warmer planet: The impact of heat stress on labour productivity and decent work, https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@dgreports/@dcomm/@publ/documents/publication/wcms_711919.pdf

Photo: Timothy Whitehouse

In a high-emissions, business-as-usual (BAU) scenario (Representative Concentration Pathway (RCP) 8.5), heat-related deaths among the elderly (65+ years) are expected to rise dramatically, from under two deaths per 100,000 annually (baseline between 1961 and 1990) to almost 70 deaths per 100,000 by 2080. However, a rapid reduction in emissions could limit this increase to about 14 deaths per 100,000 by 2080.[23]

Photo: Timothy Whitehouse

The growing use of active cooling in commercial buildings is also a concern, with air-conditioning accounting for 60-80 percent of annual electricity consumption in offices across Ghana. Furthermore, 85 percent of air conditioners used in Ghana are of the lowest energy efficiency category (1 star), and the remaining 15 percent are in the next lowest categories (2 and 3 stars).[24] This exacerbates urban heat and contributes to higher greenhouse gas (GHG) emissions, leading to further global warming and cooling equity issues. As cooling demand continues to rise, particularly in expanding cities, mapping current and future hotspots for cooling and deploying higher efficiency appliances will be critical to mitigate the UHIE and ensure equitable access.

The gender disparity in cooling access further underscores the need for targeted interventions. In Accra, for every 100 male slum dwellers over 30, there are 130 women, representing over 4.5 million poor urban women at high risk of heat stress. These women, particularly those working in the informal sector as street vendors and domestic workers, are disproportionately affected by rising temperatures. By 2030, Ghana is expected to see a 350 percent increase in work hours lost to heat stress compared to 1995, further impacting these vulnerable populations. Poorly ventilated compound dwellings in slum communities increase the vulnerability of women to heat stress, with women over 30 reporting higher perceived exposure to heatwaves than men.[25]

Addressing these gender-associated cooling risks require targeted interventions to improve living conditions in compound dwellings and support community cooling resources. By focusing on these areas, Ghana can enhance human comfort and safety, particularly for its most vulnerable populations, while also addressing broader issues of heat stress and its impact on productivity and health.

23 Climate and Health Country Profile – 2015, Ghana. Geneva: World Health Organization; 2015 URL: https://www.who.int/publications/i/item/WHO-FWCPHE-EPE-15.08.

24 Richard Opoku, Isaac Adjei Edwin, Kofi A. Agyarko, Energy efficiency and cost saving opportunities in public and commercial buildings in developing countries – The case of air-conditioners in Ghana, Journal of Cleaner Production, Volume 230, 2019, Pages 937-944, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2019.05.067.

25 SEforAL (2022), New data: Cooling access gaps among women and men in 2022, URL: https://www.seforall.org/chilling-prospects-special-gender/cooling-access-gaps

OTHER COOLING NEEDS

Beyond these critical cooling sectors, many of Ghana's industrial and commercial activities also rely heavily on effective cooling solutions. Manufacturing (i.e., textile, apparel, plastics and chemical), mining and energy industries all require advanced cooling technologies to maintain operational efficiency and safety. Additionally, as Ghana progresses in its national agenda to digitize the economy, the demand for cooling systems will expand significantly to support nationwide data centres, which are crucial for the ICT transformation. Ensuring that Ghana meets the cooling needs of its expanding industrial and digital infrastructure is critical for sustaining growth and supporting the country's broader economic transformation goals.

One prominent example is that of the Africa Data Centres (ADC), which are constructing a new data centre in Accra. This facility, set to initially consume 10 MW of power that can be increased to 30 MW with augmented data centre capacity, is part of the ADC's broader strategy to enhance digital infrastructure across Africa. Expertise in the installation, maintenance and operation of advanced cooling technologies will be necessary to ensure optimal performance and reliability.

03 SUSTAINABLE COOLING FOR ALL IN GHANA

To meet the needs and address challenges across the key cooling sectors in Ghana – agriculture, health services and thermal comfort – while reducing emissions and achieving sustainable cooling for all, integrated actions and cross-cutting interventions are necessary.

