Cool Up

MENA Region Cooling Status Report

Progress, Opportunities, and Insights | **Issue 1**

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Contents

Foreword

Human-induced climate change is causing the planet to heat up at an alarming rate. There is a chance to preserve our ecosystem from potentially fatal consequences, but action is required now.

With the report we seek to trigger discussion on the best solutions for the future of cooling in the region and ultimately inspire action.

It is not news anymore that the planet is warming quickly. As temperatures reach unprecedented levels across the globe, climate impacts like heat waves are becoming frequent, more widespread, and more dangerous. Warming at twice the global average, the Middle East and North Africa region is no exception to this troubling trend.

Across the globe and particularly in a region so vulnerable to the impacts of climate change, cooling plays a critical role both as part of the problem and part of the solution. I am thrilled that with the support of the International Climate Initiative, we as the Cool Up programme can tackle this critical topic in the region by scaling up sustainable cooling and the use of natural refrigerants. This is not something, however, that can be tackled alone. It requires collaboration, trust and ambition. Such a transformational shift also requires an open culture of mutual learning and information exchange that extends across communities and borders.

This MENA Region Cooling Status Report represents our efforts in Cool Up to do exactly that. Current information on (sustainable) cooling in the region varies and is incomplete and no comprehensive regional cooling overview exists yet. With this report, we seek to close this gap, providing a basis on which regional experts can share insights and information and lay the foundation for action on sustainable cooling across the MENA region.

In the report, we move beyond discussions about the need for sustainable cooling and address progress, opportunities and insights on the topic from the policy, technology & market, and financing perspectives.

Since the programme's inception in 2021, I have been impressed by the collaborative spirit of the many regional actors who have contributed their enthusiasm and dedication to our joint vision for sustainable cooling across the MENA region.

I invite you to engage with us, share your experience, and be part of a 'cooler' future.

Katja Eisbrenner
Cool Up Programme Director
Director, Guidehouse

Executive Summary

Why is sustainable cooling important for the MENA region?

The MENA region is exceptionally vulnerable to the impacts of climate change. It is currently warming at double the global average and predicted to be 4^{0}C warmer by mid-century.

Due in large part to extremely high and rising temperatures, as well as a growing population, the region is slated to face a 50% increase in energy demand by 2040.

What are progress and opportunities on sustainable cooling?

Policy Landscape

International agreements such as the Kigali Amendment to the Montreal Protocol provide the framework for national cooling targets, which are already underway in some countries of the MENA region.

Market Landscape

The total market size of RAC technologies in the region was estimated at around EUR 8 billion in 2018 with an expected annual growth rate of 5% until 2024.

Technology Landscape

Variable Refrigerant Flow (VRF) systems are currently the dominant cooling solution for countries in the MENA region.

Finance Landscape

Financing institutions and programmes offer new products in the sustainability field that, in part, promote sustainable cooling solutions in some countries.

What are the regional insights on sustainable cooling?

Projects in the region on sustainable cooling show the great potential and competitiveness of natural refrigerants and passive cooling.

Regional experts observe trends that underline the importance of raising awareness for sustainable cooling solutions in the region.

Setting the scene

Taking a close look at the geography, climate, and economy of the MENA region, it quickly becomes apparent how cooling demand and climate change are inextricably linked.

In an area with rapidly growing urbanisation and a heavily strained energy infrastructure, cooling represents a significant source of energy consumption. Typically, half of all households in the region are equipped with air conditioning (AC) systems that are mostly old and inefficient. The demand for cooling is expected to grow further given the rapidly growing population and improved standards of living. Due to the inevitable impacts of climate change, regional experts expect average temperatures to climb 4°C by 2050. This will lead to an increased demand for cooling and a 50% increase in energy demand by 2040[1] in this vulnerable region.

Mainly due to the desert conditions, the MENA region is sparsely populated. For the most part, the population of North Africa lives directly south of the Mediterranean coast, and the majority of Egypt's nearly 90 million inhabitants live in the areas around the Nile River.

1. British Petroleum, *BP Energy Outlook 2018 Edition.*

Most of the population in the Middle East lives in the northern part of the region, which stretches from Iran through Iraq and Syria to Turkey.

The MENA region is the most water-stressed area in the world.[2] Climate conditions are harsh, and temperatures are extremely high whilst rainfall and groundwater are limited, making this region extremely vulnerable to the impacts of climate change, the effects of which have already been observed and are expected to increase in the near future.

Evidence shows a warming process that natural variability cannot explain, and predictions show a faster than average increase in drying trends and temperatures. Scarce agricultural land and extensive desert areas coupled with water crises and shortages will have severe consequences for health and the economy. Researchers predict that even if global warming is limited to 2°C, the heat-stress mortality risk for people over 65 in the region is estimated to increase by three to seven times by 2100.[3]

Cooling and climate protection

The increase in temperatures and growing populations in the MENA region are triggering a booming demand for refrigeration and air conditioning and generating high electricity usage. Besides indirect emissions of carbon dioxide (CO_2) that result from traditional power generation, conventional cooling also causes direct greenhouse gas emissions. Most refrigeration and air conditioning technologies use synthetic, fluorinated refrigerants as cooling gases, which are substantially more harmful to the climate than CO_2. Unavoidable system leakages and incorrect disposal of cooling appliances release these harmful gases into the environment, which results in direct greenhouse gas emissions.

