



REGULATORY ANALYSIS EGYPT:

Analysis and recommendations for the regulatory and policy instruments governing the RAC sector

August 2022



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Table of Contents

- 1. Introduction 1**
 - 1.1. The Cool Up programme 1
 - 1.2. Aim and scope of this report 2
- 2. Overview 4**
 - 2.1. Setting the scene..... 4
 - 2.2. Cooling market landscape..... 4
 - 2.3. Finance landscape 5
- 3. Methodology..... 7**
- 4. Summary of key findings and recommendations 10**
- 5. Regulatory analysis 12**
 - 5.1. International protocols and commitments..... 12
 - 5.2. National plans and strategies..... 14
 - 5.3. Laws and bylaws and other national legislation 18
 - 5.4. Standards and codes 20
- 6. Bibliography 25**

Figures

Figure 1	Key responsibilities among government stakeholders in Egypt	3
Figure 2	Methodology and working steps of the regulatory analysis in Egypt.....	7
Figure 3	HCFC and ODS consumption in Egypt, Source: (Ozone UNEP, 2021).....	14

Tables

Table 1	Aspects of policy instruments analysis in Egypt	8
Table 2	Colour codes	8
Table 3	Colour codes applied for the different aspects of the policy analysis	8
Table 4	Explanation of the technical aspects considered in the regulatory analysis	9
Table 5	Status of MP ratification in Egypt (Ozone UNEP, 2021), (EEAA NOU, 2018).....	12
Table 6	United Nations Industrial Development Organization’s (UNIDO's) programmes and projects to ensure compliance with the MP in Egypt	13
Table 7	Indicator no. 7 in the key performance indicator of the environmental performance, Egypt Vision 2030	15
Table 8	Status of key national strategies relevant to ODS phaseout and cooling demand reduction in Egypt. Source: author based on various sources as mentioned in the report. For colour codes, refer to Table 3.....	17
Table 9	Initial assessment of laws relevant to the RAC sector. Colour coding as described in Table 3	19
Table 10	Initial assessment of laws relevant to the RAC sector. Colour coding as described in Table 3	21
Table 11	Summary of the assessment of standards and codes relevant to the RAC and building sectors	24

Acronyms

AC	Air conditioning/conditioner
AHU	Air handling unit
Btu	British thermal unit
CAGR	Compound Annual Growth Rate
CBE	Central Bank of Egypt
CFC	Chlorofluorocarbon
CO ₂	Carbon dioxide
COP	Coefficient of performance
EBRD	European Bank for Reconstruction and Development
EE	Energy efficiency
EEAA	Egyptian Environmental Affairs Agency
EEBC	Energy Efficiency Building Code
EER	Energy Efficiency Ratio
EGYPRA	Egyptian Environmentally Friendly and Appropriate Alternatives Assessment
EOS	Egyptian Organization for Standardization and Quality
F-gas	Fluorinated gases
FI	Financial institution
FY	Fiscal year
GCF	Green Climate Fund
GHG	Greenhouse gas
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit GmbH
GW	Global warming
GWP	Global warming potential
HBRC	Housing and Building Research Center, Egypt
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HPMP	HCFC Phaseout Management Plan
HVAC	Heating, Ventilation and Air Conditioning
ICA	Industrial Control Authority
IFI	International Financial Institutions
IKI	International Climate Initiative
INDC	Intended nationally determined contribution
MDIs	Manufacturing of Metered Dose Inhalers

MENA	Middle East and North Africa
MEPS	Minimum energy performance standards
MLF	Multilateral Fund
MoERE	Ministry of Electricity and Renewable Energy Egypt
MoHUUC	Ministry of Housing, Utilities & Urban Communities
MP	Montreal Protocol
MSME	Micro, Small and Medium Enterprise
MSMEDA	Medium, Small and Micro Enterprises Development Agency
NC3	Egyptian Third National Communication
NCAP	National Cooling Action Plan
NDC	Nationally determined contribution
NEAP	National Environmental Action Plan
NEEAP	National Energy Efficiency Action Plan
NOU	National Ozone Unit
NREA	New and Renewable Energy Authority
ODS	Ozone-depleting substances
PFI	Partner Financial Institutions
PPP	Public Private Partnership
RAC	Refrigeration, Air Conditioning
RACHP	Refrigeration, air conditioning, and heat pump equipment
RE	Renewable energy
RMP	Refrigeration Management Plan
SEER	Seasonal energy efficiency ratio
SME	Small and Medium-Sized Enterprises
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
VRF	Variable Refrigerant Flow
WMRA	Waste Management Regulatory Authority

1. Introduction

With energy demand expected to increase 50% by 2040,¹ Middle East and North Africa (MENA) countries are facing a range of climate-change related challenges. The region's energy challenges include rapidly growing populations, urbanisation, and a heavily strained energy infrastructure. Cooling in air conditioning (AC)-equipped households already represents a major source of energy consumption in the region. The use of cooling is expected to grow further since, with an improved standard of living, more households are using air conditioning (AC) systems. There is large potential for energy saving as many of the space cooling and refrigeration systems in use have a low energy efficiency. An additional climate impact from cooling comes from the refrigerants still used in many of today's air conditioners and refrigerators. Such refrigerants with a high global warming potential are 2,000 times more potent for the climate (direct greenhouse gas emissions) than carbon dioxide and natural refrigerant alternatives. Without further policy intervention, direct and indirect emissions from cooling and refrigeration may rise 90% above 2017 levels by 2050, creating a vicious feedback loop.

1.1. The Cool Up programme

The Cool Up programme promotes accelerated technological change and early implementation of the Kigali Amendment to the Montreal Protocol and Paris Agreement in Egypt, Jordan, Lebanon, and Türkiye. The programme focuses on enabling natural refrigerants and energy efficient solutions to mitigate the effects of rising cooling demand. The Cool Up approach is based on four pillars: reducing cooling demand, phasing down hydrofluorocarbons (HFCs), replacing and recycling inefficient equipment and refrigerants, and training and raising awareness.

The programme's cross-segment approach focuses on the residential and commercial AC (air conditioning) sector and on the commercial refrigeration sector.

The programme aims to develop lasting institutional capacity and increase the deployment of sustainable cooling technologies in the market. To enable a cooling market transformation towards sustainable cooling technologies, the Cool Up programme will:

- ▶ Enhance cross-sectoral dialogue between national actors to build ownership to support long-term impact.
- ▶ Develop policy actions to create a supportive regulatory environment.
- ▶ Develop financial mechanisms and funding structures to enable the cooling market transition.
- ▶ Support the commercial deployment and dissemination of existing and emerging technologies with natural refrigerants.
- ▶ Provide resources for capacity development on sustainable cooling in the four partner countries.

In Middle East and North Africa (MENA) countries, cooling constitutes a major source of energy consumption; it produces indirect greenhouse gas (GHG) emissions and contributes to ozone depletion and global warming. The Cool Up programme seeks to address this challenge in its partner countries by mitigating the adverse impacts of refrigerants through promoting accelerated technological change and facilitating early implementation of the Kigali Amendment and Paris Agreement.

The programme is divided into three pillars:

- ▶ Policy and regulation
- ▶ Technology and markets
- ▶ Financing and business models

¹ British Patrol, "BP Energy Outlook 2018 Edition"

This report focuses on the policy and regulation pillar. Policy and regulation are powerful stimuli to encourage the uptake of new technologies. In the policy and regulation pillar, the Cool Up programme supports its partner countries in leveraging policy stimuli and developing policy interventions closely linked to national policy goals, strategies, plans, and programmes as well as international processes. Cool Up works with partner countries to define roadmaps and regulatory measures to create a regulatory environment that requires reduced cooling demand and increased energy efficiency (EE) and supports sustainable cooling technologies that contribute to the phase down of hydrofluorocarbons (HFCs) and focus on natural refrigerants.

Building on a scan of policy instruments conducted for Cool Up's cooling sector status reports, the Cool Up programme developed an in-depth regulatory analysis, analysing the strengths and shortcomings in each partner country.

1.2. Aim and scope of this report

The main output of this report is to formulate policy recommendations towards phasing down HFCs, utilising natural refrigerants, and reducing cooling demand in Egypt.

The analysis covers four categories of policy instruments:

- ▶ International protocols and commitments
- ▶ National plans and strategies
- ▶ Laws and bylaws relevant to the refrigeration, air conditioning (RAC) and building sector
- ▶ Standards and codes

The report examines the status of these instruments and investigates the degree to which they are implemented and complied with in Cool Up partner countries. The analysis also discusses which technical elements are covered by each policy instrument, examining if and how they contribute to enhancing EE in the RAC and heat pump sector, reducing cooling demand, phasing out ozone-depleting substances (ODS), phasing down HFCs, and promoting natural refrigerants. Data for the analysis was gathered by studying country-specific laws, regulations, standards and codes, input from the Cool Up cooling sector status reports, secondary literature, and interviews, bilateral meetings, and stakeholder discussions with national experts and policy stakeholders. The reports culminate in an action plan and roadmap to support each partner country in making policy and institutional changes to accelerate Kigali Agreement implementation. All identified measures have been discussed and agreed upon in conjunction with the National Ozone Unit (NOU) in each Cool Up partner country. Figure 1 provides an overview of the key implementing institutions across the sustainable cooling policy space in Egypt.