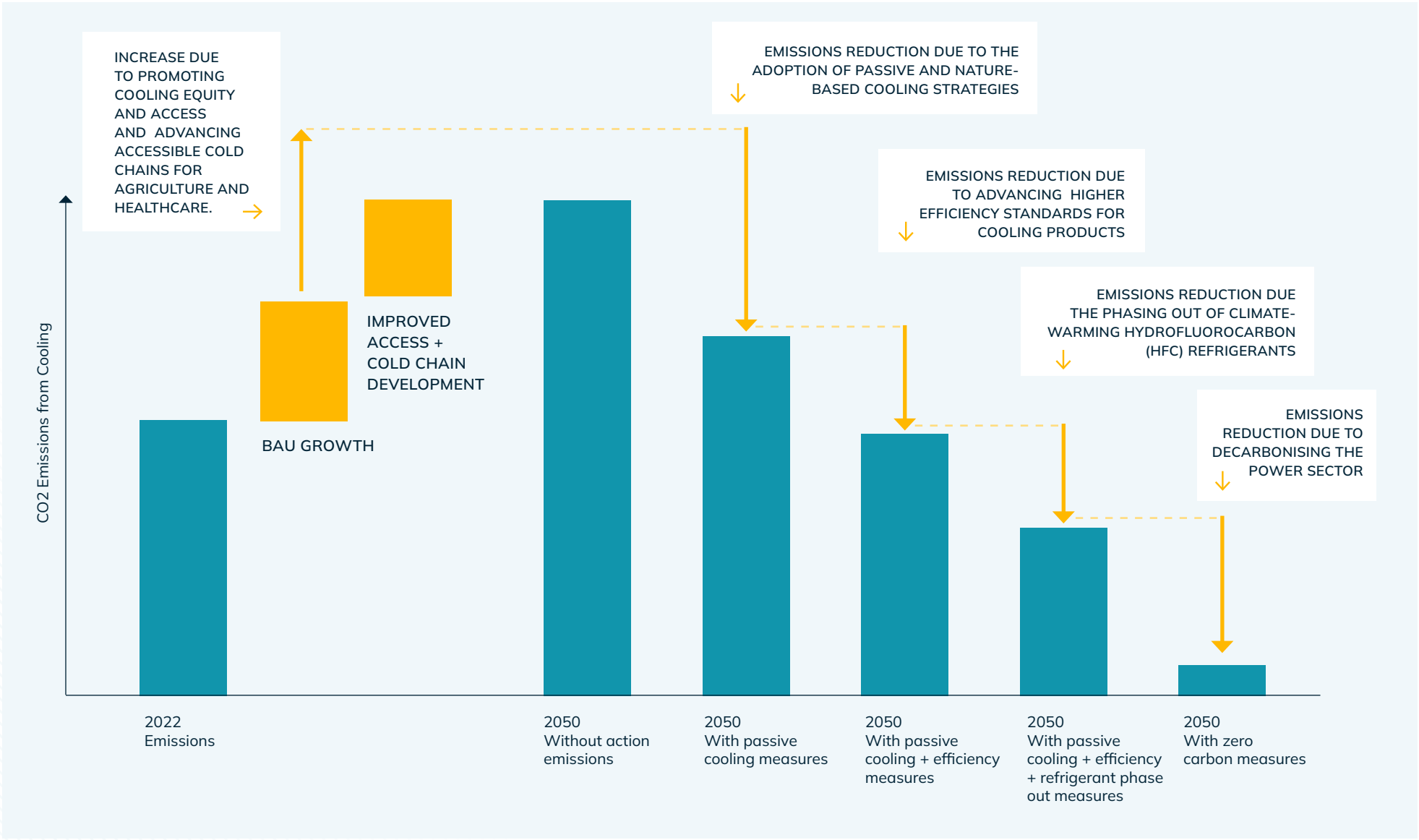
In this chapter, six key themes are identified as the fundamental elements to achieve sustainable cooling for all in Ghana:

- Adopting passive and nature-based cooling strategies
- Advancing higher cooling energy-efficiency standards
- Phasing out of climate-warming hydrofluorocarbon (HFC) refrigerants
- Decarbonizing the power sector
- Promoting cooling equity and access
- Advancing accessible cold chains for agriculture and healthcare.

Figure 7 illustrates the hierarchy and impact of the themes in terms of cooling-related carbon emissions.

Each theme and its relevance to Ghana is outlined below, with further information and implementation opportunities. The following chapter then provides recommendations for actionable policies and interventions that cut across these themes, underpinning sustainable cooling for all in Ghana.

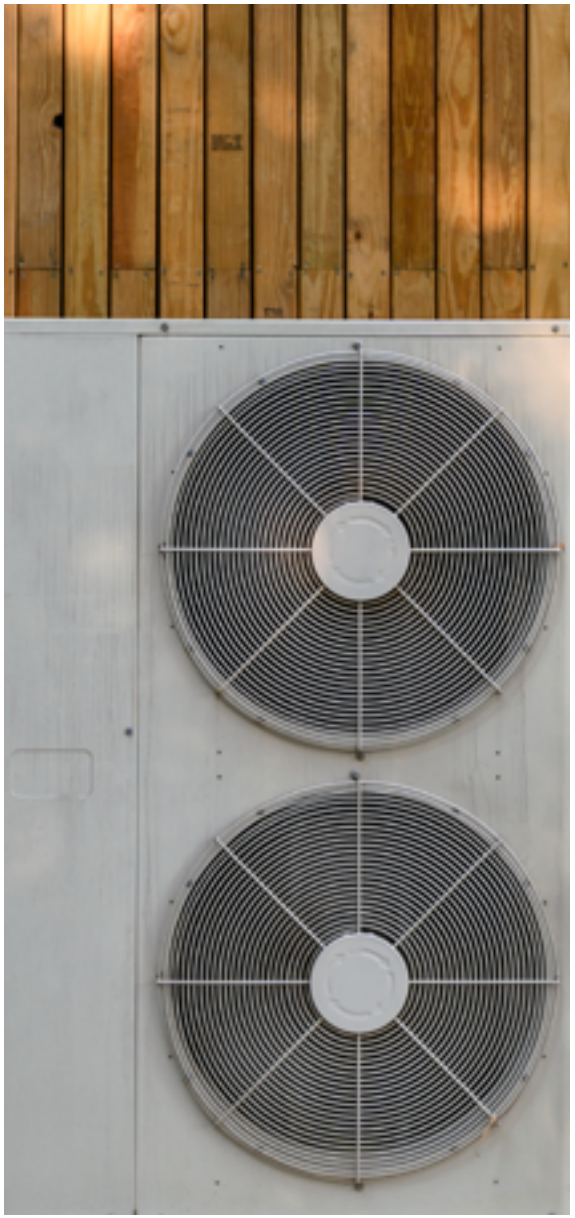
Figure 7: Illustrative emissions contribution from each theme underpinning sustainable cooling for all in Ghana (indicative illustration only)



ADOPTING PASSIVE AND NATURE-BASED COOLING STRATEGIES

The Global Cooling Watch Report, *Keeping it Chill: How to meet cooling demands while cutting emissions*[26], by the UNEP-led Cool Coalition, determines that implementing **passive and nature-based cooling strategies across all sectors could reduce global cooling power loads by 24 percent** compared to business as usual (BAU). In Ghana, the potential impact of passive and nature-based cooling strategies on future cooling demand is similarly significant. Importantly, passive and nature-based cooling strategies also protect the most vulnerable communities who lack electricity or financial resources to access active cooling by mitigating heat and reducing heat exposure.