2. Borghesi and Ticci, "Climate Change in the MENA Region."
3. Ahmadalipour and Moradkhani, "Escalating Heat-Stress Mortality."

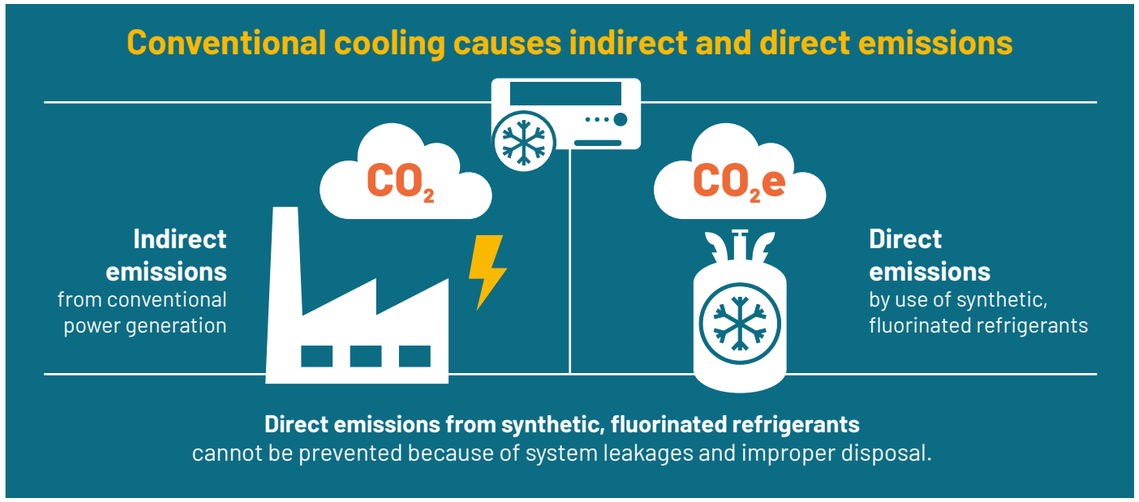

Figure 1: How conventional cooling causes indirect and direct emissions

Hydrofluorocarbons (HFCs) are one of the commonly used synthetic refrigerants. HFCs are used in conventional cooling systems like refrigerators and air conditioners as an alternative to ozone-depleting substances (ODS) like hydrochlorofluorocarbons (HCFCs) and chlorofluorocarbons (CFCs). HFCs are currently used as substitutes in cooling appliances because they do not contribute to ozone layer depletion.

While not ODS, HFCs are greenhouse gases that can have high global warming potential (GWP).

GWP is characterised as the potency of a greenhouse gas over a specific period of time in relation to CO_2. The GWP of HFCs ranges from about 12 to 14,800[4], which means that HFCs can be exponentially more potent and harmful to the climate than CO_2.

United Nations Framework Convention on Climate Change

The potential danger of synthetic refrigerants was initially recognised in 1987 when the international community came together to sign the Montreal Protocol on Substances that Deplete the Ozone Layer. The goal was to phase out the production of CFCs and other ODS that are mainly responsible for the man-made, chemical ozone depletion. At the time, more than 30 countries signed the Montreal Protocol to avert this global threat to human life on Earth. Since then, all UN Member States have ratified the Montreal Protocol. The adoption of the Kigali Amendment to the Montreal Protocol in 2016 turned the Montreal Protocol into a climate treaty.

The legally binding, multilateral agreement focuses on phasing down the production and consumption of HFCs that can be thousands of times more harmful to the climate than CO_2. To date, 132 countries have already ratified the Kigali Amendment and thus agreed to targets for the phase-down of the climate-polluting HFC gases used in cooling appliances.[5]

4. Solomon *et al.*, "Climate Change 2007: The Physical Science Basis."
5. Theodoridi, *Senate to Consider Kigali Amendment Ratification.*

The way forward: Bringing two worlds together

Cool Up supports accelerated implementation of the Kigali Amendment to phase-down HFCs and aims to catalyse change in the refrigeration and air conditioning sector with a holistic and cross-sectoral approach. To facilitate the phase-down of HFCs, we aim to take immediate actions to avoid technologies that will create a harmful impact on the climate in the coming years. Technical solutions and building design strategies that meet these criteria are already at our disposal. However, their potential remains largely untapped. Scaling up these technologies and strategies requires a step change. Our long-term vision is a transition to natural refrigerants, which have no impact on the ozone layer and very low GWP compared to conventional refrigerants. Natural refrigerants include ammonia, water, air, CO_2, and hydrocarbons like propane. Replacing HCFCs and HFCs with natural refrigerants protects the ozone layer and could avoid up to 0.4°C of global temperature rise by 2100.[6] As a result, the phase-out of ODS and the phase-down of HFCs will contribute to the goal of the Paris Agreement to limit global warming to well below 2°C, preferably 1.5°C, compared to pre-industrial levels. Sustainable cooling is at the intersection of the global ozone depletion and climate change agendas. Accelerated technology change could reduce cooling demand and enable early implementation of the Kigali Amendment to the Montreal Protocol and the Paris Agreement.