EEAA Egyptian Environmental Affaris Agency	<ul style="list-style-type: none">• Responsible for setting regulatory framework and regulation that support the implementation of standards and in the field of HFCs phase down, EE measures and environment conservation.
NOU National Ozone Unit	<ul style="list-style-type: none">• Manage the complete phase out of ODSs to meet the deadline adopted and approved by MP parties. responsible for monitoring compliance with MP targets.
EOS Egyptian Organization for Standardization and Quality	<ul style="list-style-type: none">• Responsible for the preparation and issuance of all standards through technical committees and the involvement of expert teams. In addition to inspection of locally produced appliances.
ICA Industrial Control Authority	<ul style="list-style-type: none">• Responsible for inspection of locally produced appliances together with EOS.
HBRC Housing and Building National Research Center	<ul style="list-style-type: none">• Responsible for the development of several codes such as the EEBC, district cooling codes, and HVAC codes.
NREA New and Renewable Energy Authority	<ul style="list-style-type: none">• Hosts and manages the specialized testing labs for testing the efficiency of different appliances.

Figure 1 Key responsibilities among government stakeholders in Egypt

2. Overview

2.1. Setting the scene

Egypt's climate is dry, hot, and predominantly desert. Average annual temperatures have increased by 0.53°C over the last three decades². In Egypt the number of cooling degree days is more than six times higher than the heating degree days, with more than 1800 cooling degree days annually³. Cooling degree days in Egypt rarely stray below 30 and can rise as high as 460 (more on cooling degree days here). Egypt's energy consumption continues to increase across all sectors, reaching 13.9 Mtoe in 2018⁴. The country has one of the highest growth rates of electricity consumption worldwide at an annual rate of approximately 6.2%⁵. Cooling constitutes a substantial portion of that consumption.

2.2. Cooling market landscape

In Egypt, there is a mix of local and international brands in the air conditioning (AC) and commercial refrigeration market. The residential AC market for split systems is dominated by national manufacturers. Most of the major international brands have national partners in Egypt that manufacture their products under international brands. Some commercial technologies such as air handling units (AHUs) and fan coils are manufactured in Egypt, whereas variable refrigerant flow (VRF) systems and AC chillers are mostly imported. A high custom duty on imported products (around 40% of the product value) promotes local manufacturing.

Drivers for the AC market in Egypt are economic growth, extreme weather conditions, urbanisation and population growth, new construction activities, increasing electricity prices, and the availability of new technologies. The demand for different AC technologies is driven by installations in new buildings, new installations in existing buildings (to increase the share of air conditioned rooms), and the replacement of defective AC systems. In the new construction sector, around 90% of new apartment buildings and between 80% (retail) and 90%-100% of new hotel, office, and healthcare buildings install AC systems. In existing residential buildings, about 73% of the floor area is not air conditioned, yet substantial market growth potential exists for the cooling market in Egypt.

The largest overall AC segment, single split systems, is expected to continue its growth in the future. While their absolute number is low, VRF systems are expected to experience a relatively strong growth in the future. Sales of window AC units are shrinking, leading to a decreasing future market share.

Existing and new installations have lower efficiency than the best available technology in the market, meaning there is high potential for energy savings. The energy efficiency ratio (EER) or a coefficient of performance (COP) of AC systems installed in the existing building stock is in the range of 2.7-3.7, with the majority having an efficiency of around 2.9-3.2. This is significantly below the best available efficiency range. The minimum energy performance requirement before June 2020 was class C at a coefficient of performance (COP) or energy efficiency ratio (EER) of 3.26. After June 2020, it was changed to class B with a COP of 3.51, and from June 2022 onwards, it will be 3.81.

The commercial refrigeration market heavily depends on imported units, especially compressors and control units, from major international manufacturers. The most important market segments are corner stores, which typically install standalone refrigeration units, restaurants, and supermarkets. Growing urbanisation rates have led to increased construction of new supermarkets and corner stores, driving the market for applicable refrigeration technologies, such as reach-in refrigerators, freezers, and display cabinets.

² World Bank, "Climate Change Knowledge Portal"

³ Sources: https://xp20.ashrae.org/standard169/169_2013_a_20201012.pdf, <https://meteonorm.com/en/>

⁴ Source: <https://www.iea.org/countries/egypt>

⁵ Mordor Intelligence, "Egypt Construction Market - Growth, Trends, COVID-19 Impact, and Forecast 2021-2026"

Refrigerants used in the Egyptian cooling and refrigeration sector are imported. In existing equipment, the main refrigerant type is the ozone-depleting substance (ODS) chlorodifluoromethane (HCFC-22, or R22), which is successfully being substituted by hydrofluorocarbons (HFCs). Using other alternatives to hydrochlorofluorocarbons (HCFCs), including R32 and other low-global warming potential (GWP) HFC blends, is still limited. The use of natural refrigerants at a commercial scale has not yet been introduced in AC and commercial refrigeration.

The overall market for cooling equipment in Egypt is expected to continue to grow. This strong market growth requires introducing sustainable cooling technologies and natural refrigerants early on as a direct replacement to prevent potential lock-in effects to harmful refrigerants. Egypt has the potential to develop a national natural refrigerant market, which could reduce its dependency on imports, especially for split systems. The transition towards natural refrigerants offers the opportunity to develop and expand the national cooling industry. Perceived key challenges to the uptake of natural refrigerants include safety issues and the associated costs.

Egypt can overcome these challenges and develop a natural refrigerant market by leveraging its work through the Cool Up programme to expand technical knowledge to improve energy efficiency and sustainable cooling technology options, build on the strength of the cooling manufacturing sector and growing interest in sustainable finance, and substantiate the regulatory framework to address the application of different refrigerants and manage refrigerants at the end of a system's lifetime.

2.3. Finance landscape

The banking sector in Egypt comprises 38 banks but is highly concentrated with the 6 largest banks controlling about 68.3% of total assets. The Central Bank of Egypt (CBE) periodically monitors the performance of banks of systemic importance locally in order to reduce the systemic risks that may arise from them and enhance the integrity of the banking sector. The banking sector represented 89.6% of the total assets of the financial system at the end of the fiscal year 2018/2019. The credit portfolio continued to grow and provide financing to all economic sectors with total loan disbursement around EUR 0.096⁶ trillion in FY 2018/19 and EUR 0.111 trillion in June 2020. The largest share of loans is directed towards corporates (72%), while the rest went to retail (15%) and the MSME sector (13%). Egypt's macroeconomic reforms helped stabilize the economy in recent years and allowed the country to enter the COVID19 crisis with improved fiscal accounts and a relatively ample level of foreign reserves.

Egypt imports air conditioning systems and commercial refrigeration systems as well as components of respective systems such as chillers, fan coils and compressors. Egypt assembles almost 92% of the air conditioning systems sold in the country. Most of the components of single split systems (which forms the 90% of the market) are imported and these are assembled and tested locally. Local refrigeration equipment manufacturers produce display cabinets, chest freezers and refrigerators. Egypt exports single split AC systems to a few countries which include UAE, Saudi Arabia, Tunisia etc. Egyptian commercial banks finance imports as well as imports through conventional financial products (trade finance products) such as export credit. On the other hand, manufacturing, distribution and retail operations are financed as a part of corporate finance including working capital finance. Most lending is balance sheet-based finance. Individual retail customers mainly avail of personal loans to finance purchases of appliances.

Egypt's financial sector is very active and positioning itself as a frontrunner in applying sustainable finance principles. The CBE is working to adapt and apply the UNEP Finance Initiative's Principles for Responsible Banking across the entire banking sector. Many Egyptian banks are adopting and promoting global standards on sustainable finance. International Financial Institutions (IFIs) are cooperating with local banks to promote investments in the RE and EE projects. In addition, special instruments like the Green Climate Fund (GCF) are directing growing attention in the same sector. In general, "Green Finance" is perceived as one of the important topics, which is gaining more recognition and attention. To speed the

⁶ All currencies not given in Euro were converted to EUR using the exchange rate of the European Central Bank on 05 July.

transition to a green economy, the Ministry of Finance recently issued the first sovereign green bonds in Egypt and the MENA region.

The Central Bank of Egypt SME Initiative supports Egyptian businesses with EUR 10.132 billion and a very competitive interest rate of 5% in order to aid the existing projects for development, expansion, replacement, and renewal (including EE measures). This initiative is driven through the obligation of Egyptian banks to give out at least 20% of their portfolios towards the anticipated 350,000 SMEs. The Medium, Small and Micro Enterprises Development Agency (MSMEDA) was launched in April 2017 as additional support to finance SMEs either through direct or indirect loans.

The support towards green financing is largely coming from the international funds either via on- or direct lending to local partner financial institutions (PFIs). The most active is European Bank for Reconstruction and Development (EBRD) that has significantly increased the awareness and capacity towards clean technology investments. Recently EBRD launched two programmes to boost green finance and improve value chains, aiming to foster a green recovery of the Egyptian economy.

Revolving green credit is the most applicable financing approach in Egypt followed by positive list which is easy to implement in commercial and residential sector. Public private partnership (PPP) approach could be used for public sector organisations for sustainable cooling projects. Besides, there is substantial scope to use PPP approach for district cooling projects. As regards, sources of finance commercial banks can play significant role.