Passive cooling strategies for buildings in Ghana focus on optimizing building design and materials to reduce heat and energy consumption. Techniques include using solar shading, natural ventilation, thermal mass, insulation and reflective surfaces to regulate temperatures. Studies in Ghana show that these methods can reduce cooling loads by up to 35 percent in office buildings and lower energy use by 50 percent.[27] In low-income areas, traditional materials like earth walls and thatched roofs help maintain cooler indoor temperatures, with rooms being up to 4.5°C cooler than those built with concrete and metal roofs.[28] The National Cooling Action Plan (NCAP) promotes passive cooling in new construction through cool roofs and energy-efficient materials, while more training and capacity building are needed to support widespread adoption, as well as more explicit requirements in the national building code.



26 Keeping it chill: How to meet cooling demands while cutting emissions, UNEP, 2023. https://www.unep.org/news-and-stories/speech/keeping-it-chill-how-meet-cooling-demands-while-cutting-emissions

27 Eric Ohene, Shu-Chien Hsu, Albert P.C. Chan, Feasibility and retrofit guidelines towards net-zero energy buildings in tropical climates: A case of Ghana, Energy and Buildings, Volume 269, 2022, 112252, ISSN 0378-7788, https://doi.org/10.1016/j.enbuild.2022.112252.

28 Wilby, Robert & Kasei, Raymond & Gough, Katherine & Amankwaa, Ebenezer & Abarike, Mercy & Anderson, N & Codjoe, Samuel & Griffiths, Paula & Kaba, C & Karim, Abdullah & Kayaga, Sam & Matthews, Tom & Mensah, Peter & Murphy, Conor & Yankson, P. (2021). Monitoring and moderating extreme indoor temperatures in low-income urban communities. Environmental Research Letters. 16. 10.1088/1748-9326/abdbf2.

To mitigate urban heat and enhance thermal comfort for city dwellers, it is crucial to safeguard and promote nature-based cooling solutions, such as trees, vegetation and bodies of water. Nature-based cooling solutions provide shade and temperature reduction through evapotranspiration and evaporative cooling. Capitalizing on Accra's involvement with the C40 Cool Cities Network, the implementation of a flagship 'Cool Cities' programme can effectively mobilize resources and efforts toward adopting passive and nature-based solutions, thereby mitigating and adapting to heat in urban areas.

Some useful resources for practical passive cooling solutions in cities in buildings are:

- United Nations Environment Programme (2021). Beating the Heat: A Sustainable Cooling Handbook for Cities. Nairobi. **Link**
- Primer for Cool Cities: Reducing Excessive Urban Heat – With a Focus on Passive Measures (English). Energy Sector Management Assistance Program (ESMAP); Knowledge series 031/20. Washington, D.C.: World Bank Group. **Link**

In addition, this **Airflow for Buildings CFD (ABCFD) tool** based on OpenFOAM is an open-source tool designers, architects and engineers can use to analyze the thermal comfort impact of insulated walls, external shading and efficient night-time wind-driven cooling.

Photo: Timothy Whitehouse

ADVANCING HIGHER COOLING ENERGY EFFICIENCY STANDARDS

Once cooling demand has been reduced as far as possible with passive and nature-based cooling techniques, highly energy-efficient active cooling solutions and proactive maintenance are needed to control temperatures to provide comfort while minimizing energy demand.

For health and well-being indoors, circulating fans, exhaust or fresh air supply fans, or evaporative cooling systems can provide space cooling without the need for refrigerants. If their availability is limited, split air conditioners (ACs) or chillers, for example, can be adopted.

For healthcare and agricultural cold chains, fridge/freezers and cold rooms can maintain low and ultra-low temperatures using refrigerant technology. High-efficiency refrigeration and air-conditioning (RAC) models feature advanced compressors, large heat exchangers, efficient fan motors and smart sensors, often using low global warming potential (GWP) refrigerants.

Minimum Energy Performance Standards (MEPS) for RAC equipment in Ghana were updated in 2022, requiring all new non-ducted single-split AC systems to have an average energy efficiency ratio of 3.66, up from the previous standard of 2.8. This is part of a broader effort to improve energy efficiency across the sector, with a seven-star rating system introduced to promote high-efficiency technologies. The largest RAC market shares in Ghana include single-split AC systems, comfort fans and fridge/freezers. The GIZ's 2018 market analysis of the inventory indicated that Ghana could exceed its 2030 efficiency goals, reducing cumulative carbon emissions and providing financial savings for consumers.[29]

Training and certification for RAC technicians are critical to maintaining high energy efficiency. Additionally, behavioural changes, such as adhering to thermostat set points between 23°C and 26°C, could lead to significant energy savings, with up to 44 percent reductions in air-conditioned spaces[30,31].

This resource is helpful for a deeper understanding of space cooling:

- ESMAP. 2020. Primer for Space Cooling (English). Knowledge Series; no. 30-20 Washington, D.C.: World Bank Group. **Link**

29 https://www.green-cooling-initiative.org/fileadmin/Publications/2018_GCI_Inventory_Report_Ghana.pdf

30 https://www.iea.org/reports/residential-behaviour-changes-lead-to-a-reduction-in-heating-and-cooling-energy-use-by-2030

31 Kofi Owura Amoabeng, Richard Opoku, Samuel Boahen, George Yaw Obeng, Analysis of indoor set-point temperature of split-type ACs on thermal comfort and energy savings for office buildings in hot-humid climates, Energy and Built Environment, Volume 4, Issue 3,2023,Pages 368-376, ISSN 2666-1233, https://doi.org/10.1016/j.enbenv.2022.02.00

PHASING OUT CLIMATE-WARMING HYDROFLUOROCARBON (HFC) REFRIGERANTS

The phase out of climate-warming refrigerants is fundamental to the global transition to sustainable cooling. The subsection *Cooling Power & Emissions* of this report highlights Ghana's commitment to the Kigali Amendment of the Montreal Protocol. This includes reducing the GWP of refrigerants in new and existing equipment (e.g., move to CO_2-based cooling in supermarkets, enhanced AC MEPS, low GWP limit for AC refrigerants) and preventing HFC emissions from leaking from existing equipment (through checks, servicing and recovery at end of life supported by appropriate **training and capacity building**).