The Cool Up programme focuses on Egypt, Jordan, Lebanon, and Turkey. These countries are simultaneously experiencing fast-growing demand for cooling, increasing final energy consumption, and structural challenges in the energy sector. They also have a high potential to boost energy efficiency and natural refrigerants in the cooling and refrigeration sector.

About this report

The aim of this report is to look beyond the four Cool Up partner countries (Egypt, Jordan, Lebanon and Turkey) and show valuable insights and developments in sustainable cooling with a high-level perspective and broad geographic scope across the whole region. Our key target audience is the MENA region beyond the partner countries, international organisations, decision-makers from the finance and policy sectors, and industry associations.

As this report is the first issue in a series of MENA Region Cooling Status Reports, it is intended to set the scene. Future issues will focus on a particular aspect of sustainable cooling. In all reports, we aim to show valuable developments, insights, and good practice examples regarding sustainable cooling in the region. Furthermore, the report provides a basis on which regional experts can share valuable developments, insights, and perspectives. This report series will serve as a key output of the programme. An overarching goal of this report series and the Cool Up programme is also to bring together the cooling, energy efficiency, ozone, and climate worlds.

As cooling is cross-sectoral by nature, this report is structured around the topics 'Policy', 'Market and technology', and 'Finance' to cover all aspects of the regional status of sustainable cooling. Sustainable cooling can be interpreted differently depending on the context.

Cool Up defines sustainable cooling as an affordable and safe cooling that satisfies user needs with the lowest possible impact on the environment. Specifically, it implies the absence of environmentally harmful refrigerants such as fluorinated gases; low energy demand through high efficiency; and compatibility with a fully renewable energy supply.[7]

6. Ozone Secretariat, *Kigali Amendment Hits Milestone 100th Ratification.*
7. When a renewable energy supply on the site is currently not possible, at least the readiness for a fully renewable energy supply with external sources must be ensured (e.g.by using equipment with storage and smart controls).

Policy landscape

International protocols and commitments

Montreal Protocol and Kigali Amendment

The story of the Montreal Protocol is one of the few acts of humanity in our long history where all countries came together to protect the future of life on Earth. It starts with one of the most innovative inventions of the 20th century, CFCs, which turned out to have unintended negative consequences for the planet. In the early 1970s, scientists predicted that CFCs were depleting the ozone layer at an alarming rate, which led to a decrease in the stratospheric ozone (the ozone layer) around the Earth's polar regions by the end of the decade. Throughout the 1970s and 1980s, the international community became increasingly concerned that if depletion of the ozone layer continued, the world's inhabitants would be at risk from lethal levels of UV radiation.

Faced with this global threat, the world took action and signed the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987. At that time, more than 30 countries agreed to phase out the production of CFCs. As of 2015, all Member States of the United Nations (UN) have ratified the Montreal Protocol and committed to restoring the ozone layer. The Montreal Protocol is thus the first treaty in the history of the UN to achieve universal ratification—and is considered by many to be the most successful environmental global action.[8]

With the adoption of the Kigali Amendment to the Montreal Protocol in 2016, another essential milestone in ozone protection, but also climate protection was reached. The Kigali Amendment sets out a legally binding multilateral agreement to phase down the production and consumption of HFCs.