3. Methodology

Egypt has progressed on its commitments relevant to the MP by implementing several relevant programmes, laws, and other policy instruments such as codes and standards. In this report, the policy instruments governing the RAC and building sector in Egypt are analysed to identify the key strengths and the shortcomings towards the phase down of HFCs, the use of natural refrigerants, and the reduction of cooling demand. The regulatory analysis covers the following four categories of policy instruments:

1. International protocols and commitments
2. National plans and strategies
3. Laws and bylaws relevant to the RAC and building sector
4. Standards and codes

Figure 2 explains the main steps of this analysis. First, existing policy instruments are identified. Second, these instruments are assessed and third, an initial list of policy recommendations is drafted. The initial list of recommendations has been discussed with relevant stakeholders—mainly the NOU.

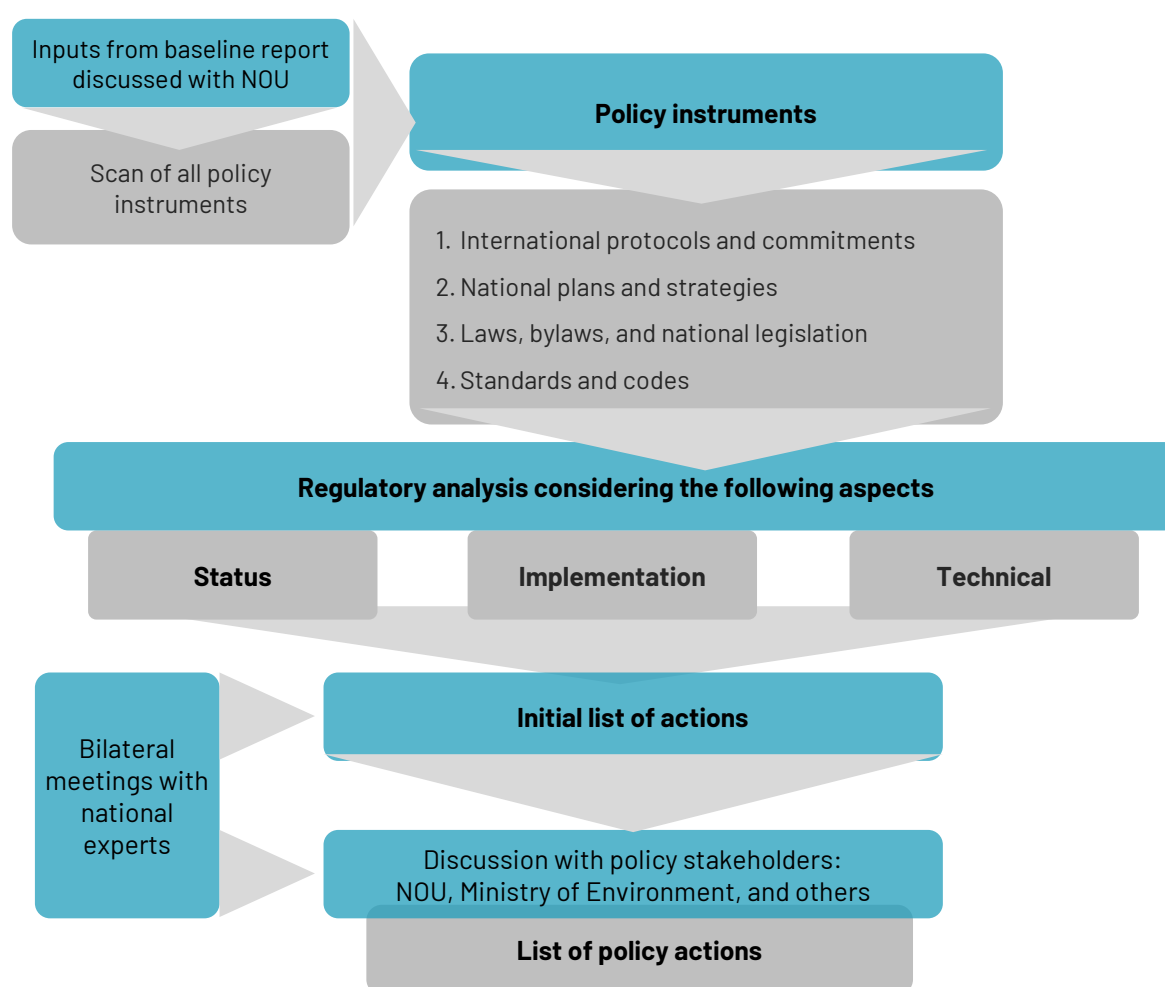


Figure 2 Methodology and working steps of the regulatory analysis in Egypt

The regulatory analysis in this report covers three key aspects (see Table 1).

- ▶ Availability status of the policy instruments in Egypt
- ▶ Implementation and compliance
- ▶ Provisions of the policy instruments in terms of the required and planned technical aspects

Table 1 Aspects of policy instruments analysis in Egypt

A. Status	B. Implementation and compliance	C. Technical aspects
In place	High level of compliance/ implementation	EE of refrigeration, air conditioning, and heat pump (RACHP) equipment and systems
Planned	Medium level of compliance/ implementation	Reducing cooling demand
Not available	Low levels of compliance/ implementation	Phaseout of ODS
		Phasedown of HFCs
		Promoting natural refrigerants

The colour codes of the analysis

For the policy instruments analysis, a colour code has been used in a table format to outline and scan the strengths and define the gaps in policy instruments governing the RAC sector. Three colour shades are used for this purpose (see Table 2).

Table 2 Colour codes

Colour	Meaning
Advanced	Highlight the aspect that has been sufficiently addressed by the policy instrument.
Moderate	Describes the aspects that are partially mentioned or partially developed.
Early	Depicts there is gap that needs to be further investigated.
White	Not applicable.

Table 3 explains the colour code applied for the different aspects of the policy analysis. For example, for the first group of aspects that cover the status of the policy instruments, the table explains the meaning of the three possible statuses (in place, planned, and not available). The second group of aspects focuses on the implementation and enforcement of the policy instruments. In many cases, the codes and standards are well elaborated and include ambitious EE requirements and sufficient technical detail, but those codes and standards are intermittently implemented and not sufficiently enforced. While some laws, standards and codes are fully enforced with high or almost complete levels of compliance, some other laws and regulations are not well enforced due to a lack of compliance procedures or the complexity of implementing these policy instruments.

Table 3 Colour codes applied for the different aspects of the policy analysis

A. Status aspects	
In place	One of the following conditions applies: <ul style="list-style-type: none"> ▶ The policy instrument has been issued/adopted through a decision, law, or other legal procedure. ▶ The competent authority has officially announced the adaptation. ▶ The policy instrument has been published in the National Gazette.
Is planned	One of the following conditions applies: <ul style="list-style-type: none"> ▶ The adaptation/issuance process is ongoing. ▶ The policy instrument has been officially announced to be under preparation. ▶ The policy instrument has been suggested/proposed by the competent authority.
Is not available	No announcement/proposal/suggestion yet.

B. Compliance and Implementation aspects	
High level of compliance/ implementation	One of the following conditions applies: <ul style="list-style-type: none"> ▶ High levels of compliance (e.g. most of the appliances have an EE label). <ul style="list-style-type: none"> ▶ A monitoring/reporting mechanism is in place. ▶ The implementation meets the planned targets (e.g. reduction of hydrochlorofluorocarbons (HCFCs) was successful).
Medium level of compliance/ implementation	One of the following conditions applies: <ul style="list-style-type: none"> ▶ Medium level of compliance—for example, there are no sufficient capacities to control compliance or there are no clear compliance/implementation procedures. ▶ The monitoring/reporting/verification mechanism is not completely implemented. <ul style="list-style-type: none"> ▶ The implementation partially meets the planned targets.
Low level of compliance/ implementation	One of the following conditions applies: <ul style="list-style-type: none"> ▶ Low level of compliance (e.g. most of the buildings do not comply with the code). <ul style="list-style-type: none"> ▶ No clear monitoring/reporting/verification mechanism is in place. ▶ The implementation has not started or is far from meeting the planned targets.
C. Technical aspects	
Specified	One of the following conditions applies: <ul style="list-style-type: none"> ▶ The criterion/topic has been explicitly specified in the policy instrument. <ul style="list-style-type: none"> ▶ Clear targets or plans have been identified.
Not specifically mentioned	One of the following conditions applies: <ul style="list-style-type: none"> ▶ The criterion/topic has not been mentioned, but other provisions indirectly lead to or promote this criterion/topic. ▶ The aspect will be considered in the update of the policy instruments or is planned to be included.
Not provided	The aspect is not covered or is not considered.

The third group of aspects covers the relevant technical criteria including the EE of RACHP equipment, reducing cooling demand, the phase out of ODS, the phase down of HFCs, and promoting natural refrigerants. Table 4 explains the meaning of each (for example, technical aspects such as reducing the cooling demand are an integral part of any plan or policy instrument to phaseout ODS consumption).