UNEP OzonAction provides guidance and resources on this topic.

BOX 1

REFRIGERANTS

Refrigerants are chemical compounds used in cooling systems, such as air conditioners and refrigerators, to absorb heat and provide cooling. They transition between liquid and gas states, enabling the transfer of heat from inside the system to the outside environment.

The selection of refrigerants is crucial due to their environmental impact, particularly concerning ozone depletion and global warming potential. Under the Kigali Amendment to the Montreal Protocol, HFCs, such as R-134a, R-410A and R-404A, are being phased down due to their high GWP.

Environmentally friendly alternatives with lower GWP include R-32, R-1234yf, R-1234ze, R-744 (CO2), R-717 (ammonia) and R-290 (propane), which are increasingly adopted to reduce environmental impact and comply with the Kigali Amendment.

DECARBONIZING THE POWER SECTOR

To reduce cooling-related carbon emissions, the power used by cooling devices must be decarbonized. To ensure this, electricity demand for cooling must be managed such that it does not undermine the country's decarbonization plans or stress the available generation capacity.

The reality of unreliable or unavailable grid power supply likely leads cooling consumers such as schools, hotels and hospitals, to on-site power generation. Low- or zero-carbon emission alternatives to diesel and petrol backup generators are sought.

The Ghana Energy Transition and Investment Plan (ETIP), which aims to meet the country's growing electricity demand while reaching net-zero carbon emissions by 2060, involves a significant expansion of solar PV and the gradual introduction of nuclear power, ensuring that the electricity grid can support sustainable cooling solutions with minimal environmental impact. Furthermore, encouraging solar-driven refrigeration and cooling systems in off-grid (or unreliable-grid) environments will help reduce reliance on back up diesel/petrol generators. For example, Akofresh is a start-up company that provides off-grid mobile cooling solutions powered by solar systems, solving the problem of food waste by using cold storage container technology in Akomadan.

Photo: AkroFresh

PROMOTING COOLING EQUITY AND ACCESS

Cooling equity and access actions must address the fundamental objectives of Sustainable Development Goals (SDGs) 1 (no poverty), 7 (affordable and clean energy) and 10 (reduced inequality) so communities have the resources to access affordable, safe and reliable cooling. The relationship between cooling equity and access is mutual since access to sustainable cooling helps alleviate poverty and reduce inequality by improving health, productivity and income opportunities. Efforts must focus on reaching the most vulnerable, i.e., the 12.9 million rural and urban poor living without access to electricity, and addressing equity issues including gender-related challenges (see **Cooling for All and Gender: Towards Inclusive, Sustainable Cooling Solutions)**.

ADVANCING ACCESSIBLE COLD CHAINS FOR AGRICULTURE AND HEALTHCARE

Given major social and economic opportunities as well as current challenges in the agriculture and healthcare sectors, it is necessary to focus on providing accessible cold chains for agriculture and healthcare that support economic development and strengthen food security and health outcomes, particularly in rural communities. This includes adopting innovative technology and services such as vaccine delivery by drone from Zipline and building on lessons learned from pilot projects such as PEG Africa's sale and leasing of solar-power freezers to rural off-grid customers in Ghana's Volta and Eastern regions. Ideally efforts should be supported by a government-backed centre for sustainable cooling and cold chains, potentially linking to the wider-continent initiative Africa Centre of Excellence for Sustainable Cooling and Cold-Chain (ACES).

By linking these themes, Ghana can accelerate its transition to sustainable and equitable cooling, addressing both immediate and long-term challenges across different sectors. These efforts will not only improve living conditions and productivity, but also contribute to the country's broader goals of climate resilience and economic development.

04 POLICY INTERVENTIONS TO ACHIEVE SUSTAINABLE COOLING FOR ALL IN GHANA

Ghana is positioned to achieve sustainable cooling for all by leveraging its national strategies and international commitments. Priority areas for policy and market interventions are recommended to strengthen the country's political landscape and enable sustainable cooling for all. The recommendations focus on integrating existing efforts, addressing policy gaps and enhancing information, awareness and capacity at both national and local levels.

INTEGRATE COOLING WITH NATIONAL AND SUBNATIONAL ENERGY, CLIMATE & DEVELOPMENT POLICIES

Given the critical role cooling plays in Ghana's development — supporting healthcare, agriculture, productivity and well-being — integrating cooling needs into energy, climate and socioeconomic plans is essential. Cooling must be highlighted in Ghana's Nationally Determined Contributions (NDCs) and aligned with the Ghana Energy Transition Investment Plan (ETIP) to ensure it contributes to

broader energy-transition climate change and socioeconomic development goals. This includes embedding cooling and cold-chain interventions into energy access programmes, particularly in rural areas where cooling enhances healthcare and agriculture.

Refrigeration and air-conditioning (RAC), energy and greenhouse gas (GHG) emission baselines and projection figures should be updated in Ghana's National Cooling Plan (NCP). A review and revision of data sources and the calculation methodology, integrating newly available information, will allow for more accurate baseline and projected energy demand and emissions data. This will be key to determining cooling's contribution to Ghana's Nationally Determined Contributions (NDCs) and overall climate goals.

