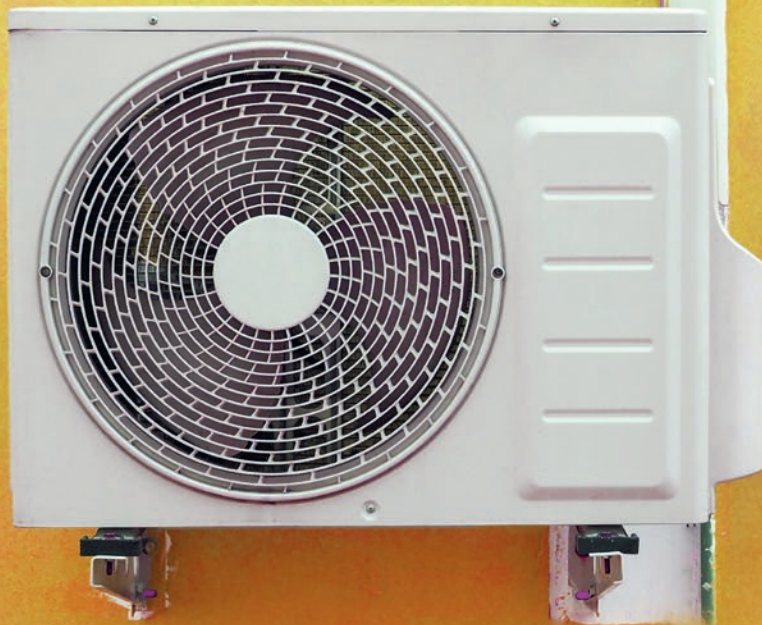




# GHANA REFRIGERATION AND AIR CONDITIONING (RAC) ROADMAP



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ENVIRONMENTAL PROTECTION AGENCY

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Accra, April 2022

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# Abbreviations

<b>AC</b>	Air Conditioning	<b>INDC</b>	Intended nationally determined contributions
<b>AFOLU</b>	Agriculture, forestry and other land use	<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>BAU</b>	Business as Usual	<b>LCC</b>	Life Cycle Cost
<b>BMU</b>	German Federal Ministry for Environment, Nature Conservation and Nuclear Safety	<b>LCDS</b>	Low carbon development strategy
<b>CCAC</b>	Climate and Clean Air Coalition	<b>MEPS</b>	Minimum Energy Performance Standard
<b>CCGELS</b>	Climate Change and Green Economy Learning Strategy (Ghana)	<b>MESTI</b>	Ministry of Environment, Science, Technology and Innovation (Ghana)
<b>CDM</b>	Clean Development Mechanism	<b>MIT</b>	Mitigation scenario
<b>CEPs</b>	Customs Excise and Preventive Service	<b>MLF</b>	Multi-Lateral Fund
<b>CSIR</b>	Centre for Scientific Industrial Research	<b>MoEn</b>	Ministry of Energy
<b>CTCN</b>	Climate Technology Centre and Network	<b>MoF</b>	Ministry of Finance
<b>EE</b>	Energy efficiency	<b>MoTI</b>	Ministry of Trade and Institutions
<b>EEOS</b>	Energy efficiency obligation schemes	<b>MRV</b>	Measuring, Reporting and Verification
<b>EER</b>	Energy Efficiency Ratio	<b>MP</b>	Montreal Protocol
<b>EERS</b>	Energy efficiency resource standards	<b>NAMA</b>	Nationally Appropriate Mitigation Action
<b>EPA</b>	Environmental Protection Agency	<b>NACODS</b>	National Committee on Ozone Depleting Substances
<b>F-GAS</b>	Fluorinated Gas	<b>NARWOA</b>	National Association of Refrigeration Workshop Owners Association
<b>GAEC</b>	Ghana Atomic Energy Commission	<b>NCCAS</b>	National Climate Change Adaptation Strategy
<b>GCAI</b>	Green Cooling Africa Initiative	<b>NCCC</b>	National Climate Change Committee (Ghana)
<b>GCF</b>	Green Climate Fund	<b>NDC</b>	National Determined Contribution
<b>GEF</b>	Global Environment Facility	<b>NGO</b>	Non-governmental organization
<b>GHG</b>	Green House Gases	<b>NOU</b>	National Ozone Unit
<b>GIZ</b>	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH	<b>ODP</b>	Ozone Depletion Potential
<b>GMeT</b>	Ghana Meteorological Agency	<b>ODS</b>	Ozone Depletion Substance
<b>GSA</b>	Ghana Standards Authority	<b>RAC</b>	Refrigeration and Air Conditioning
<b>GSGDA</b>	Ghana Shared Growth and Development Agenda	<b>RDM</b>	Roadmap (referring to scenario)
<b>GWP</b>	Global Warming Potential.	<b>SEER</b>	Seasonal energy efficiency ratio
<b>HC</b>	Hydrocarbon	<b>TCPD</b>	Town and Country Planning Department
<b>HCFC</b>	Hydrochlorofluorocarbon	<b>UNE</b>	United Nations Environment
<b>HFC</b>	Hydrofluorocarbon	<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>HPMP</b>	Hydrofluorocarbon Phase-out Management Plan	<b>VRF</b>	Variable Refrigerant Flow
<b>ICI/IKI</b>	International climate initiative/ Internationale Klimainitiative	<b>VRV</b>	Variable Refrigerant Volume

# Executive Summary

## Purpose

Refrigeration and air conditioning (RAC) are responsible for a significant share of global greenhouse gas emissions. In Ghana, with its tropical climate, high population growth and rapid urbanization, widespread electrification and economic growth, the demand for cooling equipment is rising. Low efficiencies and high leakage rates of refrigerant gases with high global warming potential will increase these emissions drastically.

The aim of the policy analysis is to discuss policies and measures that will enable the transition to environmentally friendly solutions based on identified barriers. In a second step, the roadmap highlights a stepwise timeline with milestones for two RAC sub-sectors to achieve substantial emission reductions. The document builds on a previously published inventory of GHG emissions in the RAC sector and a technology gap analysis that highlights the potential of environmentally friendly RAC alternatives to replace current systems based on technical feasibility.

In Ghana, the RAC sector was determined to have caused GHG emissions of 5.05 Mt CO<sub>2</sub>eq in 2015 and is estimated to contribute about 6 Mt CO<sub>2</sub>eq in 2020, two thirds of them being indirect emissions from energy use. With the RAC inventory, a sound database of RAC equipment in use, its distribution in the subsectors and expected growth is established. Split AC and domestic refrigerators are together responsible for 75% of RAC-sector related emissions in Ghana and are therefore the focus of future analysis.

Globally and in Ghana, there are different levels of availability for technologies with high energy efficiencies and low-GWP refrigerants (green cooling technologies). In Ghana, green cooling technologies for domestic refrigerators, stand-alone units, chillers, and centralised systems are available. On the global market, green cooling technologies are also available for split ACs, and to a small extent for condensing units. More options for chillers and centralised systems are available in terms of the variety of natural refrigerants, higher energy efficiency and more varied application of these units. Introducing best available technology to the Ghanaian market can lead to an emission reduction potential of up to 1.9 Mt CO<sub>2</sub>eq by 2030 and 4.3 Mt CO<sub>2</sub>eq by 2050 annually compared to a business-as-usual scenario.

## Policy Analysis

Ghana has established legislation regarding the management of RAC equipment in the two focus applications split AC and domestic refrigerators as well as refrigerants in general from the point of import to the recycling and disposal. It has further defined emission reduction targets in the RAC sector under its nationally determined contributions. However, not all have been implemented and there are barriers to their enforcement. Refrigerant related RAC-sector policies follow the ODS phase-out schedule of the Montreal Protocol. Ghana has ratified the Kigali Amendment and is expected to phase-down climate harming refrigerants to 80% until 2045. There are few official policies regarding the use of natural refrigerants or leakage reduction. Training is available on an irregular and non-standardised level.

Energy efficiency policies, such as minimum energy performance standards (MEPS) and labelling, specifically for the two focus sectors unitary AC and domestic refrigerators are in place. It is further not allowed to import used equipment. Increased measures and enforcement are necessary. The approval of the updated MEPS by the parliament probably in 2022 are leading towards the right direction.

Ghana has started implementing its e-waste regulations, however, it has not yet been implemented for the environmentally sound recycling of RAC equipment, which requires specific measures regarding the refrigerants.

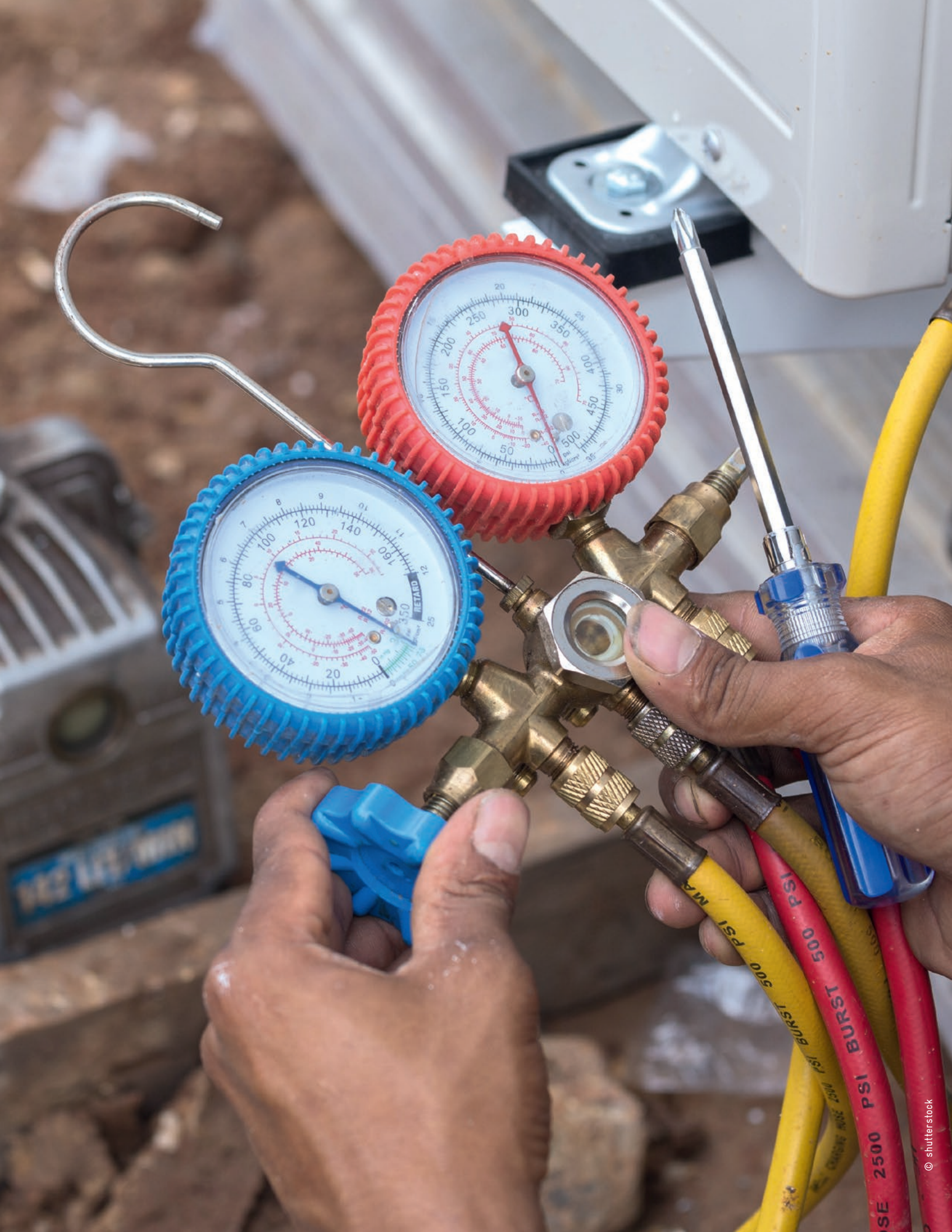
The following barriers for the introduction of green AC technologies have been identified: Lack of training for technicians in the safe use of flammable and other natural refrigerants as well as on leakage reduction and environmentally-sound recovery of refrigerants, higher investment costs of highly efficient equipment hinder end-users from purchasing equipment with lower lifetime costs, the supply chain for green cooling technologies has not sufficiently been developed, lack of implementation and enforcement of some existing regulations. For domestic refrigerators, more stringent legislation and higher enforcement could increase the energy efficiency of imported equipment. Further barriers have not been identified.

Several projects have been conducted in Ghana that have supported the introduction of green cooling technologies. As a result, MEPS and labelling have been introduced for split ACs and domestic refrigerators, leading to an increase of the average efficiency in the country. A substantial amount of ozone depleting refrigerants has been recovered and destroyed, trainings in the safe use of flammable hydrocarbon refrigerants have been conducted and hydrocarbon split ACs have been installed as part of a demonstration project and more than 10,000 ACs have further been converted to hydrocarbon refrigerant. Activities that support mandatory certification and registration of RAC technicians have been initiated.

## Roadmap

In the roadmap, findings from the inventory, technology gap analysis and policy analysis have been translated into strategies and milestones to increase the market share of green cooling technologies and mitigate GHG emissions in the RAC sector. Strategies affect increasing energy efficiency of appliances, the introduction of low-GWP refrigerants, mandatory qualification of technicians, including certification and measurement, reporting and verification of measures. The implementation of the strategies on the specified subsectors can lead to an emission reduction of 18% by 2030. The reduction is directly linked to suggested and feasible policies. Emissions in the roadmap scenario are expected to reach 8.9 Mt CO<sub>2</sub>eq in 2050 compared to 13.02 Mt CO<sub>2</sub>eq in the BAU scenario.

Considerable emission reductions can be reached in the Ghanaian RAC sector, especially when focusing measures on introducing green split AC technologies. This can for example be done by a concerted and comprehensive strategy including mandatory certification and registration of technicians including training on flammable refrigerants, a funding mechanism, such as a rebate to cover higher initial costs, end-of life management activities to recover and destroy environmentally harmful refrigerants as well as a regular update and increased enforcement of MEPS and labelling.





# 1 Policy analysis

As part of the Green Cooling Initiative (GCI), the Government of Ghana has engaged in a comprehensive response plan to carry out a greenhouse gas (GHG) inventory for the refrigeration and air-conditioning (RAC) sector and establish a technology analysis. The following document includes the policy analysis and technology roadmap.

The goal of the policy analysis is to identify possible leverage points to reduce emissions in the RAC sector by influencing the sector towards a more sustainable selection of technologies and avoidance or containment of refrigerants with high global warming potential (GWP). This activity focuses on the review of current policies in Ghana and standards related to RAC equipment (and their procurement). The analysis will include the identification of key regulatory barriers to be removed for the promotion of green cooling technologies, i.e. highly efficient equipment using low-Global warming potential (GWP) refrigerants. Examples are the recommendation of state-of-the-art minimum energy efficiency performance standards (MEPS), improved government procurement policies which inferably promotes green procurement and updated industry standards for the deployment of equipment.

## 1.1 Methodology

The first step of the policy analysis is an evaluation of existing policy documents. A set of questions was used as guidance, designed to enable a comprehensive overview on relevant policies influencing the equipment stock of the RAC sector and its associated GHG emissions. The policies are categorized into those regulating the refrigerants and those targeting energy efficiency.

In the second step, key barriers for the uptake of green cooling technologies are identified using a pre-defined grid. Four barrier categories are defined, the first assessing the availability of alternative technologies, the others looking at barriers arising from the current policy framework in three areas: Knowledge of technicians, regulations concerning refrigerants and energy efficiency, as well as awareness creation and incentives for end-users. The results are summarized in a table using a traffic light scheme to enable a quick overview of Ghana's status quo regarding its existing political framework for the promotion of green cooling technologies. Possible policy measures are given to overcome the barriers.

Finally, barriers and possible policy measures are detailed further for the focused subsectors (unitary air-conditioning and domestic refrigeration), identified in the inventory and technology gap analysis.

## 1.2 Status quo

### 1.2.1 Stakeholders

Stakeholders, generally referring to a group of people or an institution, are those that are involved in a project or heavily affected by its outcomes. They play a key role in setting priorities and objectives of projects and strategies and can considerably increase project success with their support and expertise. Identifying key stakeholders and their possible roles and responsibilities is necessary for the successful implementation of projects.

In this regard, the table below outlines the roles and responsibilities of the project stakeholders.

**Table 1:** Roles and responsibilities of project stakeholders

Project Stakeholder	Roles & Responsibility
<b>Ministry of Environment, Science, Technology and Innovation (MESTI)</b>	<p><b>The Ministry of Environment, Science, Technology and Innovation (MESTI)</b> has undergone restructuring in order to respond to the need for the integration of science, technology and innovation into national development policies (MESTI, n.d.). The Ministry's mandate is to: <i>"ensure accelerated socio-economic development of the nation through the formulation of sound policies and a regulatory framework to promote the use of appropriate environmentally friendly, scientific, and technological practices"</i><sup>1</sup></p> <p>The ministry aims to achieve its mandate through the applications of the following policy objectives:</p> <ul style="list-style-type: none"> <li>• Strengthen institutional and regulatory frameworks for sustainable natural resource management;</li> <li>• Reduce loss of biodiversity;</li> <li>• Enhance capacity to adapt to climate change impacts;</li> <li>• Promote green economy;</li> <li>• Promote the application of Science, Technology and Innovation in all sectors of the economy;</li> <li>• Strengthen the institutional framework to promote the development of research and its application;</li> <li>• Strengthen policy formulation, development planning, and M&amp;E processes for equitable and balanced spatial and socio- economic development; and</li> <li>• Promote a sustainable, spatially integrated and orderly development of human settlements.</li> </ul> <p>MESTI operates through its key agencies which are:</p> <ul style="list-style-type: none"> <li>• the Environmental Protection Agency (EPA);</li> <li>• the Council for Scientific and Industrial Research (CSIR);</li> <li>• the Ghana Atomic Energy Commission (GAEC);</li> <li>• the Town and Country Planning Department (TCPD).</li> </ul> <p>It is the lead institution for climate change activities in Ghana, serving as the Designated National Authority for the Clean Development Mechanism (CDM) under the Kyoto Protocol through the EPA (Climate Change Finance in Ghana (CCFG), 2015).</p>
<b>Environmental Protection Agency (EPA)</b>	<p>Established in 1994, by ACT 490, the EPA is the leading public body for protecting and improving the environment in Ghana.</p> <p>EPA is responsible for the implementation of actions to protect the ozone layer through its national ozone unit (NOU), such as the co-ordination with other ministries, departments and the private sector; creating public awareness; acting as a facilitator for implementing and funding agencies; processing clearances for import/export of ozone depleting substances (ODS), including refrigerants and alternatives; reporting data and progress to various UN institutions, including the Multilateral Fund and the Ozone Secretariat; and the sensitisation of stakeholders. EPA also has a leading role regarding the implementation of Ghanaian climate change and Ozone policies. The EPA has been charged with the responsibility of coordinating the implementation of technical activities on climate change and ozone through its Climate and Ozone department. This department serves as the technical hub for climate change as well as the link for international cooperation programmes including the development of a system for monitoring, reporting and verification of climate data, facilitating the development of the (I)NDC and its implementation plan. The department also implements Ghana's obligations under the Montreal Protocol (MP) through the National Ozone unit.</p> <p>This department also doubles as the focal points for the UNFCCC, MP, the IPCC, CTCN, Education, Training and Public Awareness and coordinates the preparation of national reports as part of its obligations including the national communications biennial update and national communications reports to the UNFCCC. ODS consumption reports are also reported to the Multilateral fund and Ozone secretariates. The department also steers the implementation of climate change and ozone related policies and programmes.</p>