8. Environmental Protection Agency (EPA), *International Actions - The Montreal Protocol.*

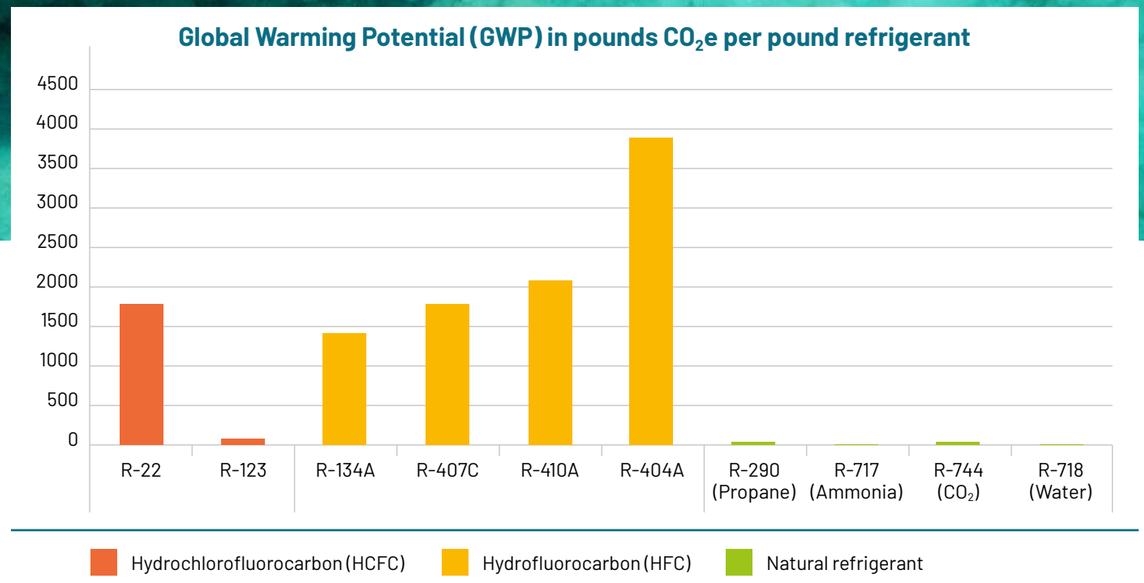

Figure 2: Comparison of the global warming potential of refrigerants[9]

HFCs are commonly used in refrigerators and air conditioners as alternatives to ODS like HCFCs and CFCs. Because they have no effect on ozone layer depletion, HFCs are currently used as substitutes in cooling appliances. While not ODS themselves, HFCs are greenhouse gases that can have high or very high GWP. GWP is characterised as the potency of a greenhouse gas over a specific period of time in relation to CO_2. The GWP of HFCs ranges from about 12 to 14,800, which means that HFCs can be thousands of times more potent and harmful to the climate than CO_2.

The Kigali Amendment to the Montreal Protocol will considerably contribute to the long-term goals of the Paris Agreement, a legally binding international treaty on climate change. It was adopted by 196 Parties at COP21 in Paris on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels.

Successful implementation of the Kigali Agreement is meant to limit global warming from HFC emissions to 0.06°C.

In contrast, without any reduction measures, HFC emissions alone could cause a global temperature increase of 0.35°C to 0.5°C. [10 11 12]

As a result of global commitments, regulatory action is being taken at regional and national levels to control HFCs. Countries that committed to the Kigali Amendment should reduce their consumption of HFCs by more than 80% over the next 30 years.[13] In effect, the Kigali Amendment's implementation can contribute to greenhouse gas emission reduction targets, thus providing a crucial opportunity to meet the Paris Agreement's long-term goals.

9. Offermann *et al.*, "Klimaschonende Klimatisierung (Heizen und Kühlen) mit natürlichen Kältemitteln – Konzepte für Nichtwohngebäude mit Serverräumen/Rechenzentren."
10. Velders *et al.*, "Future Atmospheric Abundances and Climate Forcings."
11. Velders *et al.*, "Hydrofluorocarbon (HFC) Scenarios, Climate Effects."
12. Xu *et al.*, "The Role of HFCs."
13. Ozone Secretariat, *Kigali Amendment Hits Milestone 100th Ratification.*

Dynamics in the MENA region

For developing countries in the MENA region, the phase-out of ODS (most notably HCFCs) until 2030 and the stepwise reduction (phase-down) of HFCs from 2024 onwards represent both opportunities and challenges for the transition of the sector to introduce sustainable alternatives to ODS and HFCs.

As many of the traditional space cooling and refrigeration systems in place have low energy efficiency, cooling generally represents more than half of the energy consumption in AC-equipped households in the region.

Further, most systems rely on refrigerants with a high GWP, leading to high direct emissions from the refrigerant circuit. These trends exacerbate the adverse effects that increased cooling demand in the MENA region has on the climate and environment. Introducing the most energy efficient and sustainable alternatives as replacements early on in the transition process offers additional potential to reduce direct emissions of CFCs and HFCs on the one hand and indirect emissions from energy consumption of technical systems on the other.

The different baseline years and phase-down schedules for countries that ratified the Kigali Amendment are divided in two groups according to Article 5 of the Montreal Protocol.[14]

For example, Group 1 includes Egypt, Jordan, Lebanon and Turkey; and Group 2 includes Saudi Arabia and United Arab Emirates.

Baseline years and phase-down schedules are as shown in Table 1 and Figure 3.