Integrating sustainable cooling and cold chain interventions with energy access efforts to extend the life of produce and agricultural products, or provide temperature-controlled environments in healthcare facilities, can be an important element of the integrated policy intervention. Furthermore, including considerations for gender and other vulnerabilities in the NCP revisions and other implementing policies and action plans will support equality in achieving access to sustainable cooling. This includes integrating gender-disaggregated indicators and analyses as well as income-level associated indicators and analysis and participatory mechanisms to inform the design of policies and tracking of outcomes.

STRENGTHEN THE MANDATE FOR THE NATIONAL COOLING PLAN COMMITTEE AND GOVERNANCE SYSTEM

The National Cooling Plan Committee (NCPC) proposed in the NCP, has yet to be established. A strengthened governance system is necessary for advancing sustainable cooling in Ghana. Establishing a dedicated NCPC will create cross-ministerial coordination, institutional support and oversight for implementing cooling strategies while fostering synergies among stakeholders. The committee would play a key role in tracking progress, fostering public-private partnerships and ensuring institutional capacity is built to meet growing cooling demands.

The key responsibilities of this coordinating body would include:

Coordination support, including:

- **Facilitating inter-ministerial coordination** to leverage synergies and implement integrated solutions, such as aligning investment in refrigerant transition efforts with appliance energy efficiency initiatives.
- **Coordinating collaboration** among experts and civil servants to draft, update and integrate National Cooling Action Plan (NCAP) strategies, close data gaps and identify opportunities for demonstration projects.
- **Fostering partnerships** and encouraging collaboration among governments, private sector entities, civil society organizations and international institutions to address the complex challenges of sustainable cooling. These partnerships would facilitate knowledge sharing, resource pooling and coordinated action across sectors and regions.

Knowledge support, including:

- **Establishing a national centre for sustainable cooling** to serve as a resource hub for provinces, counties and cities, offering training and knowledge exchange to enhance institutional capacities. It could also support the establishment of a government-backed centre for sustainable cold chain development, as recommended in the 'Enable access to low climate-impact cooling and cold chain for agriculture & healthcare' initiative.
- **Tracking and updating progress** towards achieving the NCP goals, developing relevant and more granular indicators, gathering data, leading analytics, integrating new information and technologies into the implementation plan, and ensuring continuous improvement.
- **Creating a national cooling repository** accessible to provincial, county and city governments, consolidating existing cooling knowledge products and policy toolkits, such as those from the UNEP-led Cool Coalition and the World Bank to bridge knowledge gaps.
- **Developing a government-backed cooling appliance database** to track cooling appliance sales and ownership, providing critical data for informed decision-making and NCP updates and tracking.

Capacity building and implementation support, including:

- **Assessing and building capacities** by evaluating the capabilities of national and county authorities, as well as key actors, to enforce and implement ongoing and planned cooling initiatives. This includes developing the workforce and technical expertise necessary for delivering sustainable cooling solutions.
- **Instituting national and county-level cooling champions**, potentially in the form of city cooling officers in flagship counties and cities, to lead cooling initiatives (see the recommendation on 'Cool Cities').

Financing and investment support, including:

- **Mobilizing funding for implementation and research & development** to advance innovative, energy-efficient, affordable and environmentally friendly cooling technologies, such as low-cost passive cooling solutions using locally available natural materials.

ENABLE 'COOL CITIES' THROUGH A CALL TO ACTION, CITY NETWORKS AND LEADING BY EXAMPLE

Urban areas, particularly cities like Accra and Kumasi, are highly vulnerable to extreme heat. A 'Cool Cities' programme could help mitigate urban heat islands through green and blue infrastructure, cool roofs and public cooling spaces. Accra's involvement in the C40 Cool Cities Network can serve as a model, leveraging city networks to share knowledge and promote integrated urban cooling strategies. The following actions are recommended:

- **Promote 'Cool Cities':** Encourage flagship counties and cities/towns, such as Accra, to develop integrated strategies that address urban cooling needs and mitigate heat. Support these efforts by urging subnational governments to sign the Global Cooling Pledge, committing to developing Heat Action Plans, increasing green and blue spaces in urban areas and prioritizing public procurement of low-global warming potential (GWP), high-efficiency cooling technologies. Strategies should focus on vulnerable populations by developing public cooling infrastructure and communication systems for heat warnings and health alerts.
- **City-to-city learning:** Establish national 'city (or county) cohorts' or knowledge-sharing frameworks to enable learning and scaling of cooling actions across counties and cities, reinforcing their contributions to national climate goals.
- **Lead by example:** City and subnational governments can set a strong example by implementing high-efficiency building standards, using best-in-class cooling equipment, and adopting procurement guidelines focused on the lowest lifecycle cost. This includes constructing municipal buildings with passive and nature-based cooling measures and choosing cooling systems that minimize energy consumption and environmental impact. These actions can inspire broader adoption of sustainable practices among businesses, organizations and residents.

INCREASE THE ADOPTION OF PASSIVE AND NATURE-BASED COOLING IN BUILDINGS AND CITIES

To ensure new and existing buildings across all sectors and socioeconomic domains do not exasperate heat exposure or cooling demand, the following are recommended:

- Update the Building Code: The 2018 Ghana Building Code already includes some energy efficiency measures but could be improved further to include additional passive design requirements.
  - **Passive cooling** measures could include window-to-wall ratios and glazing solar heat gain coefficients to limit solar heat gain; shading guidelines with detailed instructions based on wall orientation; roof Solar Reflectance Index (SRI) specifications; and maximum U-values for walls, roofs and floors in air-conditioned spaces.
  - **Energy efficiency** for cooling equipment requirements could include integrating and explicitly referencing existing

Minimum Energy Performance Standards (MEPs) for cooling equipment setting energy performance index (EPI) or energy use intensity (EUI) targets for different building types; establishing maximum cooling set points (e.g., 24-25°C) and minimum luminous efficacy standards for lighting; and providing guidelines for system commissioning and support with technical design guides like IFC EDGE standards.