Project Stakeholder	Roles & Responsibility
<b>Ministry of Energy (MoEn)</b>	<p>The Ministry of Energy (MoE) is Ghana's public institution charged with formulating, monitoring and evaluating energy related policies. It does this in conjunction with the Ghana Energy Commission and the Public Utility Regulatory Commission. The activities of this ministry to a large extent relate to climate effects. With respect to this, MoE developed key energy policies including:</p> <ul style="list-style-type: none"> <li>• Energy Policy Document in 2010 with the aim of contributing to climate change mitigation measures and initiatives to promote clean energy with less use of wood fuel and charcoal to safeguard the nation's forests that are important carbon sinks.</li> <li>• Developed and adopted the Renewable Energy Master Plan in 2019.</li> <li>• The MoE is also represented on the National Climate Change Committee (NCCC).</li> </ul>
<b>Ministry of Finance (MoF)</b>	<p>The Ministry of Finance exists to ensure macro-economic stability for promotion of sustainable economic growth and development of Ghana and her people through:</p> <ul style="list-style-type: none"> <li>• The formulation and implementation of sound financial, fiscal, and monetary policies.</li> <li>• Efficient mobilisation, allocation, and management of financial resources.</li> <li>• Establishing and disseminating performance-oriented guidelines and accurate user-friendly financial management information systems.</li> <li>• Creating an enabling environment for investment. In furtherance of the foregoing the Ministry is committed to the pursuit of excellence, transparency, probity, and accountability in the management of financial resources.</li> </ul> <p>Also, it is leading an Inter-Ministerial Working Group on Ecological Fiscal Reform (EFR) that seeks to modify taxes and public expenditure such that sustainable development, environmental protection, climate change and green economy principles are appropriately considered. Specifically, the reforms will lead to a shift in the tax base and burden away from conventional taxes, such as taxes on economic goods such as labour, investment, and consumption to environmentally damaging activities, such as use of natural resource or pollution.</p> <p>Finally, the MoF has established the National Resources, Environment, and Climate Unit (NREC) within the ministry to coordinate climate finance in Ghana</p>
<b>Ministry of Trade and Industry (MoTI)</b>	<p>The Ministry is mandated to develop a vibrant, technology-driven, liberalised, and competitive trade and industrial sector that significantly contributes to economic growth and employment creation, particularly involving mass mobilisation of rural communities and other vulnerable groups including women.</p>
<b>Ministry of Local Government and Rural Development (MLGRD)</b>	<p>The MLGRD coordinates and facilitates the participation of municipal, city, and regional governments in climate change activities at a national level. They specifically support these local authorities develop their Medium-Term Development Plans.</p>
<b>National Development Planning Commission (NDPC)</b>	<p>A Government agency responsible for ensuring that <b>climate change</b> related risks, issues, and activities are considered in the national planning process. As part of these activities, it also coordinates annual national progress reports, which cover climate change.</p>
<b>Public Procurement Authority</b>	<p>It seeks to improve the overall public financial management in the country through the effective use of public procurement procedures for national development. It also harmonizes the application of procurement related rules with international conventions and treaties.</p>

Project Stakeholder	Roles & Responsibility
<b>Ghana Standards Authority (GSA)</b>	The GSA is an agency of the Government responsible for the development, publishing, and promotion of standards in the country. The GSA does this through standardisation, metrology, and conformity assessment activities. Some of these activities are testing, inspection and certification of products that are regulated for different qualities including safety, energy efficiency, pollution emissions. These activities ensure that products and services produced in Ghana or imported are safe, reliable, and are of good quality.
<b>Energy Commission</b>	<p>The Energy Commission is the technical regulator of Ghana's electricity, natural gas and renewable energy industries and the advisor to the Government on energy matters through the Ministry of Energy.</p> <p>The Energy Commission is required by law to regulate and manage the development and utilization of energy resources in Ghana as well as to provide the legal, regulatory, and supervisory framework for all providers of energy in the country, specifically by granting licenses for the transmission, wholesale, supply, distribution, and sale of electricity and natural gas and related matters.</p> <p>Specifically, the Energy Commission support the implementation and enforcement of the Renewable Energy Act (2010) and the Renewable Energy Master Plan of 2019.</p>
<b>Energy Foundation</b>	The Energy Foundation Ghana is a non-profit, private sector institution, devoted to the promotion of energy efficiency and renewable energy, as a key strategy to managing Ghana's growing energy needs in a sustainable manner.
<b>Customs, Excise and Preventive Service (CEPS) – Ghana Revenue Authority</b>	A unit within the Ghana Revenue Authority responsible for collection of import duty, export duty, petroleum tax, import excise, and other taxes as well as ensuring the protection of revenue by preventing smuggling. This is done by physically patrolling the borders and other strategic points, examination of goods, and search of premises, as well as documents relating to the goods. Additionally, they see to the enforcement of laws on import and export restrictions and prohibitions.
<b>Council for Scientific Industrial Research (CSIR)</b>	The CSIR is mandated to pursue, amongst others, the implementation of government policies on scientific research and development, coordinate R&D activities in the CSIR and other Science & Technology (S&T) institutions nationwide and assist the government in the formulation of S&T policies for national development. The CSIR is further required to commercialize appropriate technologies, in partnership with the private sector and other stakeholders, and encourage in the national interest, scientific and industrial research of importance for the development of agriculture, health, medicine, environment, technology and other service sectors of the economy.
<b>Ghana Meteorological Agency (GMeT)</b>	Set up in 2004 under the Ministry of Communications, the Ghana Meteorological Services Agency (GMeT) provides weather information services through the collection, processing, storage, and dissemination of meteorological data to end users. This plays a vital role in the day-to-day activities of both individuals and institutions (related to climate change) since it provides information necessary for enhancing and ensuring proper climate change adaptation and mitigation measures.
<b>National Air Conditioning and Refrigeration Workers Association (NARWOA)</b>	Industry association established to act as a liaison for the technicians in the RAC sector. It has been involved in programmes to phase-out CFC refrigerants with climate friendly options such as hydrocarbons.
<b>International development agencies</b>	International development agencies, such as UNDP and GIZ are implementing programmes in collaboration with the Government of Ghana by providing both technical and financial assistance.
<b>Electronic and print media</b>	The media play a key role in promoting awareness creation, sensitization, and education in all economic sectors, including the general public.
<b>End-users</b>	The <i>end-user</i> is used to distinguish the person who will work with the good or service from individuals who are involved in other stages of its development, production, and distribution. Relevant end-users in the RAC sector include hotels, supermarkets, office buildings, hospitals, transport hubs as well as private people.

The relevant stakeholders coordinate their work within two committees:

**National Climate Change Committee (NCCC):** Its members are drawn from all relevant ministries, agencies, and planning commissions as well as non-governmental organisations (NGOs), research and academic institutions and it is hosted by MESTI. The committee supports the multi-sectoral coordination of the implementation of the national climate change policy.

**National Committee on Ozone Depleting Substances (NACODS):** NACODS constitutes several institutions which work together to achieve Ghana's mandate of the international regulations relating to the Ozone layer. These institutions include Environmental Protection Agency (EPA), Ministry of Environment, Science, Technology & Institution (MESTI), Ghana Meteorological Agency (GMeT), Ministry of Finance (MoF), Ministry of Trade and Industry (MoTI), Civil Society Organisations (CSOs), Customs Division of Ghana Revenue Authority, Energy Commission, Ghana Standards Authority (GSA), non-governmental organisations, e.g. Friends of the Earth, Development partners (UNDP and GIZ), research institutions such as CSIR and representatives of NARWOA. NACODS occasionally establishes standing committees where experts meet intermittently to address specific tasks assigned to them. An example is the sub-committee on training and certification, which was established to introduce a RAC technician training and certification scheme in Ghana set up in 2017.

### 1.2.2 Legislation

The following Ghanaian laws are relevant for the RAC sector as they concern either refrigerant use or application, GHG emissions or the energy efficiency of RAC appliances.

#### Energy efficiency:

Energy Commission - Energy Efficiency Regulation, 2008, LI 1932. Prohibits the importation and sale of used air-conditioners, refrigerators, refrigerator-freezer, and freezers<sup>2</sup> and sets the roles and responsibilities of customs officers and other agencies relating to the enforcement of the ban.

#### Energy efficiency standards and labelling (household refrigerating appliances) regulations, 2009, LI 1958.

This law mandates Minimum Energy Performance Standards (MEPS) and energy efficiency labelling for household refrigerating appliances. The law states the maximum allowed energy consumption for refrigerators and freezers according to a formula that considers the cooling volume of the appliance against energy consumption (energy efficiency index or EEI) to be allowed in the market. The law also states the labelling categories of the appliances allowed in the market from 1 to 5 stars based on the

EEI level. Finally, the law states labelling design requirements and the roles and responsibilities of government agencies relating to market surveillance, testing, and enforcement.

Revised MEPS will probably be approved by the parliament in 2022 and will increase the star ratings from 1 to 7 stars and revise the minimum EEI.

#### Energy efficiency standards and labelling (non-ducted air conditioners and self-ballasted fluorescent lamps) regulations, 2005, LI 1815.

This law mandates the implementation of Minimum Energy Performance Standards (MEPS) and energy efficiency labelling for non-ducted air conditioning units. The law states a minimum Energy Efficiency Ratio (EER) of 2.8 (this is 2.8 watts of cooling per watt of electricity input<sup>3</sup>) for non-ducted ACs stated the performance requirements for the labelling categories from 1 to 5 stars.

Finally, the law states labelling design requirements and the roles and responsibilities of government agencies, the Energy Commission, the Ghana Standards Authority, and the CEPS primarily relating to market surveillance, testing, and enforcement of the MEPS requirements.

Revised MEPS will be probably approved by the parliament in 2022 and will increase the star ratings from 1 to 7 stars and revise the minimum requirements as well as the computation from EER to Annual Energy Efficiency Ratio (AEER) or Total Cooling Seasonal Performance Factor (TCSPF).

#### Refrigerants:

#### Management of Ozone Depleting Substances and Products Regulations, 2005, LI 1812.

Implements the Montreal Protocol and its restrictions on the use of ozone depleting substances according to the prescribed schedule. It is currently being amended to include the phase-out steps of the Montreal Protocol and the Kigali Amendment. The hydrochlorofluorocarbon (HCFC) Phase-out Management Plan (HPMP) supports local government, industries, and technicians in the implementation of the Montreal Protocol.

#### Kigali Amendment:

The Kigali Amendment entered into force on 1 January 2019 and entered into force for Ghana on 2 August 2019 on the ninetieth day following the date of deposit of Ghana's instrument of ratification. It restricts the use of hydrofluorocarbons (HFCs) based on their high GWPs. Ghana is now obligated to implement national legislation that will lead to the reduction of HFCs to 80% of its baseline use until 2045, starting in 2024 with a freeze of consumption.

<sup>2</sup> [https://www.bcp.gov.gh/new/related\\_pro.php?id=MjE1%7EEnergy%20Efficiency%20](https://www.bcp.gov.gh/new/related_pro.php?id=MjE1%7EEnergy%20Efficiency%20)

<sup>3</sup> <https://www.energycom.gov.gh/efficiency/standards-and-labelling>

Kigali Implementation Plans (KIPs) will assess the national amount of HFCs that need to be phased down, support institutional strengthening, assess technical and capacity building needs and implement them.

The Hazardous and Electronic Waste Control Management Act, 2016, Act 917.

It was passed in parliament in 2016 and includes extended producer responsibility elements such as a levy on appliances to be used for their proper dismantling and disposal. Both ACs and domestic refrigerators are included in the document. The "Hazardous, Electronic and other Wastes Classification, Control and Management Regulations, 2016, L.I. 2550 are partly implementing Act 917.

#### Others:

Electrical Wiring Regulation, 2012, L.I.2008 was passed to reduce the number of electrical fires in the country. Only qualified and certified electrical wiring professionals (CEWPs) are allowed to conduct electrical wiring and installations works according to standards. The regulation will serve as the basis for the establishment of a nation-wide RAC technician training and certification scheme

The following **RAC relevant standards** are applied in Ghana:

GS ISO 11650, 1999: Refrigerating Technology - Refrigerators - Recovery and/or Recycling Equipment (ISO standard was last revised in 2014) (see also AHRI standard 740-2015)

GS IEC 60335-2-24, 2007: Household and Similar Electrical Appliances - Safety - Part 2-24: Particular Requirements for Refrigerating Appliances, Ice-Cream Appliances and Ice-Makers

GS ISO 5149, 1993: Refrigerating Technology -Mechanical Refrigerating Systems - Cooling and Heating - Safety Requirements.

The following efficiency testing standards for split AC units and refrigerators are available:

GS 362:2001: Measurement of energy consumption for ACs.

### 1.2.3 Policy documents

The following policy documents were included in the analysis:

#### **Ghana's Nationally Determined Contribution (NDC) and accompanying explanatory note (Republic of Ghana, November 2021):**

In 2021, the Government updated its NDC commitments with increased ambition levels across the mitigation, adaptation, and climate finance. The priority areas of the updated NDC include:

- Building resilience to protect vulnerable communities and ecosystems.
- Advancing climate-responsive food production systems.
- Lowering deforestation and landscape restoration.
- Scaling up penetration of renewable energy and sustainable energy transition
- Promoting clean electric mobility
- Accelerating our efforts to mobilise investments into climate actions

For this, 19 policy actions have been developed across 10 priority areas to achieve the NDC goals by 2030. These 19 policy actions translate into 13 adaptation and 34 mitigation programmes of action to achieve:

- a. Generate absolute greenhouse gas emissions reductions of 64 MtCO<sub>2</sub>e.
- b. Avoid at least 2,900 premature deaths per year from improved air quality.
- c. Create over one million decent and green jobs.
- d. Benefit cumulatively nearly 38 million people, primarily youth and women.

Of the 34 mitigation measures, nine are unconditional programmes of action estimated to provide GHG emissions reductions of 8.5 MtCO<sub>2</sub>e by 2025 and a further 24.6 MtCO<sub>2</sub>e by 2030 compared to the 2020-2030 cumulative emissions of the baseline scenario. The remaining 25 programmes of action, with potential to achieve 16.7 MtCO<sub>2</sub>e by 2025 and 39.4 MtCO<sub>2</sub>e by 2030 are conditional on support from international and private sector funding agencies to cover the full cost for implementation.

Of these actions, one is targeted directly at the RAC sector while two other actions indirectly impact emissions from the RAC sector through the promotion of energy efficiency in homes, industry, and commerce as well and decarbonization of the electricity sector.

#### **NDC implementation plan – Chapter 8: Refrigerator and Air Conditioning sector**

Under the implementation plan of the first NDCs (intended NDCs), Chapter 8 focussed on air conditioners with the aim to increase the market-share of energy efficient and climate-friendly air conditioners using hydrocarbon refrigerants to 70% in 2030. This aim was to create a positive policy environment that incentivises or mandates the private sector to import these units. The overall needed financial contribution is set at US\$ 15.5 million.

The readiness phase includes activities such as inventory and sector roadmap establishment as well as funding proposal development and submission. Furthermore, labelling categories of the star rating system are to be adjusted, a supply chain for HC-290 units is to be established, as well as training and certification activities for technicians. In Phase 1, the market share of energy efficient and climate friendly AC is planned to achieve 40%. This is to be reached by increasing MEPS, tax reduction for environmentally friendly refrigerants, guidelines for green public procurement. In Phase 2, the market share is to be increased to 70% by further increasing MEPS, banning the import of HCFC-22 units, having an established database for sales reporting. Servicing emission factors are estimated to be reduced considerably because of increased technician training.

This NDC supersedes the 2015 submission and can be found in the UNFCCC document repository<sup>4</sup>

#### **Ghana National Communications to the UNFCCC (EPA, 2001, 2011, 2015, 2020)**

The above-mentioned reports highlight the GHG inventory results and possible specific mitigation options as well as adaptation measures and further information on the country's situation. Responsibilities of climate change activities are highlighted for a range of institutions and sectors.

The largest GHG emissions are reported from the agriculture, forestry and other land use (AFOLU) sector, closely followed by emissions from stationary energy combustion and transport. Ozone-depleting substances (ODS) were included in the inventory for first time in the fourth iteration of the National Communication due low data availability in previous years<sup>5</sup>. The highest mitigation measures are seen for the energy sector, forest management and solid waste. Energy efficient refrigerators are included in the prioritised technology portfolio as a measure to reduce emissions from electricity use.

#### **Ghana National Climate Change Policy, MESTI, 2013.**

As a signatory to the UNFCCC, the development and implementation of the National Climate Change Policy supports Ghana in addressing climate change. The document is aimed at providing strategic direction for the country, focusing on effective adaptation, social development, and mitigation measures. The topics of energy and infrastructure, natural resources management, agriculture and food security, disaster preparedness and response as well as equitable social development, i.e., gender and the vulnerable are addressed. It further lists the following specific strategies:

- National Climate Change Adaptation Strategy (NCCAS)
- The Energy Strategy
- National Water Policy
- Sanitation Policy
- Action plans by Ministries, Departments, and agencies (MDAs)

**National Energy Policy. Ministry of Energy, Republic of Ghana, 2010.** The policy has the aim to improve access to clean energy in rural areas and for industrial development and to ensure secure and reliable supply of electricity. It looks at infrastructure improvement, decreasing the cost of electricity generation, and increasing the efficiency in the production of energy. Relevant national strategies include:

- **Ghana Shared Growth and Development Agenda II, 2014-2017 (GSGDA II) (Government of Ghana, national development planning commission, 2014).** The agenda supports policies and goals for sustainable development of Ghana
- **Ghana's low carbon development strategy (LCDS). MESTI, January 2016.** This document combines mitigation action and economic country development.
- **Climate Change and Green Economy Learning Strategy (CCGELS) was launched in 2016** to promote climate change education, awareness and learning in Ghana.
- **Ghana Renewable Energy Master Plan (REMP), Energy Commission (2019)** was launched to promote renewable energy development and support increased access to clean and sustainable energy.

#### **The Strategic National Energy Plan (2006-2020) (Ministry of Energy, 2006)**

Policy document focussing on the medium to long term development of the energy sector at large to ensure that the reasonable demand for energy is met in a sustainable manner. It aims to tackle key challenges such as energy inefficiency. Of the ten key objectives of the plan that are relevant to the RAC sector, objectives are included on increasing energy efficiency in the end-use sector and improving the deployment renewable energy. In other words, increase the sustainability of the electricity supply, while curbing the increase in demand.

**Under the national energy efficiency and conservation policy (2015-2020)** the Energy Commission has implemented programmes and policies to reduce electricity consumption by distributing energy efficient light bulbs and support the exchange of inefficient refrigerators. These measures are supposed to reduce the electricity consumption by 160.8 MWh per year. This reduces the need to invest in more power plants.

<sup>4</sup> [https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Ghana%20First/GH\\_INDC\\_2392015.pdf](https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Ghana%20First/GH_INDC_2392015.pdf)

<sup>5</sup> <https://www4.unfccc.int/sites/NDCStaging/pages/Party.aspx?party=GHA>

### 1.2.4 Projects

Ghana has implemented several projects that either directly reduce GHG emissions in the RAC sector or contribute to an enabling environment for the reduction of GHG emissions.