14. UNEP, The Kigali Amendment to the Montreal Protocol.

Table 1: Parameters for HFC phase down in Article 5 Group 1 and Group 2 countries

	Article 5 Parties: Group 1		Article 5 Parties: Group 2	
Baseline years	2020, 2021 & 2022		2024, 2025 & 2026	
Baseline calculation	Average production/consumption of **HFCs** in 2020, 2021 & 2022 plus 65% of **HCFC** baseline production/consumption		Average production/consumption of **HFCs** in 2024, 2025 & 2026 plus 65% of **HCFC** baseline production/consumption	
Reduction steps *Freeze*	2024		2028	
Step 1	2029	10%	2032	10%
Step 2	2035	30%	2037	20%
Step 3	2040	50%	2042	30%
Step 4	2045	80%	2047	85%

Figure 3: Phase-down schedules for Article 5 Group 1 and Group 2 countries

Phase-down schedule for HFCs

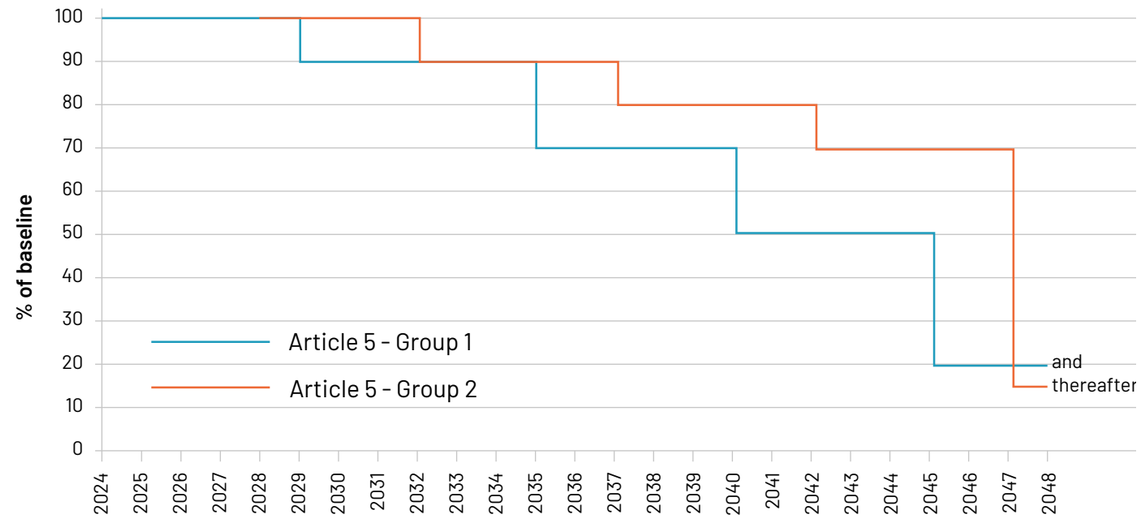

Table 2: Overview of ratification status in the MENA region as of May 2022

Country Group	Article 5 Parties: Group 1	Article 5 Parties: Group 2
No. of countries	13	8
Ratification requirements	Reduction steps not anticipated earlier than 2024	Reduction steps not anticipated earlier than 2028
Ratification complete	6: Jordan, Lebanon, Morocco, Syria, Tunisia, Turkey	0

Figure 4: Countries in the region that have ratified the Kigali Amendment as of May 2022[15]

Most countries of the region are in different stages of ratifying the adoption of the Kigali Amendment to the Montreal Protocol. Six of the countries have already ratified the Kigali Amendment.

Monitoring of activities related to the Montreal Protocol, such as plans for the gradual phase-out of HCFCs, is typically carried out by National Ozone Units (NOUs) that usually function under the Ministry of Environment. The NOUs are government units of Article 5 Group 1 and Group 2 countries responsible for monitoring their national programmes for compliance with the Montreal Protocol on ODS.

Each country has a NOU, supported by the Multilateral Fund for the Implementation of the Montreal Protocol (MLF), which provides financial and technical support to developing countries for complying with their obligations under the Montreal Protocol. Through the MLF, approximately EUR 3.2 billion has been provided to date to assist 147 developing countries.

15. Guidehouse 2022

The Fund supports technology transfer projects that have replaced ODS with ozone-friendly substitutes and technologies in developing countries. This funding has made the relevant industries more competitive and has been done carefully to mitigate the negative impacts of the changes on both the enterprises concerned and their employees. The Montreal Protocol has therefore also significantly contributed to the eradication of poverty and promotion of prosperity in these countries.[16]

National plans and strategies

The internationally defined HFC phase-down schedule of the Kigali Amendment to the Montreal Protocol supports the Paris Agreement. Furthermore, it follows the approach for all signatory states to regularly formulate their own climate protection contributions: the nationally determined contributions (NDCs). NDCs are non-binding national plans including long-term climate mitigation goals to reduce greenhouse gas emissions to contribute to the global targets of the Paris Agreement. Article 4 of the Paris Agreement requires each Party to prepare, communicate, and maintain successive NDCs that it intends to achieve. Parties shall pursue domestic mitigation measures to achieve the objectives of such contributions.[17] As the NDCs are established on a national level, signatory states have significant freedom in setting their climate protection targets.

The long-term goals of each country's NDCs represent efforts to reduce national emissions and adapt to the impacts of climate change. In some cases, these efforts include cooling-specific targets to reduce ODS and HFCs and general goals to improve the energy efficiency and disposal of cooling systems and refrigerants.