Table 4 Explanation of the technical aspects considered in the regulatory analysis

C. Technical aspects	Description and example
EE of RACHP equipment and systems	Addressing energy efficient operation of RACHP equipment and systems by establishing energy monitoring, setting targets for seasonal energy efficiency ratio (SEER) or other parameters, enhancing maintenance, etc.
Reducing cooling demand	In buildings, addressing energy consumption of buildings through measures assessing and reducing the cooling demand such as energy monitoring, insulation, shading, and utilizing renewable energy to meet the cooling demand, etc.
Phaseout of ODS	Addressing import, manufacture, export, and destruction of bulk ODS as well as the import, manufacture, export, installation, servicing, maintenance, and end-of-life management of equipment and systems containing or relying on ODS.
Phasedown of HFCs	Addressing import, manufacture, export, reclamation, and destruction of bulk HFCs as well as the import, manufacture, export, installation, servicing, maintenance, and end-of-life management of equipment and systems containing or relying on HFCs.
Promoting natural refrigerants	Addressing production and use of natural refrigerants in the RAC sector.

Awareness raising, capacity building, training, and certification will be considered when it is related to sustainable cooling (e.g. by promoting consumer information, enhancing labelling, providing information for different target groups, setting requirements for technician training and certification, and capacity building of planners, relevant authorities, etc.).

4. Summary of key findings and recommendations

Egypt has progressed on the commitments relevant to the Montreal Protocol through the implementation of several relevant programs, laws, and other policy instruments such as codes and standards. The policy instruments governing the RAC and building sector in Egypt were analysed to identify the key strengths and the key shortcomings towards the phase-down of HFCs, the utilization of natural refrigerants and the reduction of cooling demand. The analysis shows that Egypt has successfully delivered on its commitments under the Montreal Protocol and its amendments through the implementation of several relevant programs, elaboration of laws, other plans, and codes and standards. Egypt reached ODS consumption limits as required by the phase-out schedule. Additionally, Egypt developed national legislation that covers different aspects of the ODS phase-out, HFC phase-down and reduction of energy consumption. Most existing laws are well enforced and implemented. At the level of the standards and MEPS, the standards on cooling appliances and systems are well implemented, monitored, and enforced. Energy efficiency of air conditioning and refrigeration appliances, MEPS and labelling of RAC systems are mandatory. In contrast, MEPS in buildings are currently only used as guidelines.

The Cool Up regulatory analysis and the experts' interviews conducted in the framework of this analysis have shown some barriers that hinder the transition towards sustainable cooling and the upscaling of natural refrigerants in the RAC sector. Most importantly, the process of ratifying the Kigali Amendment has not yet been finalized (at the time of writing this report in May 2022), creating legal uncertainty and impeding the manufacturing sector and end-users from long-term planning and investment. In this context, national strategies and plans (e.g., National Cooling Plan, National Climate Strategy 2050, updated NEEAP) can better reflect the market transition required by the Kigali Amendment. Additionally, no Egyptian national regulations on F-gases currently exist, leaving room for improvement to develop the reduction of leakage, recovery of F-gases and appropriate treatment of used refrigerants, the transition to F-gas alternatives, technician training etc. There are other barriers such as the safety concerns related to the use of F-gas alternatives which could also be addressed through awareness raising and capacity building. The levels of awareness about natural refrigerants are not at the desired levels among different stakeholders and therefore more awareness raising, and capacity building activities are needed.

Based on this analysis, some key policy recommendations have been derived to support the preparation of policy frameworks that guide the transition towards sustainable cooling and natural refrigerants use.

1. National Cooling Action Plan (NCAP)

A National Cooling Action Plan works as a roadmap to holistically support the transition towards sustainable cooling practices and promoting the use of non-ODS refrigerants. Such a strategy covers the whole country and may include a wide range of measures such as promoting more stringent MEPS and outlining potential financial mechanisms for sustainable cooling. A National Cooling Action Plan is an integrated document linked to climate, energy, and economic development strategies. It is based on the HPMP and HFC phasedown plans (if available) and intends to promote EE and the technology transition. It links to NDCs, which drive EE requirements. The content of a National Cooling Action Plan would refer not only to RAC but to all cooling sectors, the entire cold chain, and related policies.

2. National F-gas regulation

National legislation on F-gases will be drafted in coordination with the NOU and other relevant ministries and based on experience from the EU and other countries. F-gas legislation could either expand existing legislation on ODS or represent a self-standing legal act (possibly plus side legislation). Consultations with stakeholders concerned, including other ministries and government agencies, industry (all sectors concerned), associations, and other experts, to discuss targets and potential measures are foreseen. The national rules would implement the commitments of the Kigali Amendment but could also go beyond to national strategies (e.g., climate targets). Measures to be covered include the following three categories:

3. National licensing and quota system for HFCs

As the basis for ratifying the Kigali Amendment, a national licensing and quota system for HFCs and a national reporting system for HFCs needs to be in place. The existing licensing and quota system does not seem to cover HFCs yet. Also, a reporting scheme for imports, exports, use, reclamation, and destruction of HFCs would need to be set up. The legal basis for a licensing and quota scheme and reporting could be established through existing legislation on environmental monitoring, environmental statistics, a national F-gas regulation, or separate, dedicated legal acts.

4. National certification scheme for RAC technicians

Qualification and certification of RAC technicians is important for the transition to low-GWP alternatives as required under the Kigali Amendment, especially on the safe use of flammable, toxic, and high pressure (natural) refrigerants. Training programmes should meet minimum requirements to address F-gas emissions reductions, leakage control, documentation, and safe handling of alternative refrigerants (including flammable refrigerants). To get certified, technicians should pass an exam proving the minimum qualification.

5. MEPS and building codes

Egypt is making a good progress with the MEPS, which are updated regularly. However, MEPS for further product groups could be useful (e.g. for refrigerated cabinets in commercial refrigeration, standalone equipment), if not yet existing.

Attention should also be paid to the EE of buildings as the reduction of cooling demand could be explored further, especially for the building stock. MEPS in buildings are currently used as guidelines only, and EEBCs might not be applied and enforced consistently (to be discussed with HBRC).

6. Accompanying measure: awareness activities

Mainly, awareness activities about natural refrigerants and outreach to the relevant private and public stakeholders. Awareness activities should include crucial topics such as sustainable cooling technologies and disposal of conventional refrigerants. Consumer awareness activities are needed as well to increase demand for higher energy efficient cooling appliances and for improved energy performance of buildings.

5. Regulatory analysis

5.1. International protocols and commitments

Egypt signed the Paris Agreement in 2016 and ratified it 2017. Egypt delivered its Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015; these were automatically considered to be the country's first Nationally Determined Contributions (NDCs) after it ratified the Paris Agreement (UNFCCC, 2017). The outlined high CO₂ mitigation actions in Egypt's NDCs have direct implications on the cooling sector. Egypt NDC mitigation actions include promoting efficient energy use, increasing the use of renewable energy sources, and reducing global-warming potential (GWP) gases in general. For example, the Egyptian Third National Communication (NC3) to the Conference of the Parties (EEAA, 2016) provides a list of GHG emission mitigation options in the building and housing sectors. This includes specific measures that have direct and indirect impacts on the cooling sector such as reducing the cooling load; increasing the efficiency of appliances, heating and cooling equipment, and ventilation; implementing mandatory labelling; and certifying appliance performance. The proposed measures in the NC3 are being implemented and controlled through different regulatory mechanisms (for example, appliance standards, building codes, procurement regulations, mandatory labelling and certification programmes, and utility demand-side management programmes).

Egypt is committed to the MP, which was ratified in 1988, and has ratified all MP amendments through presidential decrees (see Table 5). Egypt is still in the process of ratifying the Kigali Amendment. The Ministry of Environment in Egypt has affirmed the country's keenness to sign Kigali Amendment, and it is expected to be ratified after finalising the preparation of the ratification's technical and legislative documents (Ministry of International Cooperation, 2021) (Egypt Today, 2019) (NOU Egypt, 2021). After ratifying the Kigali Amendment, Egypt will be committed to phasing down HFCs according to the following schedule (EEAA, About Kigali Amendment (in Arabic), 2021):

- ▶ 2020-2022: Baseline
- ▶ 2024-2028: Freeze
- ▶ 2029-2034: 10% reduction
- ▶ 2035-2039: 30% reduction
- ▶ 2040-2044: 50% reduction
- ▶ 2045: 80% reduction

Table 5 Status of MP ratification in Egypt (Ozone UNEP, 2021), (EEAA NOU, 2018)

Policy instrument/ commitment/ protocol	Aspects of analysis	
	Status	Compliance and Implementation
MP and its amendments	Ratified	<ul style="list-style-type: none"> ▶ Presidential Decree (No. 239 of 1988) approving MP. ▶ Presidential Decree (No. 313 of 1992) approving the amendments of MP in the second COP (London Amendment, 1990). ▶ Presidential Decree (No. 80 of 1994) approving the amendments of MP in the fourth COP (Copenhagen Amendment, 1992). ▶ Presidential Decree (No. 202 of 2000) approving the amendments of MP in the ninth COP (Montreal Amendment, 1997). ▶ Presidential Decree (No. 276 of 2008) approving the amendments of MP in the eleventh COP (Beijing Amendment, 1999).
Kigali Amendment	Not ratified	Still in the process of ratifying the amendment.