#### HPMP stage I<sup>6</sup> (2010- ongoing; Multilateral Fund of the Montreal Protocol)

The Ghanaian HPMP is implemented by EPA, UNDP and the Government of Italy. Ghana has committed to phase out its HCFC use by 2030 under the Montreal Protocol. It therefore receives financial and technical support by the Multilateral Fund for the Implementation of the Montreal Protocol in the form of the HPMPs in two stages (2010-2020 & 2020-2030).

Under the HPMP, the following was achieved:

- Adherence to Montreal Protocol HCFC reduction schedule
- Legal framework for management of the HCFC phase-out plan (set up and update of LI 1812 to conform with Montreal Protocol), including a quota and licensing programme for refrigerant/pre-charged equipment imports
- Establishment of 2 professional training centres and 3 centres of excellence (including equipment for the safe use of hydrocarbons) with an additional centre being set up in the northern Ghana at Tamale; training of over 100 technicians in the safe use of hydrocarbons, and more than 700 in good servicing and refrigerant recovery. Training of national fire staff, distributors, importers and sales personnel in the safe use of hydrocarbon refrigerants.
- Development of guidelines on the safe use of hydrocarbons.
- More than 10,000 HCFC-22 units have been converted to HC-290 by trained technicians using these guidelines. Recovered HCFC-22 has been recycled (Refrigerant Recovery Recycling Project (RRRP)).

It is further planned to develop and implement a certification and registration scheme for RAC technicians.

#### Promoting of Appliance Energy Efficiency and Transformation of Refrigerating Appliance Market in Ghana / Refrigerator Rebate and Exchange Scheme<sup>7</sup> (2012-2016; Global Environmental Facility)

The objective of the project was to improve the energy efficiency of refrigerating appliances in Ghana through the introduction of regulatory tools (MEPS and Information Labels) as well as an incentive system for private households to purchase

new energy-efficient refrigeration appliances when replacing old but functioning ones (rebate).

The project was spearheaded by an extensive awareness creation program on the energy efficient refrigerating appliances, the benefits and the need for the rebate scheme. It was implemented by United Nations Development Programme (UNDP) and the Government of Ghana through the Energy Commission. Supporting activities included:

- testing laboratory for refrigerating appliances
- training for customs officers, appliance professionals
- Supporting implementation of import bans for used equipment

The project achieved a transformation of the refrigerator market towards higher energy efficiencies by banning used equipment and introducing MEPS, substantial CO<sub>2</sub>eq emission reductions at relatively low cost, established and implemented appropriate legislation to establish the minimum energy efficiency standards for refrigerators (LI 1958) and ban the importation of used refrigerating appliances (LI 1932) in Ghana. Emission reductions were achieved by establishing a scrap yard for dismantling refrigerators and the environmentally sound dismantling of refrigerators and destruction of collected CFCs<sup>8</sup>.

#### The German Green Cooling Initiative (GCI) (2015 – 2022; International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU))<sup>8</sup>

Implemented by GIZ and EPA, the projects aim is to accelerate the transition to climate and environmentally friendly technologies in the refrigeration and air conditioning sectors to reduce refrigerant- and energy-related GHG emissions. It implemented several demonstration installations of green ACs with high energy efficiency and hydrocarbon refrigerant and conducted trainings of technicians.

The project

- Supported EPA in integrating the cooling sector in NDCs
- Published a RAC sector inventory for Ghana in 2018
- Ghana specific Technology Gap Analysis and Roadmap towards Green Cooling
- Demonstration project: import of 380 Green AC via two importing companies

6 [https://www.gh.undp.org/content/ghana/en/home/library/environment\\_energy/HPMPdoc.html](https://www.gh.undp.org/content/ghana/en/home/library/environment_energy/HPMPdoc.html)

7 SPWA-CC: Promoting of Appliance Energy Efficiency and Transformation of the Refrigerating Appliances Market in Ghana. | Global Environment Facility ([thegef.org](http://thegef.org))

8 <https://www.green-cooling-initiative.org>



- Two trainings of trainers in the safe use of hydrocarbon refrigerants with a focus on split ACs; supply of some equipment for the Accra Centre of Excellence
- Supported the process for developing a qualification, certification and registration scheme for RAC technicians

The main challenges were identified to be the access to Green AC equipment on the global market and the lack of training for technicians.

#### **ECOFRIDGES GO (2020- ongoing; Clean Cooling Collaborative (formerly K-CEP))**

The project is implemented by UNEP United for Efficiency and the Energy Commission. ECOFRIDGES aims to accelerate the transition to highly energy-efficient cooling products that use lower global warming potential refrigerants than legacy technologies, saving consumers money on their electricity bills, enhancing energy security and economic competitiveness, and protecting the environment. This will be achieved by implementing a financial mechanism for households in order to catalyse the introduction of new high-performance products into Ghana and promote the best performing (most efficient and climate-friendly) products that are available but only in limited quantities today in Ghana.

#### **Switch Africa Green (2014-2017; European Union)<sup>9</sup>**

The project was implemented by UNEP, UNDP, EPA and several other Ghanaian agencies. The project aimed at achieving sustainable development by engaging in transition towards an inclusive green economy, based on sustainable consumption and production (SCP) patterns, while generating growth, creating decent jobs and reducing poverty. The project supported the private sector in five projects in Ghana, such as developing E-waste models or environmental management systems for small and medium-sized enterprises.

#### **Renewable Energy & Energy Efficiency in the Public Sector (REEEPublic) (2019-2021; Federal Ministry for Economic Cooperation and Development)**

The project was implemented by the Energy ministry and GIZ. It aimed at improving the conditions for increasing renewable energy and energy efficiency solutions, particularly in the public sector by operationalizing selected instruments of the RE Act, strengthening the regulatory framework for energy efficiency in buildings and supporting the Government of Ghana to reduce energy cost in public buildings at the sub-national level. It further implemented demonstration projects to reduce energy expenses in public buildings and improved the supply of quality products and services

#### **Market Entry into Renewable Energy and Energy Efficiency for the Productive Sector and TVET (2018- ongoing, Federal Ministry for Economic Cooperation and Development)**

The project is implemented by the Ministry of Energy and GIZ. It aims at overcoming barriers to market entry and development, which have so far prevented Ghana's private electricity consumers as well as businesses and households from making greater use of renewable energy and energy efficiency technologies. This will be done by providing training, advisory and other support services to strengthen the capacities of key market actors in order to enable companies to increasingly satisfy their energy needs through renewable energies. It will also address the shortage of qualified demand-oriented skilled workers (e.g. for the planning, installation, operation, maintenance and repair of renewable energy systems and energy efficient solutions).

The project has already achieved the following:

- Identifies successful reference projects for RE/EE awareness and promotion
- Links major electricity consumers with RE/EE experts to assess and improve their electricity self-generation capabilities or EE potential
- Collaborates with the utilities to develop new business strategies to prepare for a transition of losing large customers to self-generation
- Established a Sector Skills Body for the RE sector
- Initiated development of vocational standards, curricula and training material for an occupation in the field of RE
- Selected three TVET institutions to improve their capacity for implementation of newly developed training material
- Completion of EE and RE demonstration projects in selected public buildings
- Development of EE and RE training programmes

The project is likely to also support the implementation of a certification and refrigeration scheme for RAC technicians, including support in developing a legal instrument, national standard, training concept and curriculum as well as guidelines and an awareness campaign. It will further support training centres in the implementation and supply necessary equipment.

<sup>9</sup> [https://wedocs.unep.org/bitstream/handle/20.500.11822/30963/Ghana\\_Green\\_Project\\_FS.pdf?sequence=1&isAllowed=y](https://wedocs.unep.org/bitstream/handle/20.500.11822/30963/Ghana_Green_Project_FS.pdf?sequence=1&isAllowed=y)

### 1.2.5 Policy Summary for Ghana

Table 2 gives an overview of policies and standards in Ghana regarding refrigerants.

**Table 2:** Existing and planned policies and standards concerning refrigerants in Ghana

Refrigerants	
Are there policies in place <b>on regulating HCFC/HFC use and emissions</b> ? Do importers and companies using HCFCs/ HFCs have to <b>report on the used substance amounts</b> to a central database?	
Status	<p>The import and export of HCFCs is controlled under Montreal Protocol provisions. HFCs are not included in the reporting. Apart from the restrictions imposed by Montreal Protocol requirements, no targets on consumption or emission restriction are defined. It is planned to include HFCs in the legislation that implements the Montreal Protocol provisions.</p> <p>An inventory of HFC emission has been completed in 2015, funded by the Climate and Clean Air Coalition (CCAC). The Kigali Implementation Plan will further assess national HFC consumption.</p>
Are there <b>nationally adopted safety standards for (natural) refrigerants</b> ? For example, horizontal standard (ISO 5149, EN 378) or product standards (IEC 60335-2-24 (for refrigeration), - 40 (for room AC) -89 (for commercial refrigeration)) Do the national safety standards allow the use of A3 (flammable) refrigerants with sufficiently high charge amounts?	
Status	<p>The following standards are in place:</p> <p>GS IEC 60335-2-24: 2007 Household and Similar Electrical Appliances - Safety - Part 2-24: Particular Requirements for Refrigerating Appliances, Ice-Cream Appliances and Ice-Makers</p> <p>GS ISO 5149: 1993 Refrigerating Technology -Mechanical Refrigerating Systems - Cooling and Heating - Safety Requirements</p> <p>Standards IEC 60355-2-40 (Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers) and -89 (Household and similar electrical appliances - Safety - Part 2-89: Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant unit or compressor) are developed but not yet operationalised.</p> <p>Knowledge about standards by technicians is very low or non-existent. Standards are not incorporated in current training activities.</p>



Refrigerants	
Are there voluntary or mandated standards for the <b>training and certification of technicians</b> ? Does it include the handling of natural refrigerants? Who is allowed to handle refrigerants (only certified technicians or anybody)?	
Status	<p>Training is available for the handling of HCFC and HFCs.</p> <p>Few additional courses on safety measures for natural refrigerant are offered irregularly within the HPMP activities under the Multi-Lateral Fund (MLF), which are implemented by UNDP and the Government of Italy.</p> <p>The NOU has published the following guidelines:</p> <p><i>Safety Guide for the use of Hydrocarbon Refrigerants in Stationary Refrigeration and Air Conditioning systems</i></p> <p>Certification and licensing of electrical technicians has been introduced over the past few years, which mandates technicians to pass an exam and obtain a licence before they are allowed to practice their profession.</p> <p>A sub-working group has been formed out of the National Committee on Ozone Depleting Substances (NACODS) to tackle the topic of certification of RAC technicians. The work of the sub-committee has been initiated and is currently on-going (2017/2018).</p>
Are there policies / standards in place on the <b>take-back and recycling of refrigerants</b> ?	
Status	<p>Not generally.</p> <p>Official refrigerator recyclers are told to collect recovered refrigerant and blowing-agent containing foam.</p> <p>Collected refrigerants was shipped for disposal in a one-off project activity.</p>
Are <b>natural refrigerants</b> at recommended DIN or AHRI standards <b>available</b> ?	
Status	R290, R600a and R717 are available. Import of flammable natural refrigerants is currently controlled by EPA so that only expert technicians are allowed to handle the substances.
Are there policies in place for <b>incentives to use natural refrigerants</b> for industry and end-uses?	
Status	No

Policies in Ghana concerning the use and reporting of refrigerants closely follow the requirements of the Montreal Protocol. The import of ODS refrigerants is monitored, but there is no reporting on where the refrigerants are used. Collection of refrigerants is monitored insufficiently at two collection points for refrigerators only, namely City Waste Company Limited and Presank Company Limited. Technician training on proper refrigerant handling exists for fluorinated substances but is limited for natural refrigerants. Some international standards regarding refrigerants have been adopted nationally, but not all

relevant ones. Knowledge about these standards is lacking. Ghana has already indicated a preference for hydrocarbon refrigerants as replacement for ODS and high-GWP HFCs. Several activities, such as the development of guidelines on the safe use, isolated training events and monitored import of hydrocarbon (HC) refrigerants have already started. The HPMP programme implemented by the UNDP has already converted more than 10,000 split Air-conditioners (A/C) from R22 to run on hydrocarbon R290 split A/C units.

**Table 3:** Existing and planned policies and standards concerning energy efficiency of RAC equipment

Energy Efficiency	
Have <b>MEPS</b> been issued and are they mandated?	
Status	<p>LI 1815 details MEPS for split AC at 2.8 Revised MEPS will be probably approved by the parliament in 2022 and will increase the star ratings from 1 to 7 stars and revise the minimum requirements as well as the computation from EER to Annual Energy Efficiency Ratio (AEER) or Total Cooling Seasonal Performance Factor (TCSPF).</p> <p>LI 1958 (2009) details MEPS for household refrigerating appliances based on a volume dependent formula. Revised MEPS will probably be approved by the parliament in 2022 and will increase the star ratings from 1 to 7 stars and revise the minimum EEI.</p>
Have comparative <b>label standards</b> been mandated? If yes, for which RAC subsectors?	
Status	<p>Labels are mandated for split AC units by LI 1815 and for new refrigerators by LI 1958. There are no labels for larger systems (Multi-Split, VRF/VRV<sup>10</sup>, Chillers).</p>
<b>Are MEPS and labels enforced?</b> With pre- or also post market placement verification? Are MEPS and labels verified based on international testing standards? Do the testing standards include part load efficiencies? Do RAC companies placing products on the market have to report their sales to a central database/ registry?	
Status	<p>Importers have to submit test reports for verification and approval before importation. Energy Commission has trained custom officials to check these reports. Data is collected and published.</p> <p>The Energy Commission has developed a mobile phone application for consumers, which shows the energy efficiency of refrigeration appliance units.</p> <p>Ghana Standards Authority offers tests for verification according to GS 362: 2001 for non-ducted ACs and according to GS IEC 62552 for refrigerators. Equipment for refrigerator testing is available only.</p> <p>Non-complying units are seized and penalties for importers are enforced. Inspection at ports and market surveillance are carried out. Regular testing of refrigerators on the market is carried out.</p> <p>Enforcement is difficult and expensive, and it is assumed that there is still a substantial number of units that is imported without meeting the requirements.</p> <p>An update of RAC MEPS is currently underway.</p>
Are the policies in place to provide <b>incentives to invest in energy efficient products</b> for manufacturers, re-sellers and / or end-users? Are energy audits for large energy users and buildings using RAC appliances mandated? Are energy audits standardized including RAC appliances? Are the incentives given to ESCO companies?	
Status	<p>No</p> <p>However, there are several projects dealing with these topics, which are mentioned under chapter 1.2.4 Project.</p>
Are there <b>E-waste collection</b> policies and the implementation of extended producer responsibility in place?	
Status	<p>Collection of refrigerators is done by 2 companies under supervision of the EPA according to minimum environmental standards.</p> <p>The Hazardous and Electronic Waste Control Management Act (Act 917) has been passed in parliament in 2016. It includes extended producer responsibility elements in form of an eco-levy. The Hazardous, Electronic and other Wastes Classification, Control and Management Regulation (L.I. 2550) partly implements this act. The eco-levy is not yet in place, but several projects are supporting its implementation.</p>

Ghana has already introduced MEPS and labelling for the two important RAC sub-sectors with the highest number of appliances. More efficient appliances are the focus of several policies and regulations and is an important strategy to handle increased electricity demand. MEPS have last been updated several years back and are not always enforced as capacities to check units is low. Labelling classes are currently under review and planned to be updated.

The RAC sector is acknowledged as a focus area of GHG emission reduction and is mentioned in the NDC.

#### Overview

RAC-sector policies on refrigerants follow the Montreal Protocol. There are few official policies regarding the use of natural refrigerants or leakage reduction. Training is available on an irregular and non-standardised level.

Energy efficiency policies specifically for the two focus sectors UAC and domestic refrigerators within the RAC appliances are in place. Increased measures and enforcement are necessary.





## 2 Key Barriers and possible policy measures

The following chapter will highlight several key barriers for the introduction of climate friendly cooling technologies as well as possible policy measures to overcome these. It will conclude by applying these barriers and policy measures to those focus subsectors that were identified in the inventory and technology gap analysis as having both a high impact on GHG emissions in Ghana as well as available alternative technologies.

Barriers and policies are related to the following topics:

- 1) Increasing energy efficiency (EE) of appliances
- 2) The introduction of low-GWP refrigerants
- 3) Mandatory qualification of technicians, including certification and licensing
- 4) Measurement, reporting and verification (MRV) of measures

Based on the results of the Tier 2 RAC inventory and the technology gap analysis, the following focus subsectors were identified: Unitary AC (UAC) and domestic refrigeration. Those subsectors exhibit over 70% of the captured emissions and hold a high mitigation potential. For those sectors, a barrier analysis is carried out to identify suitable policy options.

### 2.1 Categorisation of barriers and policies

“Barriers are hindrances that stand in the way of the smooth implementation of different technical options, which produce in the long-term sustainable benefits that outweigh the costs and avoid or limit the emissions of greenhouse gases.” (Nama Handbook, Chapter 3; Heubes et al., 2014)

It is important to recognise that while the barriers for one subsector may be identical to another, the necessary intervention may not be the same. However, if a barrier is overcome for one subsector, it may not be necessary to intervene in another subsector anymore. An example is the availability of a refrigerant: if poor availability of R290 is identified as one of the barriers for residential air conditioning and efforts are made to make R290 widely available, this would resolve the issue, i.e., remove the R290 availability barrier for commercial and industrial refrigeration. The same may arise for other barriers, such as technician competence, safety standards, regulations, and availability of components.

Policy measures are divided into regulatory measures, fiscal measures and non-regulatory measures (*Table 4*). Enforcement of existing regulation is also an important topic, which requires knowing the reasons for non-compliance and putting appropriate reactive measures in place. Reasons for non-compliance can be deliberate for financial gain but also out of a lack of knowledge or the needed capacity. This would influence if a company or person should be fined or receive the necessary information or training.