- **Develop passive cooling, nature-based solutions and thermal comfort guidelines for low-income housing** that fall outside of the formal building regulations and regulated homes, prioritizing hot regions. This could cover:
  - **Low-cost, local materials** that enhance thermal comfort.
  - **Designing templates** incorporating passive and nature-based cooling for easy adoption, for example vegetation in compounds with a list of recommended local or native plants, white roofs and operable windows.
  - **Community training** to educate residents on maintaining and optimizing passive design features in their homes while informing them of their benefits.
  - **Identifying incentives** such as subsidies and tax credits for projects meeting passive and nature-based cooling/ thermal comfort standards.
- **Public sector to lead by example** by promoting energy efficiency and sustainable cooling in buildings through public sector improvements that set higher standards than the private sector is likely to follow. This could include:
  - Establishing **energy efficiency standards** for public buildings, requiring new and retrofitted buildings to meet benchmarks like IFC EDGE.
  - Enforcing guidelines for **passive and nature-based cooling** in public buildings (e.g., solar shading, cool roofs, green walls, green roofs).
  - Mandating **energy performance disclosure** and **benchmarking** for public buildings, encouraging transparency and continuous improvement.
  - Conducting regular **energy audits** to optimize building performance and disclose energy-saving benefits to the public.
- **Provide training & capacity building of design, construction and building management professionals** with knowledge of passive and nature-based cooling practices and materials. For example:
  - **Upskilling professionals** (engineers, urban planners and designers, architects, contractors) through continuous professional development, certification programmes and knowledge exchange platforms.
  - **Integrating cooling and sustainable building practices into educational curricula** and incorporating cooling as one of the 'Skills for National Development Priorities' in national skills development policies.
  - **Enhancing collaboration** with professional bodies such as the Ghana Institution of Engineering and the Ghana Institute of Architects.

ACCELERATE THE TRANSITION TO MODEL MEPS AND PARTICIPATE IN REGIONAL HARMONIZATION

Ghana has made substantial progress with its MEPS, but regional harmonization will further accelerate market transformation. As acknowledged in the Ghana NCP, harmonizing MEPS among neighbouring countries with similar usage and energy cost conditions across the same product categories can help with verification and compliance. Harmonized measurement standards facilitate the work of market surveillance authorities because only one test is required and used across different markets, thus avoiding test duplication. This increases the comparability of products among regions and the transparency of the market. It can also contribute to regional price reductions by lowering regulatory costs and expanding the market size, while expediting market introduction of higher standard products to multiple markets.

It is strongly encouraged that this work is continued by building on the existing initiatives:

- West Africa Energy Cooling Initiative
- West Clean Energy Eco-fridge Project
- Economic Community of West African States (ECOWAS) Centre for Renewable Energy and Energy Efficiency (ECREEE) project initiated by ECOWAS

Beyond regulations and standards, formalized training and certification schemes for RAC technicians are necessary to ensure a skilled workforce exists to install and maintain RAC equipment such that high energy efficiency is maintained throughout the equipment's lifetime. Training and capacity building extends to architects, engineers and suppliers who need to be informed and skilled to make appropriate energy efficiency sizing and selection of equipment for different applications.

STIMULATE MARKET DEMAND AND DRIVE BEHAVIOURAL CHANGE WITH GOVERNMENT LEADING BY EXAMPLE

The Government of Ghana should stimulate market demand for energy-efficient cooling products by leading through public procurement. Prioritizing energy-efficient cooling appliances for government buildings and leveraging e-procurement platforms will set an example for the private sector. In addition, behavioural change campaigns targeting both consumers and businesses will further encourage the adoption of low-global warming potential (GWP), energy-efficient products, contributing to long-term energy savings and emissions reductions.

E-procurement, the process of purchasing goods and services through electronic means, offers a streamlined, efficient and transparent method for governments to manage procurement processes. Ghana can leverage e-procurement platforms, such as the Ghana Electronic Procurement System, to enhance energy efficiency in the cooling sector through several strategic approaches:

- **Specification of energy-efficient cooling products**, e.g., incorporating requirements to meet the MEPS for fridges, air conditioners (ACs) and fans.
- **Integration of cooling appliance energy performance data into the procurement platform** enabling procurement officials to make informed decisions based on energy efficiency. Importantly, this should include lifetime cost of ownership, i.e., operational cost over equipment life plus the equipment purchase price instead of purchase price alone-based decision-making.
- **Facilitating bulk purchasing of efficient cooling equipment.** Procurement officials can aggregate multiple simultaneous procurements, across the national, regional, or local government to create larger demand for similar cooling equipment and reduce costs through bulk purchasing. Electronic procurement systems can make separate projects visible to officials who can coordinate similar product purchases.
- **Promoting competition among suppliers** to provide the most energy-efficient cooling solutions at the best prices. This can be achieved through competitive bidding processes that include energy efficiency as a key evaluation criterion.
- **Encouraging innovation and new cooling technologies that exceed current standards for energy efficiency.** The government can issue requests for proposals (RFPs) for cutting-edge technologies or pilot projects that demonstrate new ways to achieve cooling needs more efficiently.
- **Enhancing transparency and accountability** by making procurement processes of sustainable cooling solutions more visible and traceable. This can help ensure that decisions favour products that truly meet energy-efficiency criteria, reducing the risk of corruption or undue influence by suppliers of less efficient products.
- **Capacity building and awareness through providing training and resources to procurement official**s on the importance of energy efficiency in the cooling sector. This includes understanding how to evaluate energy efficiency claims and the long-term cost savings and environmental benefits.