The NOU continues the role to fulfil the Egyptian obligations under the MP with the complete phase out of all ODS by the deadlines adapted and approved by the MP parties (NOU Egypt, 2021). For example, and among several other activities, the NOU has been working on the following activities and projects:

- ▶ Developing an information system to track imports and consumption of ODS for the monitoring and licensing system in compliance with the MP.
- ▶ Continuing the role of the former Ozone Panel (established through ministerial decree No. 93 on 24 July 1993) constituting of all related ministries and authorities, to fulfil the Egyptian obligations under the MP with the complete phase out of all CFCs by 2010 or any other ODS by the deadlines adapted and approved by the MP parties.
- ▶ Monitoring and controlling imports and use of ODS in cooperation with Customs Authorities, which is based on ministerial Decree No. 77 issued in 2000 by the Minister of State for Environmental Affairs which was updated with the ministerial decree no. 392 issued in 2022 and includes the list of ODS under their control according to the regulations of the MP and its amendments. This decree prohibits import of these controlled substances without notifying the Egyptian Environmental Affairs Agency (EEAA) and the NOU (EEAA, The National Environmental Action Plan of Egypt 2002/17, 2001).

Some other international projects and MP-enabling activities are being implemented in Egypt in cooperation with the NOU, Ministry of Environment, Ministry of International Cooperation, and other stakeholders. Table 6 shows some of the internationally funded and international projects taking place in Egypt that are relevant to the cooling sector and reduction of ODS (UNIDO Open Data Platform, 2021).

Table 6 United Nations Industrial Development Organization's (UNIDO's) programmes and projects to ensure compliance with the MP in Egypt

International project and/or programmes and MP-enabling activities	Aspects of analysis	
	Status	Implementation
Phaseout of CFC consumption in the manufacture of aerosol metered dose inhalers (MDIs)	In place/ completed	Phase out 173 ton(s) of ODS. Ensure compliance with the MP.
Feasibility study for district cooling in New Cairo, Egypt	In place/ completed	The focus of the feasibility study is to link the possibility of using district cooling in the New Cairo Capital.
HCFC Phaseout Management Plan (Stage I)	In place/ completed	Ensure compliance with the ODS reduction targets, Phase out 18 ton(s) of ODS.
HCFC Phaseout Investment Activities (Stage II)(Foam Sector)	In place/ ongoing	Ensure compliance with the ODS reduction targets.
HCFC Phaseout Investment Activities (Stage II) (Refrigeration Sector)	In place/ ongoing	Ensure compliance with the ODS reduction targets. It is ongoing project expected to finish by the end of 2022.
HCFC Phaseout Management Plan (Stage II) – Service Sector and Project Management Unit.	In place/ ongoing	Ensure compliance with the ODS reduction targets. Phase out 18 ton(s) of ODS, expected to finish by the end of 2025.
Egypt HPMP Stage II Second Tranche, Residential Air Conditioning Manufacturing Sector	In place/ ongoing	Ensure compliance with the ODS reduction targets. Phase out 1,190 ton(s) of ODS, expected to finish by the end of 2022.
UNIDO MP projects: Enabling Activities for HFC Phasedown	In place/ ongoing	The objective of the project is to achieve a broader understanding of the Kigali Amendment provisions and to prepare technical and legislative bases for the ratification (Ministry of International Cooperation , 2021).
Egyptian Environmentally Friendly and Appropriate Alternatives Assessment (EGYPRA)	In place/ ongoing	The promotion of low-GWP refrigerants for the air conditioning industry in Egypt.

Thanks to the efforts of the NOU and several ongoing projects to comply with the MP, Egypt has successfully complied with its MP commitment. The Egyptian Government reported a consumption of 287.45 ODP Tons of HCFCs in 2018, which is 26% below the HCFC baseline for MP compliance in Egypt. Based on UNEP Ozone Secretariat, Figure 3 shows that HCFC and ODS consumption in Egypt are below the control limits and in line with the targets specified for Egypt (UNIDO Open Data Platform, 2021).

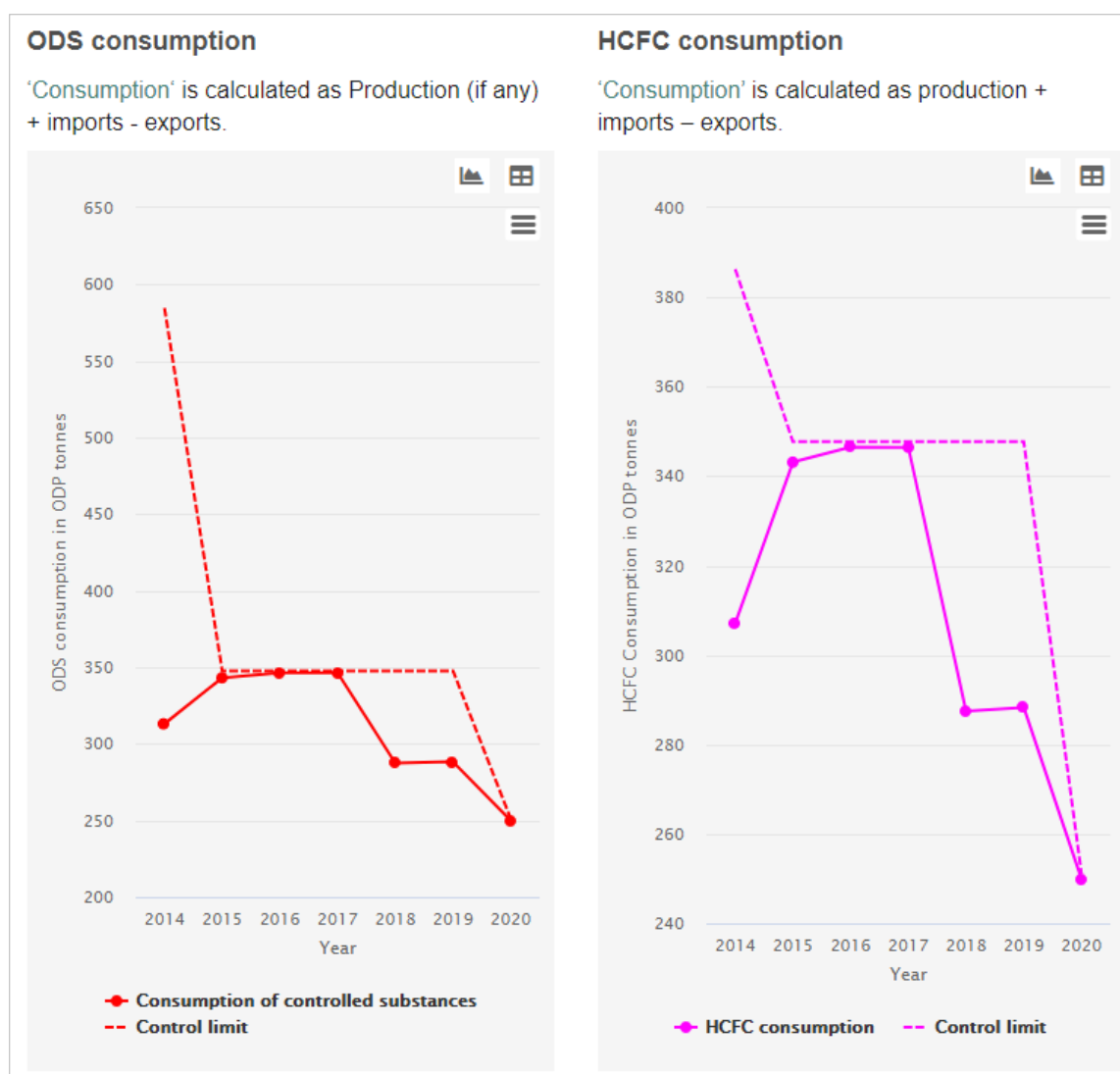


Figure 3 HCFC and ODS consumption in Egypt. Source: (Ozone UNEP, 2021)

In summary, Egypt is committed to the MP and has ratified all MP amendments. Furthermore, Egypt has succeeded in keeping ODS consumption under the control limits. Egypt is still in the process of ratifying the Kigali Amendment.

5.2. National plans and strategies

Intended Nationally Determined Contribution

Egypt submitted the INDC in 2016 and has not updated it yet. The INDC refers to the Egypt Vision 2030 and the need for EE measures in several sectors but does not present quantifiable targets nor cooling-specific measures.

Egypt Sustainable Development Strategy (Egypt Vision 2030)

Egypt Vision 2030 (2016) is a strategy that represents Egypt's general goals for 2030. It proposes three pillars for sustainable development in Egypt, including economic, social, and environmental. The strategy adopted the concept of sustainable development. The reduction of GWP gases and GHG emissions falls under the environmental dimension of the study. Egypt Vision 2030 has set clear targets to phase out

HCFCs by 2030 (see Table 7). The key performance indicator no. 7 in the environmental section of Egypt Vision 2030 targets 97.5% HCFC reduction in 2020 and 100% HCFC reduction by 2030. The strategy ambitiously aims to phase out all global warming gases from energy production by 2030.