Table 4: Policy options for the RAC sector

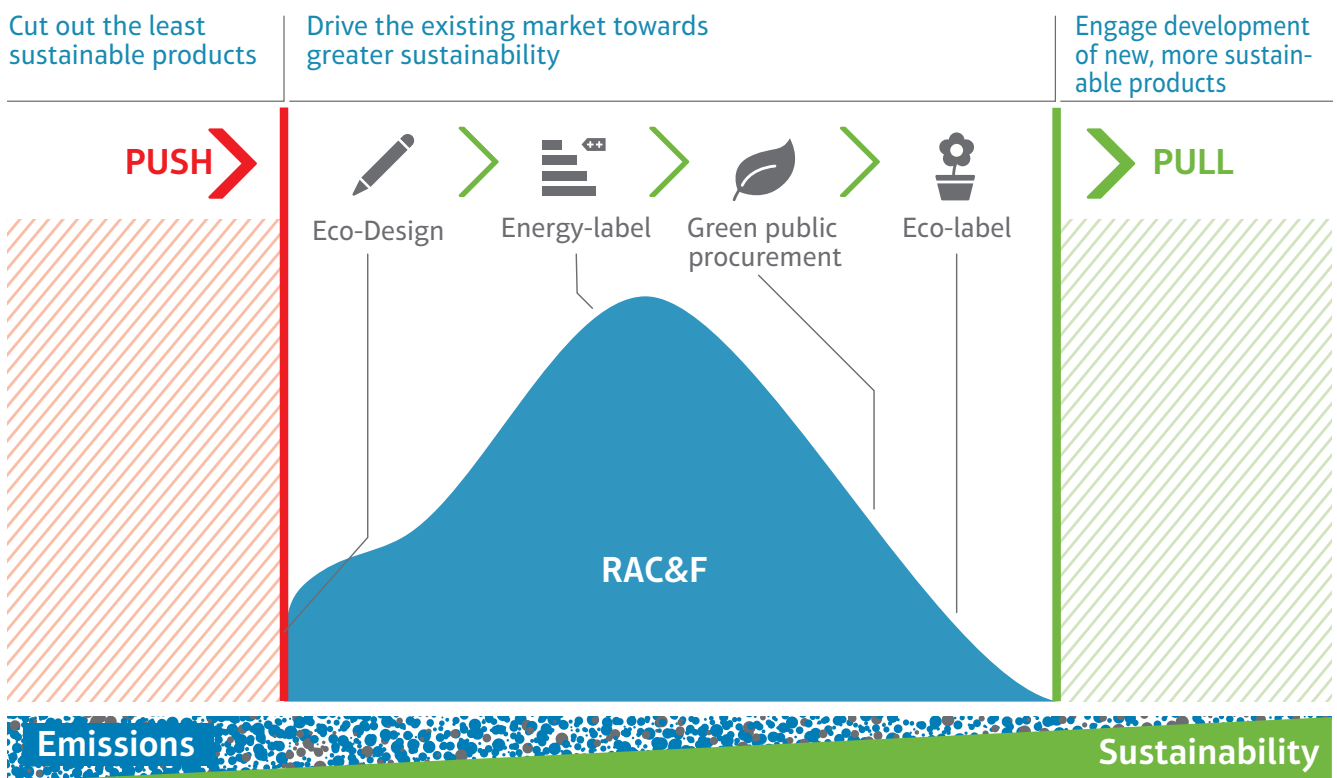
Regulatory		
<b>Refrigerant &amp; MRV</b>	ODS- and F-gas regulation (including monitoring and venting ban)	Legislation on the use of environmentally harmful refrigerants can reduce emissions due to monitoring of refrigerant use and leakages; venting bans that require recovery of refrigerants.
<b>Refrigerant</b>	Product ban, phase-out/down	Often as part of ODS or F-Gas regulation, refrigerants or appliances using these refrigerants are banned or phased-down based on ozone depleting potential (ODP) or GWP. This regulation pushes the market towards alternative technologies
<b>EE</b>	Minimum energy performance standards	By banning the least efficient units, the market is pushed towards higher EE values
<b>EE</b>	Labelling	High EE labelling pulls the market towards higher efficiencies by informing consumers about the energy consumption and ideally the refrigerant and cost comparison
<b>EE &amp; MRV</b>	Product data base	Combines control mechanism for government with information for end-users
<b>Refrigerant &amp; EE</b>	Update of existing regulation	e.g. additional or faster ban of refrigerants, increase of MEPS. These are generally faster and easier to implement instead of applying new legislation.
<b>Refrigerant &amp; EE</b>	Enforcement of existing legislation	Even comprehensive national legislation is ineffective if it is not complied with and not adequately enforced.
Fiscal		
<b>Refrigerant &amp; EE</b>	Incentives for end-users	Incentives for end-users might include consumer discounts, e.g. a tax reduction for purchasing new ODS free equipment, or the option of receiving a new unit when returning the old appliance (viably sustainable rebate scheme). These will pull the market towards more environmentally friendly units, whilst at the same time educating consumers about the impact of products.
<b>Refrigerant &amp; EE</b>	Green Public Procurement	Support the penetration of energy efficient refrigerating appliances using climate friendly refrigerants unto the local market hence fostering market transformation
<b>Refrigerant &amp; EE</b>	Information campaign	Information campaigns can either support other policy measures or be carried out independently in order to advertise environmentally friendly programmes and behaviours.
<b>Refrigerant &amp; EE</b>	Eco-labels	Pull the market towards more environmentally friendly products by informing consumers and supporting the decision-making process.
<b>Refrigerant &amp; EE</b>	Research and development funding	Supports local companies in facilitating the penetration of environmentally friendly RAC related products onto the local market. Creating competition with non-environmentally friendly RAC products.
<b>Qualification &amp; Refrigerant &amp; EE</b>	Training and certification of qualified RAC servicing personnel	Training and certification in the RAC sector is a promising measure to ensure that refrigeration technicians in the service sector are adequately qualified and the best containment practices are applied during installation, maintenance and repair. Integrating technician training and certification into legislation is an effective way to guarantee proper handling of refrigerants and emissions reductions. Effective functioning units are more efficient, thereby improving energy efficiency.
<b>Qualification &amp; Refrigerant &amp; EE</b>	Technical standards regarding refrigerants, products and testing methods	Technical norms and standards are designed to be used as guidelines or manuals that establish technical criteria and definitions, methods, applications and best practices. They can contribute to long-term emission reductions through the consensus-based application of best practices



Policies combine a mixture of push and pull measures. By raising awareness for environmentally friendly technologies and creating an enabling environment, the market is pulled towards them. These measures are usually softer, working with incentives and voluntary actions rather than regulations. Examples are eco-labels, green public procurement, or tax reductions. Once sufficient “pull” is established, the market can be forced

to move into the intended direction by push measures. Banning the least efficient units via MEPS pushes the average market efficiency towards higher values. Another “push” could be a ban of refrigerants above a defined threshold for certain appliances. *Figure 1* illustrates push and pull measures to increase the energy efficiency of RAC equipment.

**Figure 1:** Policy measures causing push and pull effects within the market using the example of increasing the energy efficiency of RAC equipment (GIZ Proklima, 2016).



### 2.1.1 Manufacturer/ supplier related barriers

Certain components or refrigerants that are used to apply the best available technology (BAT) option may not be available in a country or region. A reason for this may be that there was no demand for them before.

It is expected that once the political framework to promote the uptake of BAT is put in place, the market will follow. For example, if there are still supply shortages of the hydrocarbon refrigerants R290 or R600a, this can be overcome by working with existing refrigerant distributors to stock the desired refrigerant, develop import channels from overseas producers to local suppliers, establish cylinder populations, bulk storage and transfer facilities or install gas purification plants.

Other components that may not be available include compressors, system components such as valves or filter/dryers, ancillary components such as pressure switches and gauges, thermostats, controllers, fans. Service tools and equipment such as gas detectors, recovery machines, torque wrenches, gauge/manifold sets may also be lacking. This barrier could be overcome by sourcing the components from overseas and setting up a distribution infrastructure.

Another strategy to address the lack of BAT supply in Ghana is to establish joint ventures with AC manufacturers from overseas and build up a local assembling infrastructure.

#### Possible policy measures

- ODS and F-Gas regulation, including non-climate-friendly refrigerant ban or phase-down
  - Increase of MEPS
  - Green public procurement
  - Incentives for end-users
  - Research & development funding and capacity building for local entrepreneurs
- ✎ The measures will push BAT on the market whilst at the same time creating a market.

### 2.1.2 Knowledge related barriers

The low availability of sufficiently qualified technicians and engineers is one of the key barriers for deploying green cooling in most developing countries and Ghana is no exception. Technicians need to be able to work on the specific technology, either at installation, service/maintenance or disposal level. Engineers need to be trained to design refrigerating systems using the specific technologies, both regarding small mass-designed products and the planning of large-scale units.

Some manufacturers might be reluctant to provide equipment if the competency of the local technicians is not well articulated. Here training and especially a mandatory certification and licensing scheme for technicians can be developed and implemented. Training syllabi according to technical standards and good practice guidelines would support international comparability of technician training standards and make them quite relevant in the sector with a higher employability scale.

The successful introduction of Green ACs in other countries, such as India, has been coupled to local production and a training and certification program for technicians usually provided by the manufacturer. Producers are hesitant to provide Green ACs to Ghana because there is no guarantee that technicians

are trained in an adequate way to provide necessary installation and servicing services and there is no mandatory certification for RAC technicians in Ghana.

Installation and servicing technicians lack knowledge about flammable refrigerants and the safe installation of ACs. Some once-off training courses have been conducted and some training equipment is available at the training centres. However, the training content has not been streamlined with a national standard and there are no knowledge-based certification schemes established that guarantee a minimum level of skills in trained technicians. Safety standards are not well known nor integrated into training courses.

A large informal sector of independent RAC technicians without a standardised education or training further complicates awareness raising activities. The integration of the large informal sector of RAC servicing technicians is key to ensuring high-quality work, especially when using flammable refrigerants. Similarly, it is important to increase awareness with building managers about green cooling and the need to employ qualified technicians for effective and efficient operation of the technology and increase demand for standard qualifications.

**Current developments:**

The Green Cooling Initiative (GCI) project has supported the market introduction of 380 Green ACs by two local importers and an earlier 30 pieces for demonstration purposes and is closely monitoring installation. EPA has supported this by providing an “Eco-label”. This endorsement label highlights the environmental benefits of Green ACs in addition to the star rating only. The project has already conducted two trainings for technicians on the safe use of hydrocarbon refrigerants. One of the trainings was supported by Midea and included a product introduction session.

UNDP and UNEP have provided some tools to several training centres and conducted training of trainers.

EPA and EC have formed a sub-committee of NACODS to introduce certification of technicians. The GIZ project Sustainable Energy and Energy Efficiency for Climate Protection (SustainE-4Climate) is likely to support the following in the coming years with the goal of establishing by 2024:

- Mandatory competency-based certification, including knowledge on flammable refrigerants.
- National certification standard
- Registration system for technicians
- National training concept and syllabus
- Guidelines for technicians on the certification scheme and offered support

**Possible policy measures**

- Legislation regarding the mandatory training and certification of qualified RAC personnel
  - Technical standards regarding refrigerants, products and testing methods
- ☑ The measures will remove the knowledge related barriers

**2.1.3 Regulatory matters/ Policy/ Standard related barriers**

Regulations often interfere with the deployment of certain technical options, and such is the case with green cooling, particularly concerning refrigerants in many countries. One of the key regulatory barriers refers to the prohibition of using flammable refrigerants in buildings or limiting the quantities of higher toxicity refrigerants close to residential areas. Other regulations unrelated to cooling may be in place that inadvertently negatively impact on the application of green cooling, such as requirements for transport and storage of flammable substances, maximum capacities, or power demands of cooling equipment as well as tolerated noise levels in certain areas. The lack of regulations can also be a barrier such as the absence of safety standards for flammable and/or toxic refrigerants, the lack of or outdated MEPS or labelling regulation. As long as these are not in place, producers or importers are likely to dump their cheapest products in the market.

Ghana introduced MEPS and labelling for ACs in 2005 and the values have not been updated since. Since the MEPS introduction, efficiencies have improved considerably in a market that was previously dominated by used equipment. Successful MEPS regulations update the requirement periodically in a predictable manner to drive continuous market evolution. Revised MEPS will probably be approved by the parliament in 2022. This is important as current MEPS can be met by most new equipment that is produced globally. Parliament will further increase

the star ratings from 1 to 7 stars and revise the minimum EEI of domestic refrigerators. Around 80% of units on the market are in labelling classes 1 and 2 at the moment, therefore, a restructuring will be more effective in pulling the market towards higher efficiencies.

Green public procurement mandates that mandate public institutions to purchase highly efficient (or low carbon options) are another option to promote green cooling. Current public procurement guidelines only require an energy label to be present but give no criteria regarding the number of stars or the refrigerant. Further, considering the irrelevance of the existing MEPS, these requirements do not produce tangible outcomes. The enforcement of the MEPS and labelling is limited to verifying that units carry a label and the right star label matching their nominal EER. There is no testing laboratory for ACs to test the energy performance. However, a testing laboratory is currently being set up with support from the US government (see [below](#)).

**Current developments:**

As part of the Green Cooling Initiative (GCI) project, the AC market was analysed looking at EERs, AC price and life cycle analyses. Based on this, a proposal was elaborated that suggests a restructuring of the labelling classes. The proposal was presented to parliament and is pending approval. The proposal is aligned with the European best practice distribution in the labelling classes, leaving the top two classes empty to allow for

the market to move. The current system of 5 labelling classes was extended to 7 stars in accordance with the labelling system for domestic refrigerators, which was recently extended. The revised MEPS will also increase the minimum requirements as well as the computation from EER to Annual Energy Efficiency Ratio (AEER) or Total Cooling Seasonal Performance Factor (TCSPF).

A way to reduce these barriers is to work with requisite national authorities and the technology providers who have already market access and those who have not yet market access in order to modify the relevant regulations and develop alternative national standards. Those standards permit larger quantities or wider application of those refrigerants or develop safety control systems that enable alternative means of achieving the same level of safety.

### Possible policy measures

- Introducing and regularly reviewing MEPS and labelling
  - Training and certification of qualified RAC servicing personnel
  - Update technical standards regarding refrigerants, products and testing methods as well as building codes or building energy efficiency guidelines
- ✎ The measures will increase the safety and energy efficiency in the RAC sector

#### 2.1.4 End user related barriers

The last barrier subcategory concerns consumer issues, which include lack of awareness and inadequate knowledge sharing which negatively affects their ability to change their behaviour. Thus, while green cooling options may be available, consumers may not be aware of their existence, their benefits, or the implications from their implementation. This might be intervened by working with authorities or environmental non-governmental organisations (ENGOs) and academia to roll out awareness raising programmes. These programmes usually seek to address issues arising from the lack of information about the new systems and the benefits to the consumer to make it an appealing option. Labelling schemes are often used for this looking to inform consumers on the energy efficiency, absolute energy consumption or refrigerant type of a certain product.

Another common barrier in this category is that green cooling units usually have higher upfront costs resulting in low uptake, although consumers may be aware of the option. The low acceptance of higher initial costs is a common barrier for high efficiency products resulting from different aspects of consumer experiences but primarily include:

- Inability to pay for the larger initial cost.
- Low awareness that efficient products are usually cheaper over their lifetime despite their higher initial cost.
- Indifference.

Moreover, poor AC servicing practices prevalent in Ghana are consumer-driven to a large extent. Most end-users select technicians for the servicing of RAC equipment according to price considerations and tend to neglect recommended maintenance frequency resulting in higher long-term costs. Often, end-users catch up on maintenance needs after the first malfunction has occurred in the system.

Retailers interviewed by GIZ confirm that the primary factor affecting an AC buying decision in Ghana is upfront price, even before any considerations of lifetime energy savings. Environmental factors, such as the type of refrigerant used, play a limited role in the purchasing decision.

Extensive discussions with retailers and distributors in Ghana have consistently indicated that, for a successful market introduction, it is essential that green ACs are priced, at the point of sale, at a 10-15% discount sales price to equivalent conventional models. Unit rebates sized such that the expected green AC price premium turns, after the rebate, into a price discount vs. equivalent conventional models is a key option to address this barrier.

Other possible interventions here include the work with authorities to develop incentives, the introduction of a financial disincentives programme for consumers of non-technical option systems, a financial incentives programme for all consumers, or legislation to phase-out non-technical option products.

### Possible policy measures

- Energy Labelling
- Product data base
- Incentives for end-users
- Green Public Procurement
- Information campaign
- Eco-labels

✎ The measures will increase consumer awareness and pull the market towards more environmentally friendly units.

#### 2.1.5 Key barriers applying to the Ghanaian focus subsectors and recommendations to remove them

An overview of the different barriers for the key subsectors is given in *Table 5*, using a traffic light colour coding (adopted from RAC NAMA Technical Handbook, Module 3, Table 8 (Heubes et al., 2014)). The subsectors are analysed one by one and recommendation to overcome the barriers are given.

*Table 5* highlights the barriers for the target subsectors in the four described barrier categories.

**Table 5:** Barriers hindering market uptake for key subsectors in Ghana

		Manufacturer/ supplier related barriers		Knowledge related barriers (Training and certification requirements)		Regulatory matters/ Standard related barriers			End user related barriers (Information and incentives)		
		Technical alternatives available	Component availability	Technical competences of service technicians	Technical competences of installer	Refrigerant ban/ MEPS/ Labelling	Safety standards (low GWP refrigerants)	Recycling/ Reclamation/ EPR	Upfront vs. Running costs	Financing barriers	Information/ Education
Small unitary AC (self-contained, split)	low GWP Refrigerant					N/A			N/A		
	Energy efficient Technologies						N/A	N/A			
Large unitary AC (multi-split, VRF, rooftop ducted)	low GWP Refrigerant					N/A					
	Energy efficient Technologies						N/A	N/A			
Domestic refrigeration	low GWP Refrigerant					N/A					
	Energy efficient Technologies						N/A	N/A			

- currently prohibitive barrier
- minor barrier
- no barrier
- not applicable

## 2.2 Barrier analysis on the sub-sector basis

In this section, the two focus subsectors are analysed to identify the barriers prohibiting an uptake of BAT technologies.

### 2.2.1 Unitary AC

When looking at the barriers, it is useful to divide the unitary AC sector into small and large systems.

Small systems comprise self-contained (e.g. window units), portable units and single split units. The impact of portable and window units in Ghana is so small and their importance is

expected to decrease even further in coming years that it will not be considered as a part of the focus sector analysis. For split systems, BAT options using the natural refrigerant R290 are currently not available for purchase in Ghana, but a negligible number has been installed as part of a demonstration project. The units are expected to be highly efficient and cost competitive to units using other gases within the same energy efficiency class.



**Table 6:** Barriers hindering market uptake for unitary ACs

		Recommended policy measures
Manufacturer/ supplier related barriers	Technical alternatives are hardly available on the market in Ghana	Introduce R290 AC units to green public procurement strategy; financial incentives for R290 efficient units (e.g. rebates, tax reductions or tax increases for other units); enable official import channel through existing importers; demonstration projects
	Spare parts are not available on the market in Ghana	Official import channel through existing importers would ascertain available spare parts and components for repair and maintenance.
	Energy efficient units and components are available in limited numbers in Ghana. Low efficiency R22 units are very common.	Ban of R22 unit import: R22 units are the least efficient on the market. A ban would increase the energy efficiency of units. A maximum GWP level for refrigerant could be implemented (Example EU: 750 for split AC).
Knowledge related barriers	Installation and servicing technicians lack knowledge about flammable refrigerants and the safe installation of refrigerants. Some one-off training courses have been conducted and some training equipment is available at the training centres. Safety standards are not well known nor integrated into training courses	Mandatory training, certification and licensing scheme for technicians. Properly serviced units have higher energy efficiencies.
Regulatory matters/ Policy/ Standard related barriers	MEPS and labelling have been introduced, but MEPS are too low to achieve a market transformation towards more environmentally friendly units. Products are not distributed equally over all labelling classes, which additionally reduces the pull towards highly efficient units.	Subsequently increase MEPS level over the coming years. This should go hand in hand with an increase of required energy efficiency in the labelling categories. A life cycle cost analysis is recommended to identify the breakeven point where the higher investment cost for a more efficient unit is balanced by the lower energy cost during operation. Based on the market analysis of the inventory, an increase of the MEPS to an EER of at least 3.0 in 2020 seems feasible with an increase to 3.4 in 2025 and 4.0 in 2030.
	Safety standards are restrictive towards flammable refrigerants- Standard IEC 60355-2-40 is developed but not yet operationalised.	Adopt newest international standard. Operationalise newest version of IEC 60355-2-40.
	EPR legislation has not been implemented yet. There are few activities regarding the recycling of ACs or refrigerants from ACs.	Implement legislation. Make recovery and recycling part of mandatory training and certification. Improve equipment availability for technicians.
End user related barriers	Higher investment costs of higher efficiency unit compared to operating costs / Information about energy consumption	Information campaign about life cycle costs. MEPS and labels give some information already.
	Investment cost of low-GWP refrigerant units	These are not necessarily higher than for units with a high-GWP refrigerant with the same energy efficiency.
	There are no financial incentives for end-users wanting to invest in units with high energy efficiency and/or low-GWP refrigerant	Introduce R290 AC units to green public procurement strategy; financial incentives for R290 efficient units (e.g. rebates, tax reductions),
	Information about environmental impact of refrigerant is not available to end-users	Introduce environmental label for units; information campaign for importers/resellers/general public about harmful impact of refrigerants on environment.
Other	Leakage reduction	Conduct a study on where leaks are mainly occurring and why. Introduce mandatory training, certification and licensing of servicing technicians. Introduce further reporting requirements for large end-users and servicing technicians

■ currently prohibitive barrier  
 ■ minor barrier

■ no barrier  
 ■ not applicable

For **large unitary AC systems** (multi-split systems and large ducted systems), the main barrier is a lack of ready-made solutions using low GWP refrigerants. Charge size restriction imposed by current international standards call for divided refrigeration cycles to keep the charges size of each cycle small. Such tailor-made solutions require expert technical knowledge, which is lacking in Ghana. Similarly, the knowledge gap about the advantages of well designed, low energy and low GWP AC systems result in no existing demand for such systems.