The inclusion of cooling-specific targets in NDCs will become increasingly important as most countries of the region will experience a dramatic rise in temperatures in the future, which will lead to an increase in cooling demand and thus the emission of more greenhouse gases.

Most countries of the region do have NDCs in place that in some cases also contain targets that are directly or indirectly related to cooling, as shown below. Some countries do mention cooling or related keywords like refrigeration and AC in their NDCs, but most targets connected to the cooling topic are minor impact areas and cluster around general topics like increasing the energy efficiency of technical building systems.

16. Ozone Secretariat, *Vienna Convention and its Montreal Protocol.*
17. UN Climate Change, *Nationally Determined Contributions.*

Table 3: Example countries, based on RAC market size, and their cooling-specific targets in NDCs

Country Group	NDC in place?	Cooling- specific targets[18]
Algeria	YES	-
Bahrain	YES	-
Egypt	YES	-
Iran	NO	-
Iraq	YES	• Change the specifications of electrical equipment used in the electricity sector to cope with the increasing temperatures
Jordan	YES	• Energy efficiency targets in National Energy Efficiency Action Plan (NEEAP) • Expanding the use of solar cooling in commercial and industrial facilities • The updated NDC (2021) indicates that Jordan intends to implement pilot interventions to scale up the sustainable use of cooling technologies with climate-friendly gases
Kuwait	YES	• Use of district cooling system in projects for new residential cities
Lebanon	YES	• Development of a National Cooling Plan that was proposed to be integrated into the NDC
Libya	NO	-
Morocco	YES	• Energy-Certification Labelling of Refrigerators
Oman	YES	• Mandatory requirements in energy efficiency regulations and minimum energy efficiency requirements for air conditioners • In the process of expanding the energy efficiency regulation to include refrigerators, refrigerator-freezers, freezers, and water heaters
Qatar	YES	• Energy efficiency measures such as district cooling and energy labelling for all electronic devices are systematically being deployed • District cooling
Saudi Arabia	YES	-
Syrian Arab Republic	YES	-
Tunisia	YES	-
Turkey	YES	• Set goals to increase energy savings and use of renewable energy for heating and cooling by switching to central and district heating systems in mass housing complexes and large settlement units
United Arab Emirates	YES	• District cooling • Efficiency standards for air conditioning units and refrigeration

18. Findings considered search through NDCs including these keywords: cooling, refrigeration, air condition, AC, hydrofluorocarbons, HFC, ozone-depleting substances, and ODS.

In addition to the NDCs within the framework of the Paris Agreement, other national plans or strategies are in place or in drafting progress that include cooling-specific topics in some countries of the region. One strategy that completely focuses on cooling is the National Cooling Action Plan (NCAP), which is considered a strategy or roadmap promoting sustainable and smart cooling practices across a country.

NCAPs identify groups that are vulnerable due to a lack of cooling, promote the adoption and increase stringency of Minimum Energy Performance Standards (MEPS), and identify potential financial mechanisms for cooling.

They also include measures that can support countries to achieve major international treaties such as the Kigali Amendment to the Montreal Protocol and the Paris Agreement. NCAPs also provide a framework for coordination and cooperation among stakeholders and government agencies recognising the cross-cutting nature of sustainability interventions in the cooling sector.

Currently, Lebanon is the only country in the region that has a NCAP, it was published under the name "Guidance for Integrating Efficient Cooling in National Policies in Lebanon" in May 2021.[19] The NCAP includes the pathway for the transition to lower indirect and direct emissions through enforced energy efficiency requirements and the phase-down of high GWP refrigerants and foam blowing agents (HFCs). The NCAP also serves the purpose of providing affordable access to cooling to the population, meeting Lebanon's Sustainable Development Goals (SDGs), and meeting Lebanon's economic development targets.[20]

Another national strategy that follows a much broader approach is the National Energy Efficiency Action Plan (NEEAP). NEEAPs focus not on cooling aspects but on sustainable long-term market transformation scenarios towards energy efficiency and sustainability. Some countries in the region also include cooling-specific targets in their NEEAPs.

Although the majority of countries in the region have NEEAPs (or other national plans with a similar scope) in place or underway, cooling is generally given little or no attention. Similar to the NDCs, major topics of the NEEAPs in the region that can have direct and indirect impacts on cooling equipment are building-related energy efficiency goals and the aim of reducing greenhouse gases in general. Only one country proposes suitable MEPs for cooling equipment (see below).

19. Sustainable Energy for All, *National Cooling Action Plans*.
20. United Nations Development Programme (UNDP), *Guidance for Integrating Efficient Cooling*.