ENHANCE ACCESS TO LOW CLIMATE-IMPACT COOLING AND COLD CHAIN FOR AGRICULTURE & HEALTHCARE

Improving access to sustainable cooling, especially in rural areas, is crucial for reducing post-harvest food losses and ensuring the safe transport of medical supplies. Decentralized cooling hubs, powered by renewable energy, can provide farmers with access to cold storage, extend the shelf life of perishable goods, and enhance healthcare cold chains. Public-private partnerships and targeted investments will be key to modernizing Ghana's cold chain infrastructure in both the agriculture and healthcare sectors.

Enhanced access can be coordinated and supported by establishing a government-backed centre for sustainable cold chain development. In addition, it is recommended that improved data collection, monitoring and analytics/research is conducted to support decision-making.

With a large portion of Ghana's food production coming from rural areas, the following are recommended:

- **Post-harvest food loss management/ access to cooling**: Effective management of post-harvest food loss is crucial for maximizing the utility of agricultural produce. By providing adequate cooling access, the shelf life of perishable goods can be extended, reducing waste and ensuring more food makes it from farms to markets thus increasing farmers' income.
- **Decentralized (close to farmgate) cooling access:** Implementing decentralized cooling facilities close to farm gates allows for immediate cooling of harvests, which is vital for maintaining quality and freshness, especially in remote and rural areas. This approach is also beneficial for coastal communities where seafood must be promptly chilled to preserve freshness and quality, as demonstrated by solutions like AkoFresh.
- **Cooperatives/cooling hubs**: Cooperative cooling hubs enable resource sharing among small and medium-sized farms, reducing individual costs and fostering collaborative market access. These hubs serve as centralized points where farmers can store, cool and collectively sell their produce, improving market linkages and financial outcomes for participants, and creating economies of scale for cost reduction at an aggregated community level.
- **Strengthen access to cooling in healthcare settings:** Bulk procurement is a key strategy to expedite the adoption of sustainable cooling solutions in healthcare settings, both for vaccine refrigeration and comfort cooling. Sector-wide approaches to access to refrigeration together with sustainable, reliable energy supply in health centres can also benefit from economies of scale. There is also a pressing need to train technicians to reduce the lifecycle costs of cooling equipment.

PROMOTE SUSTAINABLE COOLING AWARENESS

Raising awareness about sustainable cooling is fundamental to driving the adoption of energy-efficient practices and effective climate change measures. A national campaign should be launched to educate consumers, businesses and policymakers about the benefits of sustainable cooling technologies.

Property and project developers, architects and engineers, suppliers, labourers and installers, building owners and occupants, and civil society need to be informed about passive and nature-based cooling strategies including their use case and benefits to apply them effectively. In addition, information about energy-efficient materials and cooling appliances needs to be widely available to increase their uptake. To increase access to information, the following initiatives are recommended:

- **A national online information-repository of energy efficiency building materials and passive strategies** including their use cases and benefits. This would include, for example:
  - Details and guidance on materials and solar shading solutions that are suitable for each climate zone across Ghana.
  - Supplier details for, e.g., glazing with low solar heat gain coefficient coatings, solar blinds and insulation.
- **A national database of efficient cooling appliances including their availability, suppliers and key technical details** in an easily comparable format. This can build on the existing Eco Fridges Product List.

05 INCREASING INVESTMENT AND FINANCE FOR SUSTAINABLE COOLING FOR ALL IN GHANA

This section outlines key funding mechanisms and financial and fiscal strategies necessary to drive the transition to sustainable cooling in Ghana. Ghana's decentralized governance model and robust financial market, which includes banks, microfinance institutions and development finance entities, provide a strong foundation for sustainable cooling investments. Government policies, such as municipal bonds, public-private partnerships and land value capture, can enable infrastructure financing for urban cooling projects.

Ghana's cooling sector relies heavily on commercial financing, with most cooling device purchases made on a cash basis, limiting options for consumers without access to credit. To promote energy-efficient cooling, innovative financing schemes have been introduced. The UNDP supported a fridge rebate programme, allowing consumers to trade in old fridges for new, efficient ones. The **Ecofridges programme** offers "Green On-Wage" financing, allowing public and private employees to replace old cooling equipment through salary deductions without upfront investment. Private sector models like **Akofresh**, provide "cooling as a service," using solar-powered cold rooms to extend the shelf life of crops from five to 21 days, helping farmers secure better prices for their produce.

Expanding financing options, such as service contracts and leasing, could further increase access to cooling and maintenance services. Another example is the **SUNREF Ghana**, an initiative supporting sustainable energy projects through loans and technical assistance.

Further scaling and expansion of sustainable cooling financing and investment models, however, are necessary to meet expected cooling needs. Key barriers include a lack of stringent policies, coordination issues among stakeholders, and limited access to capital. Addressing these challenges requires a strong policy framework, capacity building, and innovative financial tools like green bonds and blended finance.

Public sector finance and fiscal schemes play a pivotal role in addressing barriers to sustainable cooling by creating a favourable policy environment that attracts private investments. Key steps for unlocking sustainable cooling in Ghana include:

- **Regulatory optimization:** Strengthening and regularly updating Minimum Energy Performance Standards (MEPS) across a wide spectrum of appliances is crucial for ensuring energy efficiency. This regulatory framework should extend to labelling systems that inform consumers about energy-efficient products, driving market demand for green cooling technologies.
- **Institutional strengthening:** National institutions need capacity building to follow up on technological advancements, coordinate relevant actors, effectively enforce energy regulations, monitor compliance, and facilitate the adoption of climate-friendly cooling technologies. This includes training programmes for technicians and manufacturers in energy-efficient practices, as well as public awareness campaigns.
- **Incentivizing private sector engagement:** Financial and fiscal incentives such as rebates, tax credits, or deposit systems should be introduced to encourage manufacturers, investors and end users to adopt energy-efficient cooling systems and low-global warming potential (GWP) refrigerants. Establishing public-private partnerships (PPPs) can also stimulate co-financing for large-scale energy infrastructure projects.