In buildings where large systems are generally installed, such as hotels, office buildings or new apartment blocks, additional factors can be considered, such as improving the insulation shell of buildings and demand side management, which reduces the required cooling capacities, leading to lower charge sizes and thus makes the use of low GWP refrigerant easier.

**Table 7:** Barriers hindering market uptake for large unitary AC systems

		Recommended policy measures
Manufacturer/ supplier related barriers	There are currently very few ready-made solutions using low-GWP refrigerants.	Secondary loop systems, such as chillers are widely used in Ghana. These could be used as alternatives to large UACs with lower annual leakage rates.  Demonstration projects via public procurement could be a first step to raise awareness and provide an incentive for installing companies to get familiar with the technology.
	Energy-efficient VRV and multi-split systems are available	
Knowledge related barriers	Technical knowledge about well-designed secondary loop natural refrigerant solutions is lacking (e.g. R290 chiller)	Demonstration projects via public procurement could be a first step to raise awareness and provide an incentive for installing companies to get familiar with the technology.
	Technicians are regularly servicing large UAC systems. However, leakage rates are very high, which decreases the energy efficiency.	Awareness raising for technicians. Mandatory training, certification and licensing scheme for technicians. Properly serviced units have higher energy efficiencies.
Regulatory matters/ Policy/ Standard related barriers	There are no MEPS or labelling for large ACs	MEPS and labelling should be devised and applied.
	There is little knowledge about safety standards. The standards used are restrictive towards charge sizes for natural refrigerants.	GS ISO 5149: 1993 Refrigerating Technology -Mechanical Refrigerating Systems - Cooling and Heating - Safety Requirements should be updated to a newer version as it is restrictive to natural refrigerants and thus does not reflect current technology developments. Thereafter, the standard should be included in training activities.
	Large UAC systems are currently not explicitly included in the EPR scheme.	Make recovery and recycling part of mandatory training and certification. Improve reclaim equipment availability for technicians.
	Information/Education	Start co-operation with green building initiatives or strategies. Information for end-users such as hotels, hospitals, office buildings and malls.
Other	High leakage rates VRV/VRF systems due to large refrigerant piping system	Introduce regular leakage checks and reporting of refrigerant leaks to EPA

■ currently prohibitive barrier  
■ minor barrier

■ no barrier  
■ not applicable



### 2.2.2 Domestic refrigeration

Efficient and sustainable domestic refrigerators and freezers are widely available worldwide and in Ghana. The reason for limited uptake might be found in higher upfront cost for highly energy efficient units, irrespective of the refrigerant used. Ghana has already implemented several measures to reduce the import of low energy efficiency units, such as a communication campaign, banning the import of used units and the introduction of MEPS.

Increasing MEPS, restructuring labelling classes and banning high-GWP refrigerants will fasten the already started process of making R600a the dominant refrigerant without majorly impacting the industry or end-users.

**Table 8:** Barriers hindering market uptake for domestic refrigeration

		Recommended policy measures
Manufacturer/ supplier related barriers	R600a units and components as well as refrigerant are readily available	Ban high-GWP refrigerants in order to increase the percentage from R600a units to 100%.
	Highly efficiency units are readily available, but there is still a high number of inefficient units on the market	Increase MEPS and labelling categories. Increase implementation of import ban for used units.
Knowledge related barriers	Technicians are aware of the technology and have been servicing it for many years	No barrier
Regulatory matters/ Policy/ Standard related barriers	MEPS and labelling are available for domestic refrigerators. However, the average energy efficiency of units is still relatively low.	Increase the level of MEPS and the labelling categories. Ban imports of low EE units
	Safety standard GS IEC 60335-2-24: 2007 Household and Similar Electrical Appliances - Safety - Part 2-24: Particular Requirements for Refrigerating Appliances, Ice-Cream Appliances and Ice-Makers is in place	No barrier
	EPR legislation has not been implemented yet. There are several activities in the country regarding the recovery of refrigerant and foam blowing agent.	Implement legislation. Make recovery of refrigerant and blowing agent mandatory. Install country wide collection options for disposed units.
End user related barriers	Information campaigns and labelling have supported purchase decisions towards low energy efficiency units	No barrier
	There are no direct financial incentives anymore to support high energy efficiency /low-GWP refrigerant units.	Continue information campaign and labelling scheme. Financial support could be given to overcome the higher upfront cost for lower income groups. An import tax levy could also help to reduce costs.

#### Other subsectors:

Commercial and industrial stand-alone units are available in high numbers in the country. Low-GWP natural refrigerant alternatives are available on the global market at competitive prices and high energy efficiency. Introducing MEPS and labelling, banning high-GWP refrigerants or introducing incentives for these units could fasten their uptake.

Processing and AC chillers using low-GWP natural refrigerants are already present in Ghana in low numbers. More information on their application, especially in office buildings, hospitals and hotels instead of single split units, condensing units or multi-split units could be introduced. Training of technicians and engineers on the installation and maintenance of chillers could then further support their introduction. Demonstration units, green public procurement and tax reductions for environmentally friendly equipment are further options.



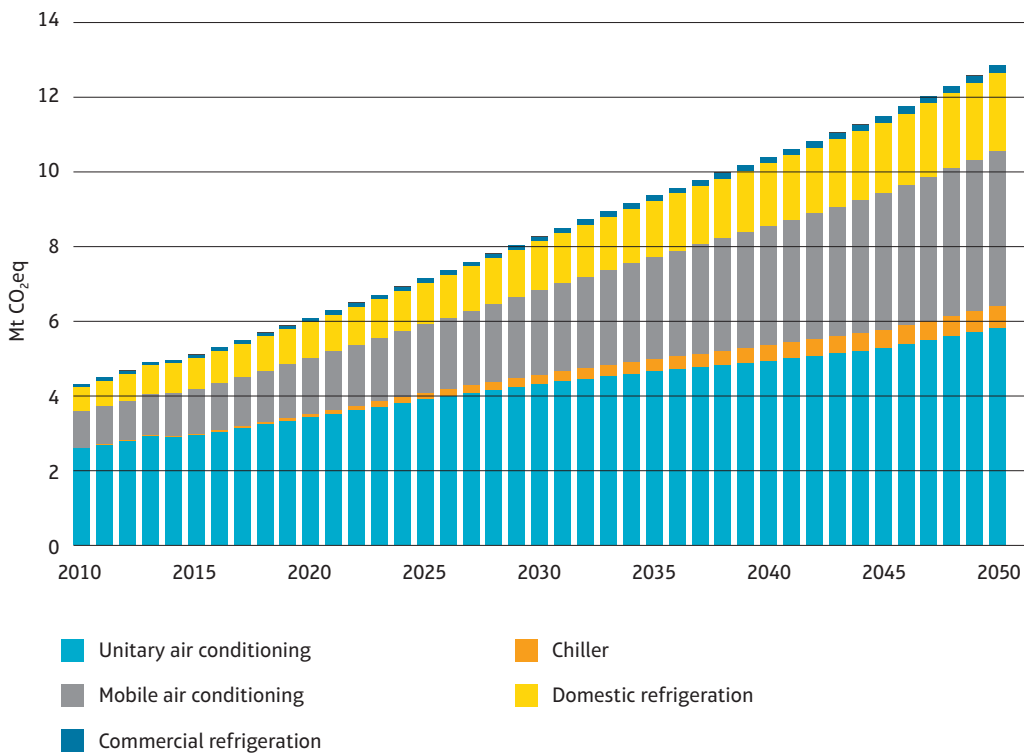
# 3 Roadmap

The roadmap is a planning instrument, translating the findings of inventory, technology gap analysis and policy analysis into strategies and milestones to increase the market share of green cooling technologies and mitigate GHG emissions in the RAC sector.

### Inventory summary

In Ghana, the RAC sector currently causes GHG emissions of 5.05 Mt CO<sub>2</sub>eq (2015), two thirds of them being indirect emissions from energy use. With the RAC inventory, a sound database of RAC equipment in use, its distribution in the subsectors and expected growth is established. *Figure 2* shows the subsector distribution and the projected development until 2050 under business as usual conditions. The highest contribution comes from the unitary AC, the mobile AC and the domestic refrigeration subsectors.

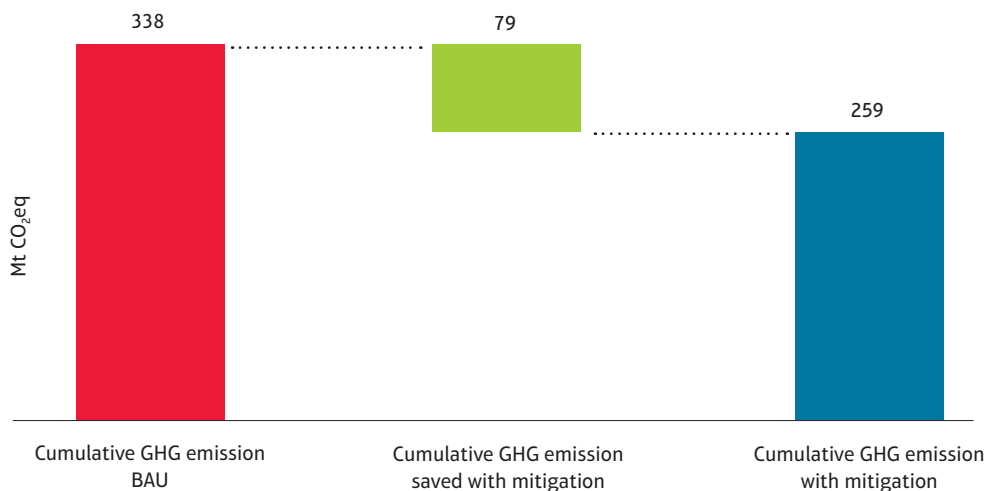
**Figure 2:** Current and projected total emissions until 2050.



Cumulated, emissions from the RAC sector from now to 2050 will reach 338 Mt CO<sub>2</sub>eq. The mitigation potential based on introduced best available technology (BAT) amounts to 79 Mt

CO<sub>2</sub>eq by 2050, meaning that only 259 Mt CO<sub>2</sub>eq would be emitted under the mitigation scenario (*Figure 3*). The introduction of BAT however depends on the implementation of suitable policy measures to overcome identified barriers.

**Figure 3:** RAC sector mitigation potential: Cumulative GHG emissions in Mt CO<sub>2</sub>eq from 2010 to 2050 with and without the application of BAT



An inventory of all GHG emissions in Ghana estimated emissions to be as high as 19.53 Mt CO<sub>2</sub>eq in 2010. Of this about 10% were due to electricity use in the residential and commercial sectors, a further 5% from the industrial sector (LCDS, 2016). The value for 2015 in the Ghanaian emission scenario was estimated based on Figure 11 in the LCDC (2016) report. Whilst indirect emissions of the RAC sector are already included under electricity use or transport (for mobile AC), the inventory of GHG emissions did not include direct emissions from the refrigerant use. In order to estimate the contribution of the RAC sector to total emissions, these were therefore added (Table 6).

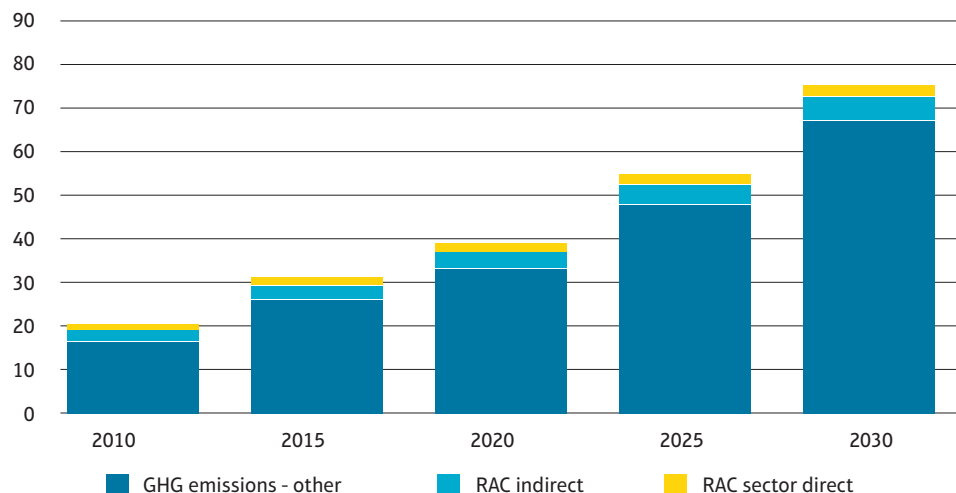
According to the inventory, the RAC sector contributed about 31% to total GHG emissions in Ghana in 2010. This is expected to decrease to 10% in 2030 as emissions from other sectors are likely to grow even faster. Direct emissions, which are currently not accounted for in the inventory contributed about 8% in 2010 and are expected to account for 4% in 2030. It can therefore be concluded that the sector is highly relevant for current GHG mitigation strategies in Ghana. Early action can considerably reduce GHG emissions in the close future and prevent an accumulation of emissions further ahead.

**Table 9:** Comparison of GHG emissions in Ghana from the national inventory to RAC sector emissions determined in the inventory report in 2017.

All in Mt CO <sub>2</sub> eq	GHG emissions Ghana	GHG Ghana & HCFC/ HFC emissions	RAC sector	RAC sector direct	RAC sector indirect	RAC sector %	RAC sector direct
2010	19.5	21.1	6.5	1.6	4.9	31%	8%
2015	30.0	31.9	7.6	1.9	5.7	24%	6%
2020	37.8	40.0	8.7	2.2	6.5	22%	5%
2025	53.5	56.0	10.1	2.5	7.6	18%	4%
2030	74.0	76.7	11.8	2.7	9.1	15%	4%

The table further compares these emissions to the RAC emissions determined from the inventory. The comparison can also be seen in Figure 4.

**Figure 4:** Comparison of Ghana's total GHG emissions to RAC sector emissions.



The focus subsectors are identified based on their emission share and availability of alternatives. The unitary AC sector contributed highest to GHG emissions. The second largest contributing subsector of mobile AC is not considered as policy interventions are unlikely to reduce emissions here. The automotive manufacturing sector is organized globally, and the technology is the same everywhere. Currently, strict regulations regarding the refrigerant in the EU and the US have introduced low-GWP refrigerants, which are expected to spread to other countries in the near future. The third highest contributions come from domestic refrigerators. Emissions are much lower, but green technology alternatives are readily available, and their widespread uptake is a so-called low-hanging fruit. It is also a highly relevant subsector for many Ghanaians as it is estimated that about 25-30% of household electricity use is due to refrigerators (Gyamfi et al., 2015).

Additionally, it was concluded from the inventory that high annual leakage rates are responsible for a large proportion of direct emissions. This topic is therefore included in more detail.

#### Technology Gap analysis

The equipment currently available on the market is assessed in regard of their energy efficiency, cooling capacity and refrigerant used. These features are compared to internationally available BAT options. Globally and in Ghana, there are different levels of availability for technologies with high energy efficiencies and low-GWP refrigerants. For Ghana, good availability is given for domestic refrigerators, stand-alone units, chillers and centralised systems. On the global market, green cooling technology is also available to a small extent for split ACs, and for condensing units. More options for chillers and centralised

systems are available in terms of a variety of natural refrigerants, higher energy efficiency and more varied application of these units, e.g. as alternatives for condensing units, multi-splits or centralised systems.

#### Barrier analysis and policy options

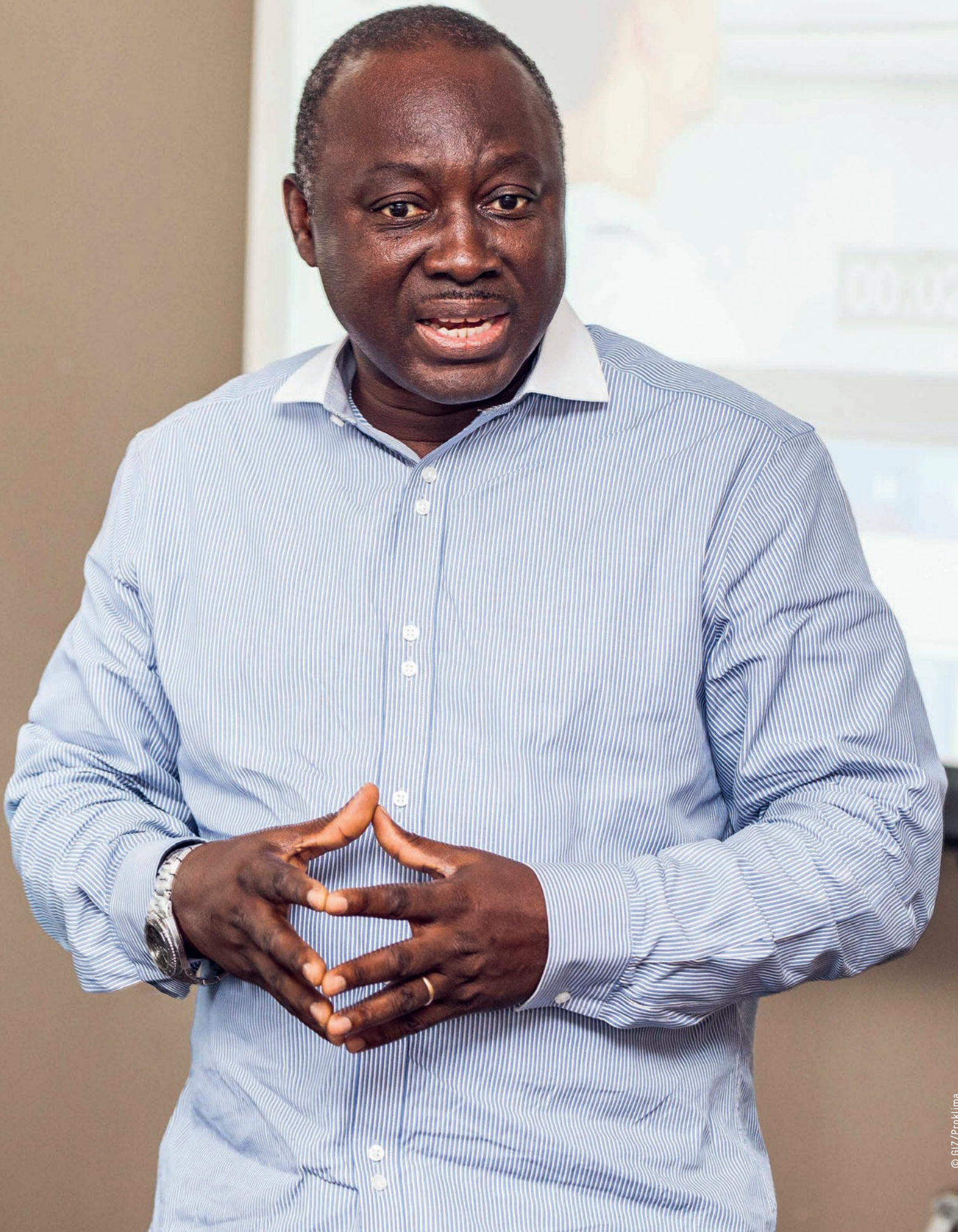
Several barriers were identified for the uptake of green cooling technologies. The main identified barrier is a lack of training for technicians, which results in high leakage rates and low energy efficiency and hinders the uptake of green cooling technologies. Formalised technician education could substantially increase the uptake of natural refrigerants, increase energy efficiency and lower leakage rates.