Table 7 Indicator no. 7 in the key performance indicator of the environmental performance, Egypt Vision 2030

Indicator	Indicator definition		2020 target	2030 target
Reduction of ODS	Including	HCFC-22	97.5%	100%
		HCFC-141b		
		HCFC-142b		
		HCFC-123		
		HCFC-124		

Egypt's National Environmental Action Plan 2002/17

The National Environmental Action Plan (NEAP) 2002/17 is a comprehensive plan that covers several action areas including water, air, land, waste, global environmental issues, and some other supportive measures (EEAA, The National Environmental Action Plan of Egypt 2002/17, 2001). The NEAP dedicated several activities to reduce CFCs and ODS, including the following measures:

- ▶ Completing the transformation of the domestic refrigeration and solvents sectors by implementing a Refrigeration Management Plan (RMP) that includes a recovery and recycling project. It suggests other measures such as formulating an information system to track imports and ODS consumption.
- ▶ In cooperation with Customs Authorities, to prepare a proposal for new legislation that regulates and systematises the import and use of ODS.
- ▶ In cooperation with UNIDO as an implementing agency and GTZ as bilateral stockholder of Multilateral Fund Secretariat (MLF), implementing a Refrigeration Management Plan (RMP) including a recovery and recycling project.
- ▶ Preparing awareness campaigns especially directed to decision makers, customs officials, students and the public. This also includes preparing materials for the awareness campaigns (films, spots, booklets, and brochures).

National Energy Efficiency Action Plan (NEEAP)

Egypt's National Energy Efficiency Action Plan (NEEAP)(2018/19 – 2021/22) is in place and suggested a few measures directly relevant to cooling systems and sectors (MoERE, 2018):

- ▶ The establishment of three certified reference laboratories to measure the EE of household equipment such as air conditioners (ACs) and refrigerators.
- ▶ Issued the first Decree No. 266 dated 16/2/2002 by the Minister of Industry, obligating all producers and importers to follow Egyptian standards set for refrigerators, freezers, and ACs (window and split types).
- ▶ Set EE specifications for components of household equipment such as refrigerators, washing machines, and ACs.

Also, in the framework of NEEAP, pilot projects relevant to the cooling sector were introduced such as solar air conditioning technology in the Ministry of Environment's buildings. NEEAP suggests training and capacity building actions the fields of AC and heating systems (MoERE, 2018). Regarding the building and construction sector, NEEAP suggests promoting the implementation and enforcement of energy efficiency building codes (EEBCs). NEEAP's strategic objective is to provide capacity building and training of specialists in municipalities to inspect buildings and determine their level of compliance with the EEBCs.

Egyptian programme to protect the ozone layer

Egypt implements an ambitious programme called the Egyptian programme to protect the ozone layer. The programme covers several industrial and agricultural sectors such as the foam strip, refrigerator sector, maintenance sector for RAC units, solvent sector, halon sector, methyl bromide sector (EEAA NOU, 2018). Furthermore, the programme aims to achieve the following key goals:

- ▶ Complete implementation of the plan to phase out the use of ozone-depleting HCFCs in the manufacturing foam products and insulation materials sector by completing the reconciliation of national companies working in this field, switching to the use of friendly materials, and stopping the use of HCFC-141b by 2020 in cooperation with the UNIDO and the United Nations Development Programme (UNDP).
- ▶ Choose the best alternatives and modern technologies according to the Egyptian Environmentally Friendly and Appropriate Alternatives Assessment (EGYPRA) initiative in the home and industrial air conditioning industry and overcome the challenges resulting from stopping the use of the R22 refrigerant that depletes the ozone layer to allow Egyptian products to compete in global markets.
- ▶ Adhere to the reduction percentages indicated in the HCFC phasing out schedule.
- ▶ Continue the procedures and preparation towards the ratification of the Kigali Amendment. Currently, EEAA and NOU are working on a project to achieve a broader understanding of the Kigali Amendment provisions and to prepare the technical and legislative bases for the ratification.

HCFC phaseout plans in Egypt

Egypt has been working on a plan to reduce HCFCs by 25% by the end of 2018, 67.5% by 2025, and a complete phaseout in 2040. Stage II of the HCFC Phaseout Management Plan (HPMP) 2017-2025 is being carried out to reduce HCFC consumption by 67.5% of its baseline with support from the UNDP, United Nations Environment Programme (UNEP), and UNIDO.

Licensing system and quota system

In 2013, the HCFCs licensing and quota system came into force to control imports of HCFCs and monitor the implementation of the HCFC phaseout (except for HCFC-141b in imported pre-blended polyols).

As of 1 January 2018, the government banned the import of HCFC-141b in pre-blended polyols. The ban is implemented through the cooperation between EEAA and the Customs Authority, where the Customs Authority checks all imports under the general Harmonized System code for polyols with the assistance of the NOU (UNEP, 2019).

EGYPRA promotion of low-GWP refrigerants for the air conditioning industry in Egypt

The EGYBRA initiative was launched in 2014 to assess low-GWP alternatives in the air conditioning sector in domestic and commercial applications. EGYBRA built and tested prototypes using different HCFC alternatives to compare the performance and efficiency of those alternatives. The project tested custom-built AC split unit prototypes with capacities between 12,000 Btu/hr and 24,000 Btu/hr and central unit prototypes with a cooling capacity of 120,000 Btu/hr to operate with alternative refrigerants and compared their performance against HCFC-22 and R410A units.

The project involved building and testing 19 custom-built split unit prototypes with dedicated compressors and refrigerants provided by several local manufacturers. All the prototypes and the base units were tested at locally available accredited labs. The results show there is a potential to improve the capacity and EE of the prototypes using alternatives to HCFC-22, and the potential for improvements for the prototypes working with alternatives to R-410A is better. The test results show that all refrigerants used in the project (including R290, R32, R457A, R454B, R454C, R447A, and R444B) are viable alternatives from a thermodynamic point of view. The project indicates there is a need for capacity building to enable professionals and technicians to design, optimise, and test units with flammable refrigerants to improve the performance and meet EE standards (UNIDO Open Data Platform, 2021)(UNEP, EGYBRA – PROMOTION OF LOW-GWP REFRIGERANTS FOR THE AIR CONDITIONING INDUSTRY IN EGYPT - REPORT, 2019).

National Climate Strategy 2050

A recent decision was made to prepare the first comprehensive national climate change strategy for 2050, which lays down the directions and policies to be adopted by the country to fulfil its climate action aspirations. The strategy includes five main goals:

- ▶ Achieving sustainable economic growth and low-emission development in various sectors
- ▶ Enhancing adaptive capacity and resilience to climate change and alleviating the associated negative impacts
- ▶ Enhancing climate change action governance
- ▶ Enhancing climate financing infrastructure
- ▶ Enhancing scientific research, technology transfer, knowledge management, and awareness to combat climate change

Key conclusions of analysis of the national plans and strategies

Table 8 shows the status assessment of the national strategies, the level of implementation, and the technical aspects covered in those strategies and plans. Overall, Egypt has progressed on the commitments relevant to the MP through the implementation of several national strategies and plans (e.g. including ODS reduction targets in national strategies and the successful implementation of ongoing projects to phase out HCFCs). Several pilot projects to assess the potential of alternative refrigerants in the RAC sector have also been implemented.

There is a room for improvement to further support national plans and strategies relevant to the cooling sector in Egypt. For instance, and according to the NOU, there is no national cooling strategy in Egypt. Developing such a strategy may help pave the way for a more comprehensive transition towards sustainable cooling in the country. A national cooling strategy may also help pave the way to strengthen the coordination among the involved national and international stakeholders.

Table 8 Status of key national strategies relevant to ODS phaseout and cooling demand reduction in Egypt. Source: author based on various sources as mentioned in the report. For colour codes, refer to Table 3

National plans/ strategies	Status	Compliance and implementation	Technical aspects				
			EE of RACHP equipment and systems	Reducing cooling demand	Phase out of ODS	Phase down of HFCs	Promoting natural refrigerants
Egypt Sustainable Development Strategy (Egypt Vision 2030)	In place	Being implemented	EE mentioned	EE mentioned	Phaseout GW gases by 2030	Specified complete phaseout by 2030	Promote environmentally friendly technologies
NEAP 2002/17	In place	Being implemented	EE mentioned	EE mentioned	Phase out of ODS	Phase down of HFCs	Supporting innovative strategy
NEEAP 2018/2022	In place	Being implemented	Specified	Specified	Not provided	Not provided	Not provided
National Climate Strategy 2050	Planned	Not available	Not available	Not available	Not available	Not available	Not available
National Cooling Plan	Not available	Not available	Not available	Not available	Not available	Not available	Not available
Egyptian programme to protect the ozone layer	In place	Being implemented	Not specifically mentioned	Not specifically mentioned	Specified	Specified	Not specifically mentioned

National plans/ strategies	Status	Compliance and implementation	Technical aspects				
			EE of RACHP equipment and systems	Reducing cooling demand	Phase out of ODS	Phase down of HFCs	Promoting natural refrigerants
HCFC Phaseout Management Plan (HPMP)	In place	Being implemented	Specifically Mentioned	Specifically mentioned	Specified	Not mentioned	Not mentioned
HCFC licensing and quota system	In place	Being implemented			Specified	Not mentioned	Not mentioned
EGYPRA							

5.3. Laws and bylaws and other national legislation

Egypt has developed several laws, regulations, and policy instruments that govern EE and environmental protection. The following text explains the key laws and codes relevant to the RAC sector in Egypt and their main provisions.