Table 4: Example countries, based on RAC market size, and their cooling-related targets in NEEAPs

Country	Type	Cooling (refrigeration or air conditioning) specific targets[21]
Algeria	NEEAP II in progress[22]	No public information is available.
Bahrain	NEEAP 2017	Bahrain adopted its NEEAP in 2017, and the government enacted MEPS and energy efficiency labelling of small AC units (Ministerial Order No. 70/2015). In 2012, existing thermal insulation regulations were extended to cover all buildings (Ministerial Order No. 63/2012). The specific target for AC for the residential and commercial sector is 430 GWh potential savings in 2025.[23]
Egypt	NEEAP II	No specific targets; however, Egypt's NEEAP II sets specific energy savings targets for the country, including different sectors such as the building sector.
Iran	NEEAP	Iran's first NEEAP is currently under preparation with support from the German Energy Agency. No public details are available; however, it is expected that this document will focus on the industrial sector and the energy efficiency of its cooling systems.
Iraq	NEEAP	Iraq adopted its NEEAP in 2013 and set targets until 2030. This NEEAP does not include cooling-specific targets; however, it includes general building requirements that would result in reduced cooling demand.
Jordan	NEEAP II	Jordan's NEEAP II includes general building requirements that would result in reduced cooling demand, but there are no specific cooling targets.
Kuwait	-	-
Lebanon	NEEAP II	Lebanon's NEEAP II includes measures to proposes suitable MEPs for the cooling equipment. There are some steps towards developing NEEAP III.
Libya	NEEAP	Libya's NEEAP includes general measures proposing the development of an energy efficiency building code.[24]
Morocco	-	-
Oman	-	-
Qatar	National Development Strategy 2018-2022 (NDS-2)	Qatar's NDS-2 does not include specific targets for cooling systems; however, the strategy has a set of targets, which includes energy efficiency improvements.
Saudi Arabia	National Energy Efficiency Programme (NEEP)	Saudi Arabia's NEEP does not include specific air conditioning targets; however, refrigerants consumption decreased by 22% because of the energy efficiency standards, according to statistics of the Ministry of Energy.[25]
Syrian Arab Republic	-	-
Tunisia	-	-
Turkey	NEEAP	Turkey's NEEAP includes proposed measures to promote the use of efficient cooling systems and technologies.
United Arab Emirates	UAE Energy Strategy 2050	The UAE's Energy Strategy plans to reduce CO_2 emissions by 70% by 2050; however, there is no specific target for cooling systems.

21. Information presented in this column is based on the published national energy plans of the respective countries.
22. Regional Center for Renewable Energy and Energy Efficiency (RCREEE), *Overcoming Challenges in Preparing.*
23. Kingdom of Bahrain, *National Energy Efficiency Action Plan.*
24. Alkishriwi, *Energy Efficiency Opportunity in Libya.*

MENA Region Cooling Status Report
POLICY LANDSCAPE

Laws and bylaws, codes, and standards relevant to the RAC sector

International protocols and commitments, as well as national plans and strategies, build the base of a long-term strategy to reduce greenhouse gas emissions. Still, they are not binding in most cases.

Unless action is taken to transpose them into law, commitments and plans remain just that. Laws and bylaws play a vital role in bringing strategies and plans to life.

Given the increasing importance of integrating cooling as a key issue in the fight against climate change, the legislative process of implementing cooling-specific regulations, codes, and standards is already underway in some countries. One example can be found in the United Arab Emirates (UAE) that adopted regulations for district cooling systems.

25. Ministry of Energy, "Saudi Energy Efficiency Program."

> "District cooling can play an important role in phasing down HFCs. However, the vital factor is how the district cooling was produced. The Cool Up programme also examines this question."
>
> **Markus Offermann,** Guidehouse cooling expert

Regional example:

Abu Dhabi's district cooling regulatory framework as first district cooling regulation in the region

United Arab Emirates

Abu Dhabi announced its first comprehensive regulatory standard on district cooling in 2019. It led the way in developing and now implementing the first comprehensive District Cooling Regulatory Framework in the region and puts the responsibility for regulating the district cooling sector on the Emirate's Department of Energy.[26] To address the growing demand for cooling, Abu Dhabi seeks to become the regional pioneer in centralised and district cooling systems. The objective was to provide a clear regulatory framework to protect consumers, encourage sustainable growth, and use district cooling technologies as a more energy efficient solution. In accordance with the regulation, the Department of Energy issued its first district cooling licences for two projects within Abu Dhabi, the Saadiyat Island and the New York University Abu Dhabi.

KEY FACTS

- **Minimum capacity of a cooling system must be 17.6 MWc (~5,000 tonnes of refrigeration)**
- **Minimum requirements on tendering district cooling projects**
- **Need for metering and establishing minimum standards on district cooling services**