The availability of green cooling technologies is not always given, so that policies are needed to create a market. Here, financial incentives and regulation of high-GWP refrigerants could be considered. Units with high energy efficiency can be supported by means of increased MEPS and labelling standards.

#### Aim of this roadmap

The roadmap concentrates on the focus subsectors identified during the inventory, UAC and domestic refrigeration, and on the identified key barriers of the policy analysis. Implementing the measures outlined in this roadmap, a mitigation of 18% by 2030 is possible.

The roadmap includes four strategies to overcome the identified barriers. For each strategy, specific recommendations are formulated tailored to the focus subsectors or are aimed at cross-cutting topics important to the whole RAC sector.



# 4 Strategy

## 4.1 Overview

The strategies presented in this chapter follow the categorization introduced in chapter 1 “Policy analysis” and target the main barriers identified in previous chapters that are hindering the uptake of highly efficient, low GWP RAC appliances:

- 1) Increasing energy efficiency of appliances
- 2) The introduction of low-GWP refrigerants
- 3) Mandatory qualification of technicians, including certification
- 4) Measurement, reporting and verification of measures

A crucial point for the successful implementation of any measure is sufficient ownership within the respective ministry. It is the task of the ministry to entrust responsible bodies with the implementation and enforcement of agreed measures. Suggestions for stakeholders to be involved in the strategies are included.

A strategy with its own bundle of actions is suggested for each of the categories. For each category, specific measures targeting the focus subsectors or the whole sector as cross-cutting issue are outlined. [Table 7](#) provides a summary.

**Table 10:** Existing and planned policies and standards concerning energy efficiency of RAC equipment

Strategy	Measures	Target sector
<b>1) Increasing energy efficiency</b>		
<ul style="list-style-type: none"> <li>• Ban inefficient products from the market</li> <li>• Provide incentives to accelerate market uptake</li> <li>• Inform end-users about life-cycle costs</li> <li>• Make energy use transparent</li> </ul>	<ul style="list-style-type: none"> <li>• Set or increase MEPS</li> <li>• Set or increase labelling requirements</li> <li>• Increase activities to verify labels and sanctions for infringements</li> <li>• Import tax depending on energy efficiency</li> <li>• Green public procurement guidelines</li> <li>• Widen information campaign for end-users</li> </ul>	<ul style="list-style-type: none"> <li>• UAC: Single splits</li> <li>• UAC: Multi-Splits, VRVs</li> <li>• Domestic refrigeration</li> <li>• Commercial stand-alone units</li> </ul>
<b>2) Transition to low GWP refrigerants</b>		
<ul style="list-style-type: none"> <li>• Push units with low-GWP on the market</li> <li>• Provide market with guidance that low GWP refrigerants are politically favored</li> </ul>	<ul style="list-style-type: none"> <li>• Favor systems using low-GWP refrigerants by lower import tax or similar incentives</li> <li>• Establish supply structures for units using low-GWP refrigerants</li> <li>• Ban high-GWP refrigerants in systems where alternatives exist</li> <li>• Define (or adopt) safety standards for flammable refrigerants to allow sufficiently high charge sizes</li> <li>• Adapt green public procurement guidelines</li> <li>• Ecolabelling for end users</li> </ul>	<ul style="list-style-type: none"> <li>• Single split</li> <li>• Domestic refrigerator</li> <li>• Commercial stand-alone</li> <li>• AC chiller</li> </ul>
<b>3) Ensuring proper installation and servicing to maintain safety and energy efficiency</b>		
<ul style="list-style-type: none"> <li>• Establish framework conditions for a safe uptake of flammable/toxic refrigerants</li> <li>• Improve skills of technicians</li> <li>• Increase awareness for refrigerant containment</li> </ul>	<ul style="list-style-type: none"> <li>• Expand training content to cover the safe use of natural refrigerants</li> <li>• Include design options for energy efficiency</li> <li>• Establish compulsory certification scheme</li> <li>• Set up a registry for certified technicians</li> <li>• Adopt all relevant international safety standards and include them into the training scheme</li> </ul>	Cross cutting issue, applies to all subsectors, but effects on emissions are more pronounced in larger appliances
<b>4) Establishment of a MRV system</b>		
<ul style="list-style-type: none"> <li>• Introduce institutionalized emission monitoring for the RAC sector</li> </ul>	<ul style="list-style-type: none"> <li>• Introduce a data base where all importers need to report imported equipment including Brand, model capacity, EER, refrigerant and initial charge</li> <li>• Include RAC sector in national inventory for Ghana</li> <li>• Link MP reporting of F-gases to UNFCCC reporting</li> </ul>	<ul style="list-style-type: none"> <li>• All sectors (start with the focus subsectors)</li> </ul>

During a workshop in Accra in October 2017 with stakeholders from both industry and the policy sector, participants were asked to contribute their view on the main barriers and possible policy options regarding the 4 strategies. The results are included in each of the chapters.

## 4.2 Strategy 1: Increasing energy efficiency

### 4.2.1 General strategy description

The target of Strategy 1 is the improvement of energy efficiency in smaller RAC appliances in the short term and larger systems in the medium term.

MEPS and labelling schemes are often coupled together, as is the case in Ghana for split ACs and domestic refrigerators. It is suggested that MEPS are subsequently increased and the lower labelling classes successively banned for these two subsectors and MEPS and labelling introduced for other subsectors. Subsectors where units are sold in higher numbers to non-specialist consumers and that are easy to specify are more recommended as targets, such as stand-alone units or small chillers. Larger appliances are not as easily categorized as they usually consist of more parts and are often customised to the building where it is installed. Here, MEPS are more useful than labelling or MEPS for compressors. It is advised to extent MEPS to larger appliances after MEPS have been introduced in the main target sectors in order to prevent replacement of regulated subsectors with sub-standard equipment.

The set point of MEPS are to be found according to a national (or regional) life cycle cost (LCC) assessment. Depending on investment costs and energy prices, the breakeven point between inefficient units with low investment cost and high operation cost and efficient units with higher investment costs and lower operation cost is a guide to a suitable level of a MEPS. MEPS and labelling schemes are the most successful, if clearly defined product groups are targeted. Standard measurement and calculation methods need to be in place. This is both the case in Ghana for split AC and domestic refrigeration. Independent verification of the correctness of the stated energy parameters and the resulting label class is still necessary. Responsibilities within the government are to be defined and sufficient funds provided for sufficient random testing. Sanctions for wrong or missing data are to be defined and executed. Responsible bodies are to be named for prosecution. Whilst standards and responsibilities are clearly defined in Ghana, enforcement is often difficult because of a lack of equipment for AC testing and funding for these activities.

The metric for MEPS and labelling in Ghana is the energy efficiency ratio (EER). In some countries, the seasonal energy efficiency ratio (SEER) is now introduced instead in order to account for operating conditions that are different from testing conditions. This is particularly interesting for countries where temperature varies and ACs are often running on part load or if there is a high penetration of inverter technology, which is more efficient at part load. For Ghana, where temperatures are high all year round and inverter penetration is still low, this is not the highest priority.

Financial incentives for example include import taxes depending on energy efficiency. These can provide an incentive for green appliances and add to balancing the higher investment cost for highly efficient products. The labelling scheme can be a guideline for setting tax reductions. Additional measures to enhance the market uptake of energy efficient units could be the introduction of a "new for old scheme", replacing old, inefficient units with new, highly efficient units (a further scheme for refrigerator/freezers or a new scheme for ACs). Similarly, a grant could be given to lower-income households to balance the high investment costs for highly efficient units.

Green public procurement can add to the uptake of energy efficient units, as it sets a role model and provides a clear signal to the market that highly efficient units are wanted. Government institutions, universities and hospitals contribute considerably to the use of RAC appliances and could therefore influence the market.

Ghana has already had good experiences with an information campaign about energy efficient appliances in the domestic refrigeration sector. These efforts could be widened to cover the AC sector or efforts in the domestic refrigeration sector could be repeated.

### 4.2.2 Workshop results

Participants were asked to list the highest barriers and possible policy measures for the increased introduction of energy efficient equipment (*Table 8*). Higher costs or higher perceived costs were seen as the main barrier, followed by a lack of awareness. Interestingly, consultants were seen as a main target group for awareness raising as they are in many cases responsible for purchasing large numbers of equipment, e.g. ACs for big office buildings.

Suggested policy measures target the costs, e.g. through tax incentives or green public procurement measures, but also call for bans of low EE units (i.e. an increase of MEPS) and awareness campaigns, e.g. through training or energy labelling.



**Table 11:** Barriers and relevant policy measures for the introduction of energy efficient equipment, determined during a stakeholder workshop in Accra.

Barriers	Policy Measures
<ul style="list-style-type: none"> <li>• Costs               <ul style="list-style-type: none"> <li>- Import tariffs</li> <li>- Initial cost of energy efficiency equipment (inverter units)</li> <li>- Perception that new appliances are expensive</li> <li>- Influx of cheap used and old appliances</li> </ul> </li> <li>• Education               <ul style="list-style-type: none"> <li>- Lack of awareness of alternatives</li> <li>- Consultants specifying tender, do not know green cooling technologies</li> </ul> </li> <li>• Technology               <ul style="list-style-type: none"> <li>- Availability of alternatives</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Public Education, Sensitization, Advocacy               <ul style="list-style-type: none"> <li>- Training for entire value chain</li> </ul> </li> <li>• Freeze and bans               <ul style="list-style-type: none"> <li>- Ban low EE units</li> </ul> </li> <li>• Tax regimes               <ul style="list-style-type: none"> <li>- Incentives for alternative processes</li> <li>- Duties and tariffs reduced for high EE</li> </ul> </li> <li>• Energy labels</li> <li>• Green procurement by government etc.</li> </ul>

## 4.3 Strategy 2: The introduction of low-GWP refrigerants

### 4.3.1 General strategy description

Strategy 2 targets the selection of refrigerants used in RAC equipment. Despite the Kigali Amendment, giving an expiry date to the wide-spread use of HFCs, the presently employed refrigerants are still usually HFCs. It requires a strong political signal for the market to shift towards low GWP refrigerants. The best-practice example is the EU Regulation on fluorinated greenhouse gases (EU F-gas regulation), setting a strict quota system to reduce the use of HFCs to 21% of its 2014 level until 2030. Additionally, the EU F-gas regulation bans the use of refrigerants above a certain threshold where low GWP alternatives are established.

While a general HFC phase-down is too ambitious for Ghana at present, banning the use of high GWP refrigerants in selected applications for new units still provides a strong market signal. The product group with a well-established low GWP alternative is domestic refrigeration. Banning the sale of domestic refrigerators using refrigerants with a GWP above 150 might not result in a high emission reduction, but shows international supplies that HFCs are no longer favoured. Similarly, single-split ACs and commercial stand-alone units could be targeted at a later point in time. Since the EU F-gas regulation targets the same product groups, the market will have developed sufficient alternatives. The following dates are suggested and implemented in the roadmap scenario (*Table 9*).

**Table 12:** Prohibition years for selected product groups under the EU F-gas regulation and suggested years for Ghana

Product group	GWP threshold	Year of prohibition EU-F-gas regulation	Year of prohibition Ghanaian roadmap scenario
Split ACs (below 3 kg charge)	R22	N/A	2025
	750	2025	2030
Domestic refrigeration	150	2015	2020
Commercial stand-alone units	2500	2025	2020
	150	2030	2025

Additionally, measures are suggested that support the introduction of low-GWP ACs specifically as they are not yet established in the market, such as tax incentives, green public procurement and the involvement of the private sector. The ODS regulation in Ghana, LI 1812, already includes the possibility to support ozone-friendly equipment by tax waivers or reductions (provision 16).

Communication strategy is supported by section of LI 1812 where it mandates the EPA to carry out public awareness activities and programmes relating to the elimination of Ozone depleting substances (ODS) and products. The activity can be carried through the mass media which includes publicly exhibited posters, newspaper, radio, television, social media, or other electronic media used for such purposes. In a market with a small number of suppliers and where a good relationship exists between a market transformation program and the suppliers, awareness creation can be most effective. Especially when trust has been built before and there are policies to back such programmes. Market research helps point to the most effective approaches.

#### 4.3.2 Workshop results

Participants were asked to list the highest barriers and possible policy measures for the increased introduction of low-GWP refrigerant equipment (*Table 10*).

Barriers were seen mainly in the higher cost of equipment or refrigerant or the negligence of recycling costs of synthetic high-GWP refrigerants. The lack of knowledge about the low-GWP refrigerant technology was further seen as a barrier and also a lack of refrigerant availability, which is currently restricted.

The proposed policy measures to overcome these barriers therefore focused on financial incentives and education and capacity building, e.g. training for technicians according to established safety guidelines. Additionally, it was proposed to regulate refrigerants with high-GWPs and accelerate the phase-down of R22 in new equipment.

**Table 13:** Barriers and relevant policy measures for the introduction of low-GWP refrigerant equipment, determined during a stakeholder workshop in Accra.

Barriers	Policy Measures
<ul style="list-style-type: none"> <li>• Cost               <ul style="list-style-type: none"> <li>- Lack of knowledge about costs</li> <li>- Prices and recycling</li> </ul> </li> <li>• Training, Awareness &amp; Capacity Building               <ul style="list-style-type: none"> <li>- Lack of knowledge and training for technicians</li> <li>- Lack of awareness of environmental effects</li> <li>- Lack of safety guidance</li> </ul> </li> <li>• Technology               <ul style="list-style-type: none"> <li>- Lack of refrigerant availability</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Regulatory policy measures               <ul style="list-style-type: none"> <li>- Regulation on ODS should be expanded to also include non-ODS refrigerants with high GWP</li> <li>- Enforce R22 phase down</li> </ul> </li> <li>• Tax regimes               <ul style="list-style-type: none"> <li>- Introducing incentives and disincentives</li> <li>- Lower taxes for importers and retailers for equipment with lower GWP refrigerants</li> <li>- Buy-ins</li> </ul> </li> <li>• Education &amp; Capacity Building               <ul style="list-style-type: none"> <li>- More training</li> <li>- Safety guidelines for technicians</li> <li>- Sensitization on benefits of low-GWP refrigerants</li> <li>- Broader stakeholder consultations</li> <li>- Cost education</li> </ul> </li> </ul>

## 4.4 Strategy 3: Formalized training and certification scheme for RAC technicians

### 4.4.1 General strategy description

**Strategy 3** aims at establishing a formalised training and certification scheme for RAC technicians. Being able to proof a certain skill level also to international technology suppliers is crucial for gaining market access to technologies using flammable and/ toxic refrigerants. In additions, skill is equally required to maintain high energy efficiency throughout the lifetime of the equipment. In absence of national safety standards, international standards could be adopted, providing legal security on the applying safety standards.

While new alternatives are environmentally safe, there are several technical challenges to overcome. For example, the use of flammable substances for refrigeration, as is the case with hydrocarbons, requires a different safety concept and control than for substances classified as not flammable. Public safety is a key concern when introducing new alternatives. Even though knowing that the introduction of such alternatives in products and installations in Europe achieves, without compromise, the same level of safety as with HFCs. The main reason being that the necessary qualitative infrastructure for the introduction of these technologies is missing. The introduction of new, often more complex, technologies, requires new skills, know-how and quality control. Conformity of process, product, or service with required good practice and standards can be enforced with certification, regulation and market incentives. Companies, as well as technicians need to conform with good practice and standards. Finally, the safety of the product or installed equipment needs to be verified.

Training builds capacity of personnel to effectively deliver their mandates. However, critical aspects of the impact of personnel on public or environmental safety need to be assessed through third party verification.

In other words, the introduction of new alternatives will also depend on the availability of qualification and verification systems and intermediaries that enable certification of conformity of relevant processes, products and services. Therefore, the objective is to establish a qualitative infrastructure for RAC technologies at various levels through policy action, private sector cooperation and code of practice and commercial services & requirements that enable overall monitoring of the quality of products, services and processes.

Qualification systems need to ensure that personnel in public and private sector are trained in fulfilling relevant technical standards and that requirements are enabled to qualify for examination and certification. For certificates to be reputable and accepted worldwide (e.g. by suppliers of parts and equipment), accreditation of third party certification bodies (although not always mandatory) is strongly recommended. Accreditation is validating the appropriateness of the structure and governance of the certifying body, the characteristics of the certification programme, the information required to be available to applicants, and the recertification initiatives of the certifying body.

Furthermore, accreditation is facilitating acceptance of the certification bodies and their certification schemes and mutual recognition of personnel competences and services on national and international levels.

A staged training and certification process is recommended, including:

1. **Qualification:** Education, experience and knowledge are the basis for evaluating the qualification level of trainees
2. **Training:** Courses can be conducted by any institution with demonstrated experience in the field. They be supported by standardized curricula
3. **Training certificate for successful participation:** Training institutes will certify successful completion of the training. However, this is in generally not considered sufficient when liability issues are involved
4. **Application for certification:** With proven entry qualification 3rd party examination can be applied for. A diversified structure is needed to allow all levels of proficiency to acquire certified competence.
5. **Examination by 3rd party:** Internationally or nationally accredited training institute will issue a certificate based on locally adapted international standards for certification.
6. **Registration:** After certification, the certified person needs to be registered by a national body. This database can be made available to end-users.

#### 4.4.2 Workshop results

Participants were asked to list the highest barriers for increased capacity building and possible policy measures to overcome these (*Table 11*).

The main barriers were seen in a lack of technical know-how and expertise as well as a lack of adequate tools and missing involvement of local stakeholders. All these points can be interpreted as the result of a lack of resources to fund further training and equipment. Lack of involvement of local stakeholders and a resistance to change are further barriers that are more related to missing awareness.

Suggested policy measures involve a mandated training, certification and licensing scheme, which would ensure a minimum knowledge in all technicians. This is only possible with dedicated financing for training and equipment, but also for awareness raising and information on the cost of different technologies. Specific training should be offered for importers so that they better understand the different technologies and the policies that will impact them.

**Table 14:** Barriers and relevant policy measures for increased capacity building, determined during a stakeholder workshop in Accra.

Barriers	Policy Measures
<ul style="list-style-type: none"> <li>• Lack of resources to fund training, tools and equipment</li> <li>• Lack of technical know-how &amp; expertise</li> <li>• Lack of adequate tools for natural/ low-GWP refrigerants</li> <li>• Lack of involvement of local stakeholders</li> <li>• Resistance to change</li> </ul>	<ul style="list-style-type: none"> <li>• Training, Certification and Licensing</li> <li>• Train importers to understand technology and policy</li> <li>• Dedicated financing               <ul style="list-style-type: none"> <li>- Sensitization on benefits of low-GWP refrigerants</li> <li>- Broader stakeholder consultations</li> <li>- Cost education</li> </ul> </li> </ul>

## 4.5 Strategy 4: Measurement, reporting and verification of measures

### 4.5.1 General strategy description

The focus of Strategy 4 is to develop a MRV system in order to track the effects of any policy option, whether nationally or internationally funded. It is also aimed to collect activity data of the RAC sector to be integrated into the GHG inventory process. For a detailed knowledge of equipment in use, it is important to know what is sold in the country. For an importing- only country such as Ghana, it might be sufficient to closely monitor imports and exports of equipment. Best practice is a database of sold RAC equipment including selected technical parameters such as cooling capacity, energy efficiency metric, labelling class (if applicable), initial charge and contained refrigerant. This database could in a second step be made public so that end-users can make even more informed decisions.