Environmental Law

Environmental Law No. 4 of 1994, amended by Law No. 9 of 2009 and Law No. 105 of 2015. Environmental Law is the main law that reflects concern for the environment and stresses the importance of safeguarding natural resources in Egypt. The law provides incentives to those that implement environmental protection activities or projects and enacts penalties against those that violate its provisions. The law calls for the protection of biodiversity, ozone, and water resources and the conservation of natural resources. It also requires a mandatory environmental review, to be undertaken by the competent administrative authority according to EEAA's instructions, as part of the approval process for all proposed projects.

Electricity Law

Electricity Law No. 87 issued in 2015 regulates all electricity activities in the country and aims to establish a competitive electricity market. It refers to cooling in several articles such as Article 48 on the improvement of the power usage efficiency, Article 49 on the annual plan for energy efficiency and load management, Article 50 to develop policies and specifications for energy efficiency labels and the replacement of low-efficiency appliances, and Article 51 on the energy efficiency cards on electric devices. The Electricity Law allows for private sector participation in the generation and distribution of electricity, introducing the concept of competitive electricity markets for the first time in Egypt by setting out the framework for market liberalisation.

Unified Building Law

The Unified Building Law of 2008 No. 119 and its Implementing Regulations of 2009 (the bylaw) are the fundamental legislation that administer the urban development and building construction in Egypt. The Unified Building Law and its bylaws are enforced through the Ministry of Housing, Utilities & Urban Communities (MoHUUC), governorates, and municipalities. Apart from general provisions of EE, the Unified Building Law of 2008 No. 119 and its bylaw of 2009 do not impose detailed EE requirements. The bylaw of the Unified Building Law requires all buildings in Egypt to comply with several standards and ministerial decrees.

Ministerial decrees

In Egypt, the ministerial decrees issued and published in the National Gazette have a strong legal competency. Ministerial decrees enforce a number of provisions as stated in the decrees or issued to enforce a specific standard or a code or a number of measures. The following paragraphs summarise the key provisions of ministerial decrees relevant to the RAC sector in Egypt.

Ministerial decree 1129 for 2019 was issued to formulate the general policies of the state in dealing with climate change and to work on formulating and updating an inclusive national climate change strategy. This impacts the mitigation actions for climate change, which include the phasing out of HCFCs and phasing down of HFCs and focusing on the use of natural alternatives.

Import and export regulations under law no. 118/1975, which was amended by law no. 139 for 2003 and ministerial Decree 770, issued in 2005 in Egypt include, among other things, regulations for inspections of RAC equipment for domestic use. It also bans the import of used equipment and devices that work with ODS.

Ministerial decision 477/2018 (issued by the Egypt Ministry of Commerce and Industry) requires several listed products (including ACs and refrigerants) to comply with designated EE and labelling standards. It is mandatory to have an energy efficiency licence and an approved EE label. The Egyptian Organization for Standards and Quality (EOS) is the only organisation authorised to issue the EE licence and label; manufacturers are required to submit test reports issued by EOS-accredited laboratories according to the applicable Egyptian standards.

Ministerial Decree 171/2011 obliges producers and importers to put energy consumption labels on electrical appliances (including ACs) and light bulbs for home use.

Ministerial Decree No. 77 issued in 2000 which was updated with the ministerial decree no. 392 issued in 2022, includes the list of ODS and prohibits import of these controlled substances without notifying EEAA/NOU.

Waste Management Law

Waste Management Law No. 202/2020 aims to create a waste management regulatory authority (WMRA) to oversee proper waste management and recycling practices. WMRA will be in charge of creating a national strategy to tackle the issue of waste management.

Technicians and certification

A certification scheme for technicians is typically established through national legislation certifying technicians to safely use and dispose refrigerants. Due to the lack of such national legislation in Egypt, no mandatory certification and or training schemes exist for technicians working on the safe use and disposal of refrigerants. Therefore, certification and capacity building and awareness programmes are needed to appropriately qualify technicians for the safe installation, maintenance, repair, and end-of-life treatment of RACHP equipment and systems.

Key conclusions of analysis of the national legislation

Table 9 shows the assessment of the laws, bylaws, and other national legislation such as the ministerial decrees. The assessment considers status, the level of implementation, and the technical aspects covered. Generally, national legislation covers a wide range of aspects addressing HFCs, HCFCs, and ODS. Most of those laws are—to a large extent—well enforced and implemented. Yet, specific F-gas regulations need to be developed. Additionally, the Waste Management Law does not include any provisions relevant to ODS phaseout. Therefore, it is important to develop legislation for the disposal of ODS and F-gases. Certifying technicians dealing with refrigerants should also be addressed.

Table 9 Initial assessment of laws relevant to the RAC sector. Colour coding as described in Table 3

Laws and bylaws	Status	Compliance and implementation	Technical aspects				
			EE of RACHP equipment and systems	Reducing cooling demand	Phase out of ODS	Phase down of HFCs	Promoting natural refrigerants
Environmental Law					Ministerial Decree 1129 for 2019	Ministerial Decree 1129 for 2019	Ministerial Decree 1129 for 2019

Laws and bylaws	Status	Compliance and implementation	Technical aspects				
			EE of RACHP equipment and systems	Reducing cooling demand	Phase out of ODS	Phase down of HFCs	Promoting natural refrigerants
Electricity Law			Articles 48-51				
Renewable Energy Law			Presidential Decree No 17/2015				
Unified Building Law							
Import and Export Appliances Law			Ministerial Decree No. 770 issued in 2005 & Ministerial Decision No 477/2018 Ministerial Decree No. 171/2011		Law 139 for 2003		
ODS regulation					Ministerial Decree 77 issued in 2000 which was updated in the ministerial decree no. 392 issued in 2022		
Waste Management Law							
Certification scheme for technicians							

5.4. Standards and codes

Minimum energy performance standards (MEPS)

EOS is responsible for the development and implementation of all standards and for the Egyptian equipment EE programme, where the minimum energy performance standards (MEPS) and labelling scheme for appliances are mandatory regulations. The MEPS were last updated in 2018. Appliances with energy performance below the MEPS are not allowed to enter the Egyptian market. The EE label categories for each appliance are developed specifically for Egypt. The AC standards and labels focus on window, split, and package units (ducted systems). The central AC systems typically used in commercial purposes have MEPS only—no label. Furthermore, according to the Ministerial Decree No. 171/2011 that obliges producers and importers to put energy consumption labels on electrical appliances (including ACs) and light bulbs for home use, EOS must review the manufacturer's data and verify the level of energy consumption according to the existing EE and AC standards before putting them on the market. Table 10 lists some of the key standards in Egypt relevant to RAC equipment as issued by EOS and buildings codes issued by the HBRC.

RAC Minimum Energy Performance

Minimum energy performance for RAC systems is covered in several national standards:

- ▶ **Standard No. 5072/2020:** Ducted Air-Conditioners and Air-To-Air Heat Pumps – Testing and Rating for Performance. This document specifies performance testing, standard conditions, and test methods for determining the capacity and efficiency ratings of air-cooled, ACs, and air-to-air heat pumps. This document covers residential, commercial, and industrial single-package and split-system ACs and heat pumps, factory-made, electrically driven and use mechanical compression, utilising single, multiple, and variable capacity components, and multiple split-system using one or more refrigeration systems, one outdoor unit, and one or more indoor units, controlled by a single thermostat or controller.
- ▶ **Standard No. 6423/2015:** Refrigerant compressors - rating conditions, tolerances and presentation of manufacturer performance data. This document specifies the rating conditions, tolerances, and the method of presenting manufacturer data for the positive displacement of refrigerant compressors.
- ▶ **Standard No.6425/ 2021:** Compressors and condensing units for refrigeration - performance testing and test methods. This document applies to refrigerant compressors only and describes a number of selected performance test methods.
- ▶ **Standard No. 3794:** Energy Efficiency of Household and Similar Electrical Appliances Measurement and Calculation Methods for Energy Consumption of Refrigerators, Refrigerator-Freezers and Freezers. This specification aims to set rules for evaluating the energy consumption efficiency of electric household appliances to raise their efficiency and reduce their energy consumption through some unified procedures for methods of measuring and calculating energy consumption. It also sets a maximum value for their energy consumption provided they are modified and upgraded as a periodical every 2 years.
- ▶ **Standard No. 3795:** Energy Efficiency Label Requirements for Air Conditioners. This standard is divided into seven complementary parts and. This standard specifies requirements for EE labels for heating and cooling. It aims to rationalise the consumption of electrical energy and improve environmental conditions by reducing the emissions of gases harmful to the environment and the result of the increased use of energy. This specification sets a set of rules for evaluating the energy consumption efficiency of ACs to raise their efficiency and reduce their energy consumption through some unified procedures for methods of measuring and calculating energy consumption; it also sets a maximum value for their energy consumption provided they are amended and upgraded as a periodical every 2 years. Egyptian standards 4814, 4855, and 7278 are complementary to this standard. The standard ensures that all the targeted ACs sold in the market meet the minimum MEPS. The standard aims to provide the end consumers with detailed information on the efficiency and the consumption of the targeted ACs. Table 10 details the updates of the standards to increase the efficiency requirements by year.