- **International support and technical assistance:** International financial institutions, such as the World Bank and regional climate funds, play a vital role in providing upfront capital and technical support where domestic budgets fall short. These funds can be used to finance pilot projects, support market transformation and promote the deployment of innovative cooling technologies. Additionally, philanthropies are increasingly exploring avenues to bundle international financing and scale private sector investments in developing countries such as Ghana.

Furthermore, to drive the transformation toward sustainable cooling for all, several critical recommendations are outlined for stimulating finance and investment in Ghana's cooling sector:

- **Improve climate finance tracking:** Ghana should enhance the granularity of climate finance tracking at the national level to develop detailed sectoral financing roadmaps. The development of tools like CLIMFINTRACK, which tracks public sector climate finance, is a promising step. Expanding this to include private sector investments through frameworks like the Sustainability Accounting Standards Board (SASB) and Global Reporting Initiative (GRI) can help standardize reporting and improve alignment with international taxonomies.
- **Establish a climate finance baseline:** Creating a clear baseline and target for climate finance is essential to identifying and removing investment barriers in key sectors. This baseline will help to track progress, prioritize investments, develop investment targets and align climate finance with Ghana's broader development goals.
- **Leverage innovative financing instruments:** Utilizing green bonds, blended finance and other innovative financial tools can help mobilize private capital for climate-friendly cooling projects. Blended finance can be instrumental in reducing risks for private investors while ensuring that investments align with both market priorities and Ghana's climate goals.
- **Build pipelines of investable companies and projects:** To attract more climate capital, Ghana needs to foster an ecosystem that supports the growth of locally

investable enterprises, especially small and medium-sized enterprises (SMEs). This includes strengthening business advisory services that enhance investment readiness and help businesses adopt climate-friendly cooling technologies at local level that contribute to lower the service costs and retain payments within the country. Establishing a pipeline of investable projects, particularly in agriculture and healthcare, with a strong focus in rural areas, will also help channel funds into sustainable cooling technologies.

- **Align Nationally Determined Contributions (NDCs) with investment flows:** Ghana's NDCs should be aligned more closely with investment strategies to ensure that climate finance is effectively channelled towards national priorities and that projects embody them. This could involve the development of a dedicated climate finance taxonomy to improve the transparency and rigour of financing flows.
- **Promote case studies of adaptation finance:** Developing case studies and examples of successful climate finance in adaptation, particularly for agricultural resilience, will help build confidence among investors. By demonstrating the economic and social benefits of such investments, Ghana can attract more climate funding from diverse private capital providers.
- **Foster collaboration between financial institutions and climate finance ecosystems:** Building stronger communication channels between financial institutions including local commercial banks and the climate finance ecosystem is essential to overcoming barriers to investment. This includes improving connectivity between demand (climate projects) and supply (capital providers) and ensuring that both sectors are aligned in their goals. Collaborative platforms can also be developed to share knowledge, identify challenges and unlock greater deal flow for sustainable cooling initiatives.

By implementing these recommendations, Ghana can accelerate its transition to sustainable and equitable cooling, ensuring that both the climate and social equity dimensions of cooling are addressed in a cohesive and forward-looking manner.

ANNEX 1
FINANCIAL MECHANISMS FOR SUSTAINABLE COOLING

TABLE 2: Financial mechanisms for sustainable cooling

CLUSTER OF FINANCE	CHARACTERISTICS	USES	STRENGTHS AND WEAKNESSES
GRANTS/TECHNICAL ASSISTANCE	• Provided by development and philanthropic actors • No financial return expectation	• Supporting instruments, intended to help achieve impact goals • Important when entering new markets • Preferred for nascent technologies where secondary market hasn't developed	• Require less financial knowledge • Need to strike a balance between accountability and flexibility • Historically criticized for lack of effectiveness • Cause market distortions.
RESULTS-BASED FINANCING (RBF)	• Links impact creation directly to financial rewards/Incentives • Allows stakeholders with different interests to be aligned • Addresses an impact-specific need with performance-based KPIs	• Directly creates impact and strengthens the relationship between impact and the financial payment • Demonstrates the effects of the instrument • Can be combined with grants and technical assistance/Capacity enhancement instruments	• Creates knowledge sharing of an impact sector or region among stakeholders • Clear impact measurement and reporting • Tends to be smaller in size and higher in complexity–needs to answer the question of scalability and phaseout • Requires appropriate and material financial reward to be effective • Can invite public scrutiny when misunderstood as subsidizing the private sector • Creates knowledge sharing of an impact sector or region among stakeholders
MARKET-RATE DEBT & EQUITY, SUBORDINATED DEBT, CONCESSIONAL DEBT & EQUITY	• Clear distinction between debt and equity capital • Equity takes a higher risk, higher return and ownership; debt takes a lower risk, lower return and no ownership • Subordination is about risk–taking a junior position and a lower priority for repayment • Concessionally is about lower return and/or longer time horizons • Capital providers can be both subordinate and concessional, but are not necessarily so	• Varying motivations depending on debt vs. equity, market-rate vs. subordinate vs. concessional capital • Chosen for being an established instrument • Important to align risk and return expectations by using clearer terminology	• Established instruments easily understood by the private sector and other stakeholders • Require financial knowledge • Impact not explicitly built into the structure • Financial and impact additionality is contested

ABOUT SEforALL

Sustainable Energy for All (SEforALL) is an independent international organization that works in partnership with the United Nations and leaders in government, the private sector, financial institutions, civil society and philanthropies to drive faster action on Sustainable Development Goal 7 (SDG7) – access to affordable, reliable, sustainable and modern energy for all by 2030 – in line with the Paris Agreement on climate change.

SEforALL works to ensure a clean energy transition that leaves no one behind and brings new opportunities for everyone to fulfil their potential. Learn more about our work at www.SEforALL.org