Setting up such a comprehensive database requires an institutional framework, defining reporting obligations for all market participants. Nevertheless, it is a powerful information source, once established.

Ghana has already started in setting up such a database for domestic refrigerators. Unit specific information is collected by the energy commission and can be seen by end-users via a mobile app. The number of sales is not currently recorded. It is recommended to further include split ACs into this scheme. Both product groups have technical parameters that are either already defined by (parallel) labelling requirements or are unproblematic to define. The counting of sales can be additionally established within customs, including the count of re-export. However, the assumption that all units that are imported are promptly sold and consequently in operation needs to be verified. If feasible, reporting obligations are best to be established at a level where double counting can be avoided and all units sold are recorded.

To highlight the importance of the RAC sector, it is advised to include direct emissions into the national inventory and indicate its percentage of residential and commercial electricity use. In order to reliably include data in the future without the high cost and effort of an inventory, it is recommended to introduce a level of institutionalization of data collection. The aforementioned database is one step. Further, parameters could be developed based on statistical data to estimate the number of units in the country. Cooperation between Montreal Protocol reporting, which in future will include high-GWP HFCs and UNFCCC reporting is advised. The high relevance of the RAC sector can be included in Ghanaian policies regarding climate change and energy.

### 4.5.2 Workshop results

Participants were asked to list the highest barriers for successful MRV implementation and possible policy measures to overcome these (*Table 12*).

Many barriers were listed for MRV in the RAC sector in Ghana. A lack of coordination between the relevant agencies make data collection difficult, as well as a lack of necessary monitoring equipment, lack of staff and resources. At the same time, importers are unwilling to hand over data and record keeping is generally poor.

However, many suggestions were also made to improve MRV, ranging from introducing tools and training and recruitment of more personal and resources to streamlining roles and responsibilities and drafting additional policies that facilitate data collection.

**Table 15:** Barriers and relevant policy measures for successful MRV, determined during a stakeholder workshop in Accra.

Barriers	Policy Measures
<ul style="list-style-type: none"> <li>• Lack of supervision by regulatory agencies</li> <li>• Lack of coordination of regulatory bodies, duplication of roles</li> <li>• Lack of necessary monitoring equipment</li> <li>• Lack of resources (staff and logistics) of monitoring bodies</li> <li>• Lack of skills</li> <li>• Inability of government to collect data</li> <li>• Unwillingness of importers to provide data</li> <li>• Poor record keeping</li> </ul>	<ul style="list-style-type: none"> <li>• MRV Tools and Training</li> <li>• Streamlining roles and responsibilities, increasing coordination between regulatory bodies</li> <li>• Data submission to EPA by largest importers</li> <li>• Recruitment of personal and resources</li> <li>• Database on all RAC imports</li> <li>• Certification of RAC equipment imports</li> <li>• GSA to draft policy on verification of RAC equipment</li> </ul>

## 4.6 Overview of strategies relevant for the potential mitigation effects

The following table (Table 13) shows the specific milestones in terms of MEPS and refrigerant bans for the different subsectors. These numbers are used to calculate the potential emission

reductions due to the described policy actions. Additionally, expected emission reductions through improved technician knowledge and leakage reduction are listed.

**Table 16:** Milestones for subsector specific roadmap actions

		2020	2025	2030
Split AC	1	Strengthen MEPS: EER $\geq$ 3.2 Adjust labelling categories	Strengthen MEPS: EER $\geq$ 3.8 Establish an SEER metric for MEPS, keep both systems in parallel	Replace EER metric with SEER metric Review MEPS (EER: 4.3 about equal to SEER 7.5)
	2	Phase down of units using R22; introduce tax reductions based on GWP of refrigerant; guidelines for green public procurement	Phase-out of units using R22	Ban units with charges sizes below 3 kg using refrigerants with GWP above 750
	3	Service and EOL emissions are decreasing due to better training Annual emission factor (EF) = 23% EOL EF = 95%	Annual EF = 10%, EOL EF = 75%	Annual EF = 8%, EOL EF = 50%
	4	Database recording sales incl. technical parameters is functional	Review functionality and coverage of database	
Larger UAC systems	1	Incentive for high EE Established guidelines for Green Public procurement of AC equipment	MEPS apply	Review MEPS
	2	Incentive for low GWP refrigerant Choice of refrigerant included in guidelines for Green Public procurement of AC equipment		
	3	Service and EOL emissions are decreasing due to better training Annual EF = 35% EOL EF = 90%	Annual EF = 20%, EOL EF = 90%	Annual EF = 15%, EOL EF = 75%
Domestic refrigeration	1	MEPS: EEI equivalent to annual energy use = 360 kWh Labelling scheme is operational	Strengthen MEPS: EEI equivalent to annual energy use = 320 kWh	Review MEPS EEI equivalent to annual energy use = 260 kWh
	2	Ban units using refrigerants with GWP above 150		
	4	Database recording sales incl. technical parameters is functional	Review functionality and coverage of database	
Self Contained	3	Annual EF = 25%, EOL EF = 95%	Annual EF = 15%, EOL EF = 85%	Annual EF = 10%, EOL EF = 75%
Split (ducted)	3	Annual EF = 20%,	Annual EF = 10%, EOL EF = 70%	Annual EF = 8%, EOL EF = 60%

		2020	2025	2030
Air conditioning chillers	3	Annual EF = 22%, EOL EF = 95%	Annual EF = 15%, EOL EF = 90%	Annual EF = 10%, EOL EF = 80%
Process chillers	3	Annual EF = 22%, EOL EF = 100%	Annual EF = 15%, EOL EF = 90%	Annual EF = 10%, EOL EF = 80%
Car air conditioning	3	Annual EF = 20%, EOL EF = 100%	Annual EF = 20%, EOL EF = 90%	Annual EF = 20%, EOL EF = 85%
Large vehicle air conditioning	3	Annual EF = 30%, EOL EF = 80%	Annual EF = 30%, EOL EF = 75%	Annual EF = 30%, EOL EF = 70%
Commercial stand-alone units	1		MEPS: EEI equivalent to annual energy use = 1730 kWh Labelling scheme is operational	Strengthen MEPS: EEI equivalent to annual energy use = 1570 kWh
	2	Ban units using refrigerants with GWP above 2500		Ban units using refrigerants with GWP above 150
	4			Include subsector in database
Condensing units	3	Annual EF = 30%, EOL EF = 85%	Annual EF = 20%, EOL EF = 85%	Annual EF = 15%, EOL EF = 80%
Centralised system	3	Annual EF = 38%, EOL EF = 90%	Annual EF = 20%, EOL EF = 85%	Annual EF = 15%, EOL EF = 80%
General RAC sector Cross cutting	3	Established training and certification system according to international standard	Make certification according to EN 13313 (or a comparable standard) compulsory. Include mandatory natural refrigerant training.	
	4	Define working plan setting a time plan for subsector coverage Define linkages to GHG reporting	Database for refrigerators and small UAC is up and running	More product groups are included in database



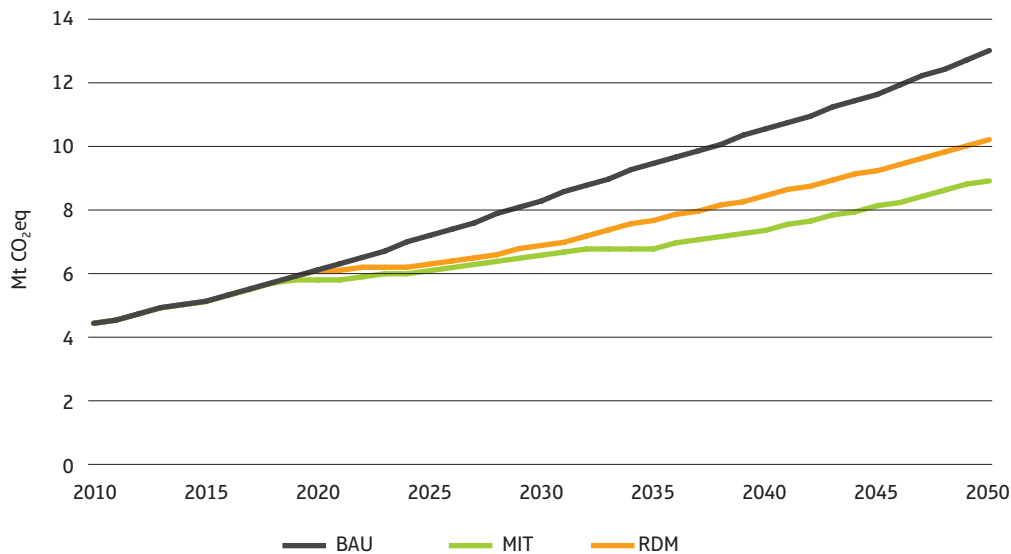


## 5 Potential mitigation effects

The implementation of the strategies on the specified subsectors can lead to an emission reduction of 18% by 2030. The roadmap scenario therefore shows the reduction that can be reached by introducing certain feasible policies. By contrary, the technology gap mitigation scenario is based on the introduction of best practice technologies and assumes no supply, knowledge, regulatory or end-user related barriers.

The roadmap scenario only includes reductions directly linked to policy measures described in chapter 4. Emissions in the roadmap scenario are expected to reach 8.9 Mt CO<sub>2</sub>eq in 2050 compared to 10.2 Mt CO<sub>2</sub>eq in the MIT scenario and 13.02 Mt CO<sub>2</sub>eq in the BAU scenario (*Figure 5*).

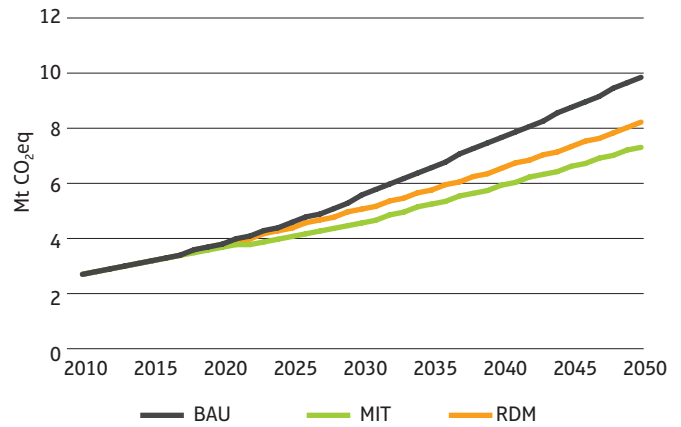
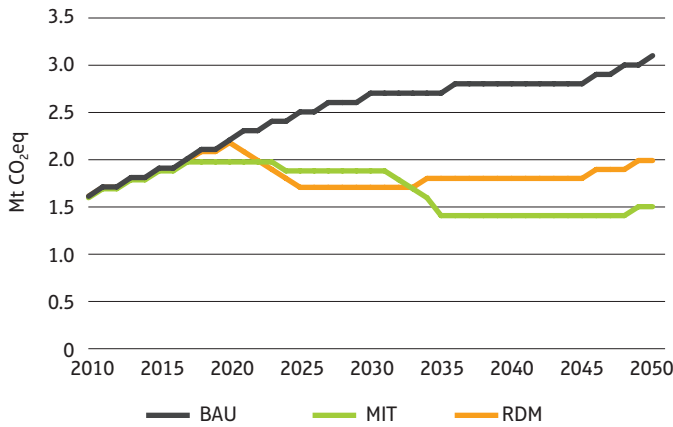
**Figure 5:** Business as usual (BAU) scenario, potential technical mitigation (MIT) scenario, as developed during inventory and technology gap analysis and roadmap (RDM) scenario for the Ghanaian RAC sector (based on strategies detailed in chapter 4).



The distinct steps are due to the introduction of policies and the assumption of leakage rate reductions every 5 years, which can be seen more clearly in the direct emissions (Figure 6 left).

Here the roadmap scenario reaches even lower numbers than the mitigation scenario.

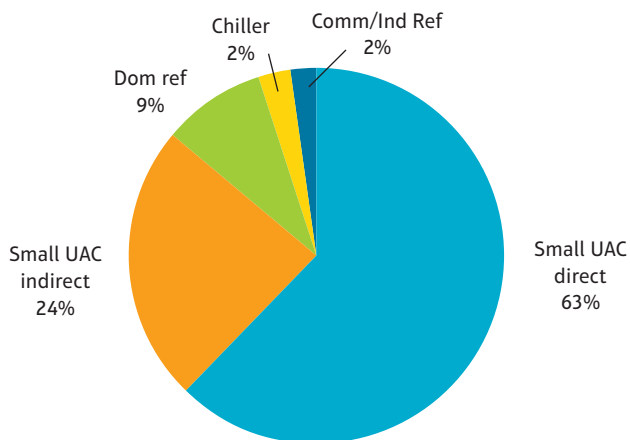
Figure 6: BAU, MIT and RDM scenario for direct (left) and indirect (right) emissions respectively.



The largest share of emission reduction in the roadmap scenario stems from UACs, with direct emissions contributing the higher proportion. Most of these reductions are from split ACs (Figure 7). The second largest contributions are due to the complete transition of the domestic refrigeration subsector to R600a with the concurrent introduction of stricter MEPS. Other subsectors contribute on a much smaller scale.

Emission reductions in the mobile AC subsector, due to changes on the international market, which are not easily influenced by local interventions, are not shown. They are in a similar magnitude as emission reductions in the domestic refrigeration subsector.

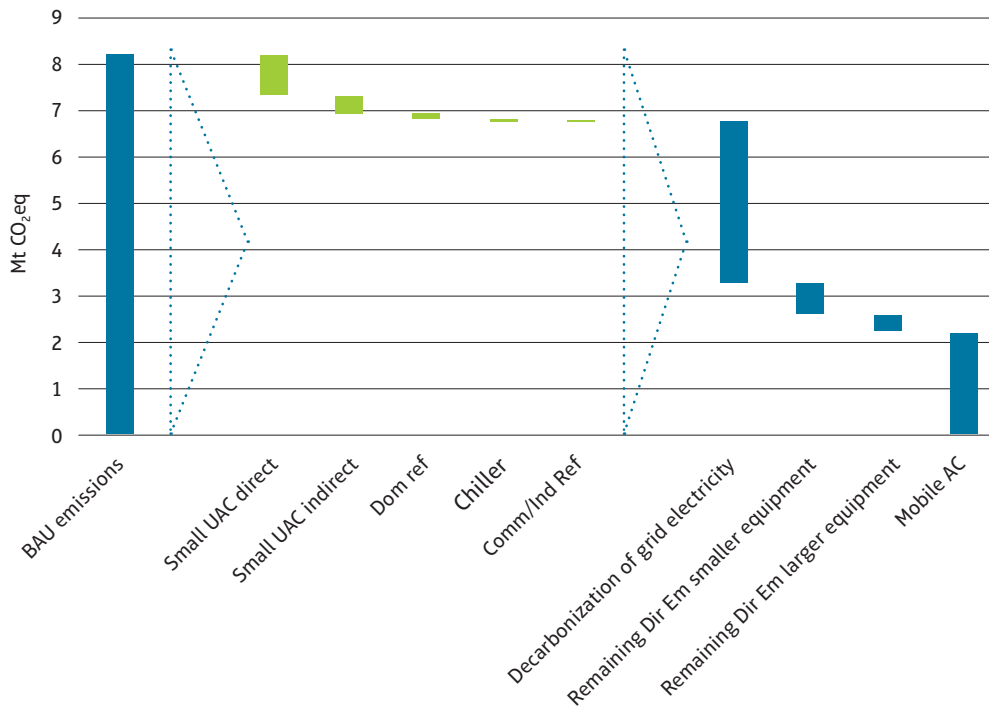
Figure 7: Contribution of subsector groups to mitigation in 2030



The stepwise reduction of RAC sector emissions can be seen in [Figure 8](#). The remaining emissions cannot be easily reached by the roadmap: Indirect emissions cannot be avoided completely by the introduction of more efficient units and only the intro-

duction of renewable energies can eliminate these emissions. It will further not be possible to reduce direct emissions to zero in the short time frame until 2030.

**Figure 8:** Roadmap scenario reductions according to subsectors based on strategic actions.





# 6 Funding requirements and financing options

For the accelerated transition towards climate friendly and energy efficient, green RAC appliances the funding needs for the implementation of this roadmap must be met. The following chapter outlines the funding requirements and financing options. Relevant target groups for funding are importers, end-users, servicing technicians and government agencies. Both private as well as commercial end-users have to be considered. Depending on the target group, different financing options can be considered.

Financing of green cooling technologies can reach two different goals:

- Initial market introduction of new RAC appliances with low GWP refrigerants and high energy efficiency until such products reach a sufficiently high market penetration that their technology is well known and accepted, and prices have become competitive.
- Continuous financing of top label products to create a permanent pull effect towards introduction of appliances with high energy efficiency

The following financing options are further analysed:

- Financing through local public organization
- Private sector engagement
- Funding through banks
- Funding through energy efficiency obligation schemes (EEO) or energy efficiency resource standards (EERS)
- International and regional institutions

## 6.1 Financing through local public organization

Green Public Procurement can be a very effective and easy to implement measure to locally initiate the transition to green cooling alternatives. Government entities can demonstrate early action and act as a role model for actors in the private sector. The existing government procurement budgets can be used to purchase green cooling technologies. If these are more expensive, these costs can again be saved by lower electricity bills and servicing charges.

Public procurement guidelines for RAC appliances can be adjusted to include only the green cooling equipment available in the country. The requirements to be met will have to be specified. The following example is for split ACs and information from the technology gap analysis can be used:

- Low-GWP refrigerant (< 10)
- Upper two labelling classes for energy efficiency
- Low noise emissions

Implementation can be varied, e.g. starting only in one test region or focusing on one subsector. Procurement requirements can also gradually be increased.

Taxes on high-GWP refrigerants or rebates on green ACs, are other options to make green cooling technologies more competitive. The taxation on refrigerants or equipment using the refrigerants is ideally based on the level of GWP.

As all high-GWP refrigerants and pre-charged equipment are imported, such taxes can be raised at the time of import. At the same time or alternatively, taxes can be lowered for low-GWP refrigerants and pre-charged equipment. The higher charges for high GWP refrigerants and rebates for low GWP refrigerants will signal market participants to accelerate the transit to low GWP options. Such transitions can take place well ahead of the first mitigation step of 10% in 2029 as it has been agreed in the Kigali Amendment (*Clark and Wagner, 2016*). Ghana even has the option of lowering taxes for environmentally friendly AC in its legislation, as is described earlier. A reduction in import tax income for the government can be balanced by higher taxes for units that are bad for the environment.

Several schemes can be seen as self-financing after an initial support from an external funding body. One example from Ghana is the certification and licensing of electrical technicians where even though the licensing fees are relatively low, the high number of licenses pays for most of the scheme of training courses, examination fees and issuing of licenses.