Table 10 Initial assessment of laws relevant to the RAC sector. Colour coding as described in Table 3

Before June 2020	From June 2020	From June 2022
A++++ $4.99 \leq \text{COP}$	A+++++ $5.27 \leq \text{COP}$	A+++++ $5.57 \leq \text{COP}$
A+++ $4.69 \leq \text{COP} < 4.99$	A++++ $4.99 \leq \text{COP} < 5.27$	A+++++ $5.27 \leq \text{COP} < 5.57$
A++ $4.4 \leq \text{COP} < 4.69$	A+++ $4.69 \leq \text{COP} < 4.99$	A++++ $4.99 \leq \text{COP} < 5.27$
A+ $4.1 \leq \text{COP} < 4.4$	A++ $4.4 \leq \text{COP} < 4.69$	A+++ $4.69 \leq \text{COP} < 4.99$
A $3.81 \leq \text{COP} < 4.1$	A+ $4.1 \leq \text{COP} < 4.4$	A++ $4.4 \leq \text{COP} < 4.69$
B $3.51 \leq \text{COP} < 3.81$	A $3.81 \leq \text{COP} < 4.1$	A+ $4.1 \leq \text{COP} < 4.4$
C $3.26 \leq \text{COP} < 3.51$	B $3.51 \leq \text{COP} < 3.81$	A $3.81 \leq \text{COP} < 4.1$

- ▶ **Standard 4790/2005:** Household Refrigerators - Methods of Test for the Information of the Consumer is a complementary standard to the previous one as it specifies methods for testing domestic refrigerators that are used as a technical basis for the following activities: preparation of information cards, comparison tests, marks, and certification.

Safety and disposal standards

Safety and environmental requirement standards are part of **Standard No. 5056/2020** (four parts). This standard is intended to reduce potential hazards to persons, property, and the environment from refrigeration systems and refrigerants. These risks are mainly related to the physical and chemical properties of the refrigerants and the pressures and temperatures that occur in refrigeration cycles. The purpose of this standard is to promote the safe design, construction, disposal, and installation and operation of refrigeration systems. This standard has been revised and updated as a result of the industry's response to the ODS phaseout to accelerate the introduction of alternative refrigerants. After introducing new refrigerants to the market, the safety ratings were revised and updated. This part of the standard is applicable to:

- ▶ Fixed or mobile systems (except for vehicle AC systems)
- ▶ New refrigeration systems and their accessories
- ▶ Changes to existing systems and systems in use
- ▶ Systems moved to another location and commissioned
- ▶ If a system is converted to another refrigerant

The last part of this standard specifies safety and environmental requirements for operation and maintenance; repair of cooling systems; recovery, reuse, and disposal of all types of cooling media; and oils, cooling, and heat transfer fluids for refrigeration systems or their parts. These requirements aim to reduce the risk of injury to persons, damage to property and the environment resulting from improper handling of refrigerants or from contaminants that lead to system failure, and emissions from refrigerants. Natural refrigerants are not specifically mentioned.

Standard No. 4855/2015 Refrigerants -- Designation and Safety Classification establishes a system for assigning a safety classification to refrigerants based on toxicity and flammability data and provides a means of determining the refrigerant concentration limit. Tables listing the refrigerant designations, safety classifications, and the refrigerant concentration limits are included based on the data made available.

Refrigeration and Air Conditioning (RAC) codes

The **Egyptian Code of Refrigerants** was released in 2020 and consists of a technical background on international requirements and obligations arising from the ozone protection agreements and the MP and its amendments. The code mentions that HFCs must be phased down to lower GWP refrigerants and natural ones by testing R-290 and R-1270. However, no specific percentages have been determined.

It explains the characterisation and classification of cooling media (consists of choosing alternative cooling media), the safe handling of refrigerants, the criteria for selecting cooling media, the requirements for the proper containment and use of refrigerants; this includes and consists of operating and servicing RAC equipment; recovery, recycling, reclaiming, and safe disposal of refrigerants; retrofitting RAC systems; transportation; handling; and storage.

Several codes and standards also discuss the RAC design and installation. The **Egyptian Code for Air Conditioning and Refrigeration** (304) is based on the similar Arab code. The code for the design principles and conditions for the implementation of RAC works consists of three volumes. It aims to provide at least the minimum conditions of comfort, health, public safety, and security resulting from AC or ventilation of a place while achieving reduced energy consumption through organising and controlling the design, planning, installation, quality of materials, operation, inspection, maintenance, and safety of AC, ventilation, and cooling systems; the code also suggests choosing environmentally friendly refrigerants and provides a methodology for analysing the economic performance of refrigeration plants.

The **Egyptian Code for District Cooling** was released in 2020 and includes the general features and economic characteristics of district cooling and heating systems, water refrigeration unit stations, hot and cold-water distribution networks systems for district cooling and heating systems, power

transmission stations. It also includes the main keys to the design process for a layered thermal energy tank and centralised measurement, control, and monitoring systems.

Energy Efficiency Buildings Codes (EEBC)

EE in buildings is a topic that needs more exploration in the Egyptian context. Codes related to this topic are issued and in place, but they need to be updated and are only relevant to new buildings. Additionally, such codes act as guidelines and are not mandatory. No current penalty or incentive plans are in place to support the enforcement of these codes. The **Egyptian Code to Improve Energy Efficiency in Buildings (306/2005)** is divided into a section on residential buildings and a section on commercial buildings. This code provides the general principles of buildings through improving the EE used to achieve thermal and optical comfort in the design and implementation of:

- ▶ New residential and commercial buildings
- ▶ The residential and commercial parts of the new multi-purpose buildings
- ▶ New residential and commercial parts in the existing buildings
- ▶ New devices and systems in residential and commercial buildings

Other codes that support the EE in buildings include:

- ▶ The **Egyptian Code for Ventilation in Buildings**, which defines the requirements for the design and implementation of works and installations of ventilation systems to maintain the quality of the environment inside buildings.
- ▶ The **Egyptian Code for Housing and Planning (602)**, which includes criteria for building and site design in general.
- ▶ The **Building Environment Design Standard**, which applies to new buildings, existing buildings, and rehabilitated buildings. It is concerned with providing guidelines related to the EE of buildings to assist designers and participants in collecting and supplying the data required during the various stages of the design process. This standard is applicable to new buildings and to AC equipment, heating plants, and new buildings.

In general, EEBCs in Egypt are not well-enforced and implemented. This is mainly due to the complexity of the codes and the lack of procedural manuals to implement their technical provisions. With the lack of EEBC enforcement, there is no official baseline for the EE of buildings and no labelling or energy passports for buildings.

Key conclusions of analysis of the standards and codes

Table 11 assesses the key standards and codes relevant to the RAC sector in Egypt. The EEBCs are detailed, but they are not enforced well and, apart from aiming to reduce the cooling demand, EEBCs do not cover most of the technical aspects considered in this analysis. The standards for appliances such as the MEPS and labelling of appliances such as ACs and refrigerants are well-implemented, monitored, and enforced.

Table 11 Summary of the assessment of standards and codes relevant to the RAC and building sectors

Standards and codes	Status	Compliance and implementation	Technical aspects				
			EE of RACHP equipment and systems	Reducing cooling demand	Phaseout of ODS	Phasedown of HFC	Promoting Natural Refrigerants
RAC MEPS	Standard No. 5072/2020 Standard No. 6423/2015 Standard No. 6425/2014 and 6425/ 2021 Standard no. 2930/ 2005 Standard 3794 Standard 4790/2005	Standards are obligatory.	Standard No. 5072/2020 related to Standard No. 6423/2015 Standard No. 6425/2014 and 6425/ 2021 related to refrigeration				
RAC labels	EE Label Requirements for AC Standards 3795 (7 parts) Standards no. 4814, 4855, and 7278	The standard ensures that all the targeted ACs sold in the market are labelled and meet the minimum MEPS.	Rules for evaluating the energy consumption efficiency of ACs to raise their efficiency and reduce their energy consumption.		Improve environmental conditions by reducing the emission of gases harmful to the environment.		
RAC installation and maintenance	The Egyptian Code for Air Conditioning and Refrigeration (304) The Egyptian Code for District Cooling 2020		Provide at least the minimum conditions of comfort, health, public safety, and security resulting from AC or ventilation while reducing energy consumption.		Second volume targets choosing environmentally friendly refrigerants.	Second volume targets choosing environmentally friendly refrigerants.	Second volume targets choosing environmentally friendly refrigerants.
RAC safety and environmental requirements	Standard No. 5056/2020 (four parts) Refrigerants -- Designation and Safety Classification The Egyptian Code of Refrigerants 2020				The Egyptian Code of Refrigerants: requirements and obligations arising from the ozone protection agreements	The Egyptian Code of Refrigerants: requirements and obligations arising from the ozone protection agreements	The Egyptian Code of Refrigerants explains the characterisation and classification of cooling media, which consists of choosing alternative cooling media and retrofitting RAC systems
EE buildings	Egyptian Code to Improve EE in Buildings (306/2005) Egyptian Code for Ventilation Building Environment Design standard		Building Environment Design standard				

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