## 6.2 Private sector engagement

The transition towards climate friendly and energy efficient RAC appliances is a clear trend, underlined by more and more countries globally adopting MEPS and labelling and the Kigali Amendment determining the change from HFCs to low GWP refrigerants in the RAC sector. Private companies investing in green cooling technologies early will profit from gaining a competitive edge and avoid a second transition from high-GWP refrigerants to low-GWP refrigerants.

The involvement and the commitment of private sector companies in the RAC sector, such as retailers of RAC appliances and commercial end users, such as supermarket operators, operators of vessels in the fishing sector or companies purchasing and operating ACs in commercial buildings, are important for the success of both local and internationally supported financing and funding programmes.

For importers and retailers in Ghana, green cooling technologies can present a business opportunity. Training opportunities in the use of flammable refrigerants for staff would not only improve the overall safety of the company but also the attractiveness as an employer. Loans to end-users can be provided for example with the help of banks (see Financing through banks) for the purchase of small appliances. Commercial end-users of larger appliances would benefit from the energy savings and refrigerant costs that green technologies could offer.

## 6.3 Financing through banks

There is an increasing global trend toward socially responsible financing through commercial banks. Banks realize that particularly long-term financing, especially of their corporate customers, is more sustainable and additionally more profitable if the environmental and climate integrity of the financing is considered. It is recommendable that banks are educated regarding their loan programmes to include evaluation criteria which consider the climate impact of RAC appliances. Furthermore, local banks can play an important role as partner banks for programme proposals.

Potential options for cooperation between the commercial RAC sector stakeholders in Ghana and banks are:

- **Green loan financing schemes with resellers:** Consumer loans are regularly offered by banks, but interest rates can be over 30%<sup>11</sup>, and lower rates starting just over 20%<sup>12</sup>. In Ghana, there are currently no offers online for lease payments to purchase appliances instead of upfront payments by resellers of household appliances. Some appliance shops in the country in partnership with some financial institutions offer high purchase plans or instalments plan<sup>13</sup> to customers whereas interest rates in Ghana are very high, financial programmes with concessional loans can potentially lower the refinancing costs significantly. Concessional loan programmes of local banks can be refinanced with international donor loan programmes, e.g. from the African Development Bank.
- **Green loan financing schemes with commercial end users of RAC appliances:** With improved energy efficiencies, green cooling appliances offer energy savings over time. If such appliances have higher upfront costs, end users are often holding back from buying such appliances, even if the higher upfront cost can be amortised within a few years through the energy savings. This financing barriers can be bridged through targeted financing programs where loans are offered at concessional terms to local correspondence, private banks. Loans are then provided at concessional terms to commercial end users.

## 6.4 Energy efficiency obligation schemes

Increasingly countries are ensuring to meet their energy efficiency targets through EEOSEERS. Under EEOS or EERS, energy saving targets are determined on a country basis and then allocated to energy consuming actors as obligated parties e.g. energy providers. These parties then have to support end-consumers in reducing their energy consumption. The measures have to be approved and are subject to approved calculation methods so that they can be quantified.

For mass appliances default energy savings, “deemed savings” are assumed for appliances meeting a specific minimum standard. For larger and customized systems, default engineering calculations are taken with reported specific operating parameters of the installed systems or direct monitoring devices are

11 <http://citifmonline.com/2017/11/21/banks-lending-rates-drop-marginally>, accessed Jan 31, 2018.

12 <https://www.gcbbank.com.gh/news/8-gcb-base-rate-is-the-lowest.html>, accessed Jan 31, 2018.

13 High purchase plans is an arrangement whereby a customer agrees to a contract to acquire an asset by paying an initial installment of the total amount and repays the balance of the price of the asset plus interest over a period of time.

installed for the systems. Obligated energy parties face fines calculated as USD per kwh or USD per ton CO<sub>2</sub>eq, if they do not meet their target. From the level of the fines the value of the energy savings for eligible energy savings measures can be calculated. Depending on the market pressure, the refinancing of EEOS can take place effectively through surcharges the obligated parties will place on their energy consuming customers. EEOS are currently implemented in 16 European countries and EERS are implemented for example in parts of Australia and China. The main advantages are that there is no direct fiscal burden to the government, except for administrative costs and the quantitative targets that ascertain the government will achieve the energy saving objective. It is also a market-based approach that leaves electricity distributing companies with the decision of which pre-approved measures they want to implement in cooperation with their customers.

The following elements need to be considered as critical success factors:

- Clear and transparent list of eligible energy saving measures
- Clear and transparent calculation methodologies
- Truly independent institutions to approve the delivery of deemed, monitored or calculated energy savings
- Central registry for “earned” energy savings
- Strict enforcement of fines if the targets of the obligated parties are not met
- Ideally there is competition in the market with more than one obligated party

For the RAC sector, EEOS can be applied as follows:

- Introduce energy efficiency obligation to electric distribution companies
- Include energy savings in the RAC sector / RAC appliances in as clear target for yearly consumption reduction
- Refrigerators and air conditioners to be included in mass appliance scheme. These could be coupled to the labelling scheme, e.g., only for five-star units (highest category) can savings be applied.
- “Engineering Calculation” on the energy savings for customized systems like supermarket refrigeration or AC/ refrigeration chiller systems
- The obligated electricity company can earn energy savings by contracting with their customers or authorized third parties on implementing eligible energy savings measures. For example, electricity distribution companies can contract with re-sellers to sell eligible five-star room air conditioners or refrigerators, or they can contract with authorized ESCO companies as authorized third parties to install energy saving chillers or supermarket refrigeration systems.

## 6.5 International and regional institutions

International financial support can be given for additional measures that go beyond common practice. There is no clear set of rules to define what such additional efforts constitute. It is rather the decision of each donor to determine the funding requirement. In order to gain the interest of international donors, the following requirements are to be met in general and specifically for the RAC sector. These requirements need to be met for the design and implementation of financing and funding schemes addressing the transformation of the RAC sector towards energy efficient and climate friendly applications. General requirements:

- Transformational change: The funding proposal needs to outline the intended scope. Ideally, the scope covers both (a) the transition to high energy efficiency with a robust regime on MEPS and labelling (b) and the accelerated phase- down of HFCs and the phase- in of low GWP natural refrigerants
- Ownership of government and private institutions in Ghana: The participation of key RAC stakeholders from the beginning will be important for a successful implementation programme. Eligible beneficiaries of concession loans or funding programmes should provide a clear commitment and tangible and verifiable action towards Green RAC technologies. This includes both government agencies and the private sector.
- Measuring, reporting and verification (MRV): International donors regularly require the tracking of measures and their mitigation impact. The proposed tracking of mitigation action should follow the same Tier 2 methodology of the Intergovernmental Panel on Climate Change (IPCC) guidelines on GHG inventories.

RAC sector specific requirements:

- Thorough understanding of the baseline and future projection of BAU emissions and mitigation options. The mitigations options need to be based on alternative RAC technologies suitable for Ghana’s RAC sector. The relevant inventory and the emission pathways were presented in part 1 of the response plan.
- Transition to best practice RAC technologies suitable for the RAC sector in Ghana. Such technologies were identified in the Technology Gap Analysis in part 2 of the response plan
- Transition to best practice RAC policies suitable for the RAC sector in Ghana. Such policies were presented in part 3 of the response plan.
- Establishment of a clear and well-established Roadmap showing a sustained path towards green cooling technologies as presented here.

Request for providing the funding and financing this roadmap, can be presented to the relevant instruments of regional and

international donors. *Table 14* outlines some relevant donors and their programmes:

**Table 17:** Overview of relevant international and regional funding and financing organisations

Institutions	Funding programmes / features
<b>Green Climate Fund (GCF)</b>	Under the UNFCCC stronger linkages between its financing mechanisms, particularly the GCF and GEF, and its technology mechanism are to be sought. There are several options to request support from GCF. Ghana has previously launched a Green Climate Fund Readiness Programm <sup>14</sup> , which supports the country in building capacities for applying for and managing international climate finance.
<b>Global Environmental Facility (GEF)</b>	Similar to the GCF, the GEF is requested to support activities which are strengthening the cooperation on technology and technology transfer. The technology gap analysis and the technology focus areas of the roadmap can serve as a basis to request technology transfer and cooperation related funds from the GEF.
<b>Multilateral Fund (MLF)</b>	With the Kigali Amendment, parties of the Montreal Protocol have agreed to release “fast start” financing for transition from HFCs to low GWP refrigerants <sup>15</sup> . The proposals made in this roadmap fully support the objectives of the fast-track funding to lower GHG emissions from the RAC sector through transition to low GWP refrigerants and the enhancement of energy efficiency.
<b>Nationally Appropriate Mitigation Action (NAMA) Facility</b>	In the past, the German-UK NAMA facility has financed RAC related requests, e.g. in Thailand <sup>16</sup> and Colombia <sup>17</sup> . Activities suggested under this roadmap or in a regional context might be eligible for the financing under the NAMA facility.
<b>African Development Bank</b>	As a multilateral development bank, the African Development Bank, has a dedicated programme on climate financing <sup>18</sup> . The bank offers loans and grant based components, e.g. under its African Climate Change Fund <sup>19</sup> , which might serve to finance elements suggested under this roadmap.

## 6.6 Funding needs for the RAC sector transition in Ghana

There are two kinds of funding necessary for the accelerated transition of the RAC sector in Ghana towards climate friendly technologies. On the one hand, support is necessary for market and impact studies (also for monitoring), communication effort, government support for the concept, implementation and enforcement of legislation and the development and implementation of a training and certification/licensing scheme. On the other hand, a fund would be necessary to support the financing

of equipment through loans or even to support tax incentives, rebate schemes and green public procurement. It has to be said however, that green public procurement could finance itself through energy savings and tax incentives that could also be balanced within the country. Funds should be revolving to ascertain the highest impact and interest rates for consumer or commercial credits should be much lower than those currently offered in Ghana.

<sup>14</sup> <http://www.gcfreadinessprogramme.org/country/ghana>, last accessed 14/08/2017

<sup>15</sup> <https://www.nrdc.org/experts/david-doniger/countries-adopt-kigali-amendment-phase-down-hfcs>, last accessed 10.05.2017

<sup>16</sup> <http://www.nama-facility.org/projects/thailand-refrigeration-and-air-conditioning-nama>, last accessed 10.05.2017

<sup>17</sup> <http://www.nama-facility.org/projects/colombia-nama-for-the-domestic-refrigeration-sector>, last accessed 10.05.2017

<sup>18</sup> <https://www.afdb.org/en/cop21/climate-finance>, last accessed 10.05.2017

<sup>19</sup> <https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/africa-climate-change-fund>, last accessed 10.05.2017



The following list gives examples of possible measures supported by technical assistance:

- Market study to determine MEPS and label levels for Ghana
- Behavioral change communication and education, communication campaign for high energy efficiency units/ cost savings for consumers
- Stakeholder consultation workshops
- Training of customs division officials of the Ghana Revenue Authority.
- Extended laboratory capacities/training for staff (UAC and domestic refrigeration, additionally for commercial refrigeration/chiller/multi-split units)
- Implementation of legislation, tax incentives, green public procurement schemes
- Evaluation of the impact of refrigerant bans on the local market
- Develop training and certification scheme for RAC technicians, including standards, curricula and training materials; equipment for training centres and technicians
- Extend database of imported products, including refrigerant and energy efficiency as well as volume
- Institutionalize inventory development

**Table 18:** Overview of funding needs and financing options

Subsector/ application	Key end users	Funding Needs <sup>20</sup> 2020/ 2025 (annually)	Financing Options
<b>UAC / Energy efficient AC appliances with low-GWP refrigerants</b>	Retail customers and government buildings with room ACs	Financing volume 5 to 24 million US\$ Technical assistance 1 to 3 million US\$	Low interest rate financing programmes linked to consumer financing; Government: Green public procurement
<b>Domestic refrigeration/ Energy efficient domestic refrigerators with low GWP refrigerants</b>	Retail customers	Financing volume 23 to 30 million US\$ Technical assistance 0.5 to 1 million US\$	Low interest rate financing programmes linked to consumer financing

Funding needs here refer to a credit to the amount of the value of international best practice technology. This is likely to decrease in the future.

UAC units with low-GWP natural refrigerant are currently not on the market. In order to reach the targets suggested in this roadmap, at least 20% of the annual market volume should be targeted by financing, e.g. concessional loan financing or green public procurement or similar support of high-energy efficient units.

Domestic refrigerators already have a substantially higher market penetration of natural low- GWP refrigerants (R600a). Different from the other subsectors, domestic refrigeration requires less supportive financing for the transition to low- GWP refrigerants, as this change is already under way. Financial support for domestic refrigerators, focuses on the introduction of a mandatory and fully enforced labelling scheme combined with financing (low interest) support for top labelled product, targeting the top 20% fraction of the product classes. Here, consumer concessional loan schemes should mainly create and sustain a promotional pull effect for the market to strive to high energy efficiency, addressing about 5% of the annual market.

<sup>20</sup> Funding needs were calculated as follows: It is assumed that the whole price of a unit is necessary (independent of the question whether funding ultimately comes from private customers or public/international funding or both, e.g. through rebate schemes, loans or tax exemptions). The cost of an international best practice units was assumed (see technology roadmap). The span in funding needs ranges from 5% of new sales in 2020 to 20% of new sales in 2025.



# 7 Outlook and next steps

This roadmap together with the inventory report, technology gap and policy analysis show a path towards reducing GHG emissions from the RAC sector. It includes clear emission reduction targets, specific technology recommendations and information on the necessary policy measures to implement the targets. Indicative funding needs are highlighted.

Ghana has already included RAC sector targets in its NDCs, specifically for split AC, which have the highest contribution to RAC sector GHG emissions. At the same time, strategies for an HFC phase-down have been developed as part of the HPMPs. In the past, the NOU has been promoting natural refrigerant technology options of which there is public support and more than 10,000 R22 based ACs have been converted to R290 by trained technicians. Co-operation between NDC strategy development and HPMP and later KIP implementation is advised in order to generate synergies and combine financing options for the largest possible impact.

A comprehensive stakeholder process on developing a country and sector wide strategy with NACODS and RAC experts from different backgrounds is recommended to discuss the results presented in the inventory, technology gap and policy analysis and roadmap. The outcome of such a process could be the identification of sector transforming project ideas for international funding bodies.

Mandatory certification and registration as well as extending qualification options, also for informal sector technicians, is a key aspect regarding all future activities to reduce emissions in the RAC sector. It will not only enable the import and safe installation of green cooling technologies, but also make all system installations run more efficiently and safer while reducing leakage of high-GWP refrigerants into the atmosphere. Targeting the development of national legislation, a national syllabus and standard and training concept should be an immediate focus.

## Cooling for all

Projections included in the inventory and roadmap so far highlight high but steady growth, assuming more and more saturation of the currently existing market as time goes on. However, in the tropical climate of Ghana, the ultimate goal should be an access to refrigeration and air conditioning for all inhabitants. This not only means domestic refrigerators and domestic AC, which currently have by far the highest share of all RAC equipment in Ghana, but would grow faster than currently assumed. Cooling for all further includes high growth in sectors that have so far had very little impact on the Ghanaian RAC market and hardly contributed to GHG emissions. Most importantly this includes reliable cold chains in order to enhance food security and nutrition and access to vaccines and medical supplies. Refrigerated transport, packing stations and warehouses have to be set up to guarantee uninterrupted cold chains. Improved living conditions can also be created through expanding access to air conditioned public and personalised transport. Air conditioning at work not only improves well-being but has also been shown to increase productivity.

Higher access to cooling services will significantly increase energy use to the point where additional power generation might be necessary and lead to higher refrigerant consumption. It would make it more difficult for Ghana to meet its GHG mitigation targets of the NDC. Sustainable growth that does not lead to an increase in GHG emissions is therefore even more important. It highlights the need for green RAC solutions, such as the use of natural refrigerants coupled with high energy efficiency and the use of renewable energies.



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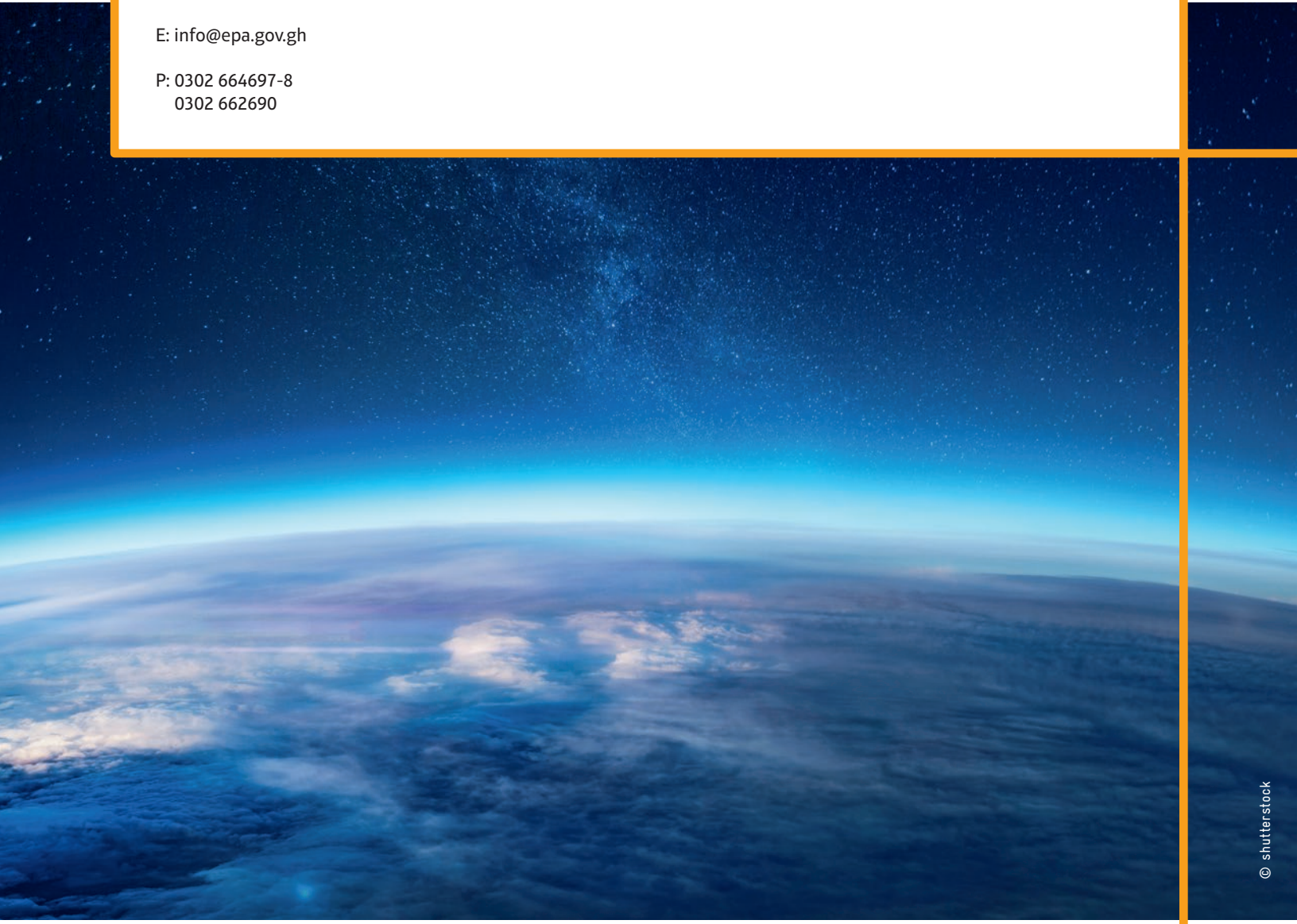


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