26. Shaheen, *First District Cooling Regulation*; ZAWYA, "Abu Dhabi's District Cooling."

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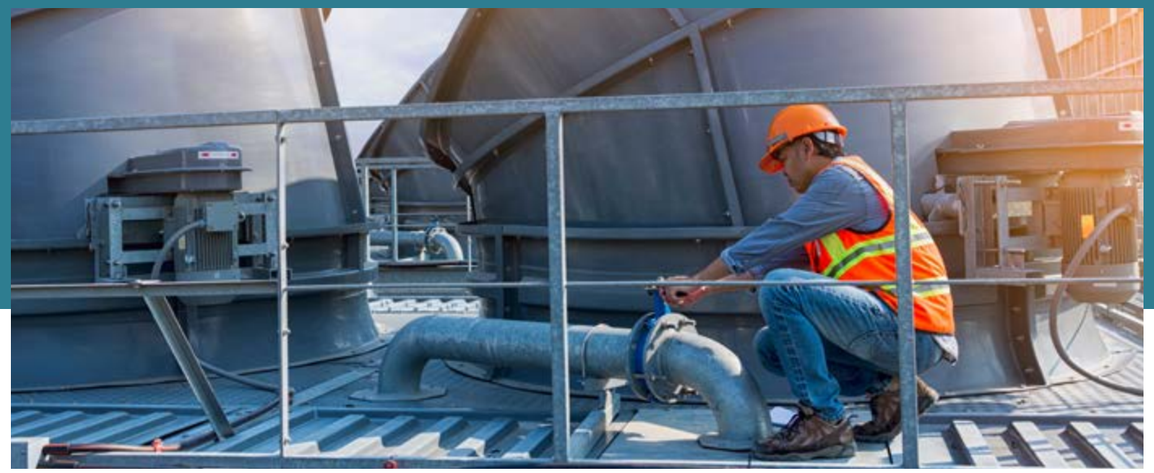
POLICY LANDSCAPE

What is district cooling about?

District cooling is the cooling equivalent of district heating and usually consists of a cooling centre with large chiller units and a network of insulated pipes laid underground. This underground pipe distribution network transports chilled water to commercial and residential buildings to use it for their cooling needs. The supply temperature is usually 6°C or 7°C, but ice mixtures of 0°C are also used. When the chilled water reaches the energy transfer station in the basement, it is used to cool down the building's water through a plate heat exchanger. Electronic pumps pump the cool water through the building into the fan coil units where fans push the cold air into the room.

Market and technology landscape

Since 1990, global energy consumption from space cooling has more than tripled.[27]

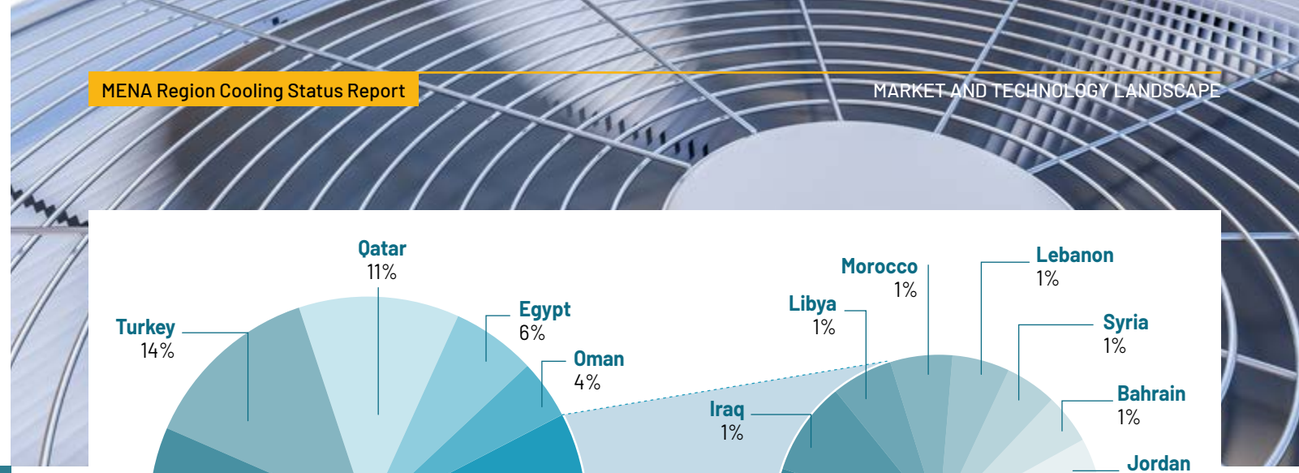


This significant growth in energy consumption has implications for electricity grids. Cooling peak loads during heat waves requires additional capacity that can lead to risks like electricity shortages, increasing energy prices, and investment needs for the maintenance and extension of the electricity grid infrastructure. Around two billion AC units are currently installed globally, which subsequently puts space cooling among the key drivers of electricity demand in buildings.

The International Energy Agency (IEA) estimates that space cooling may account for more than 15% of the building sector's electricity consumption globally.

The global refrigeration and air conditioning (RAC) market volume reached nearly EUR 125 billion in 2018. Several studies assume that the share for residential buildings within the RAC market is nearly 50% to 60%.[28] In 2018, The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) estimated that more than 110 million AC systems were sold globally in just one year, of which 96 million units were room air conditioners.[29]

27. IEA, "Cooling."
28. Economist Intelligence, *The Cooling Imperative*
29. JRAIA, *World Air Conditioner Demand*



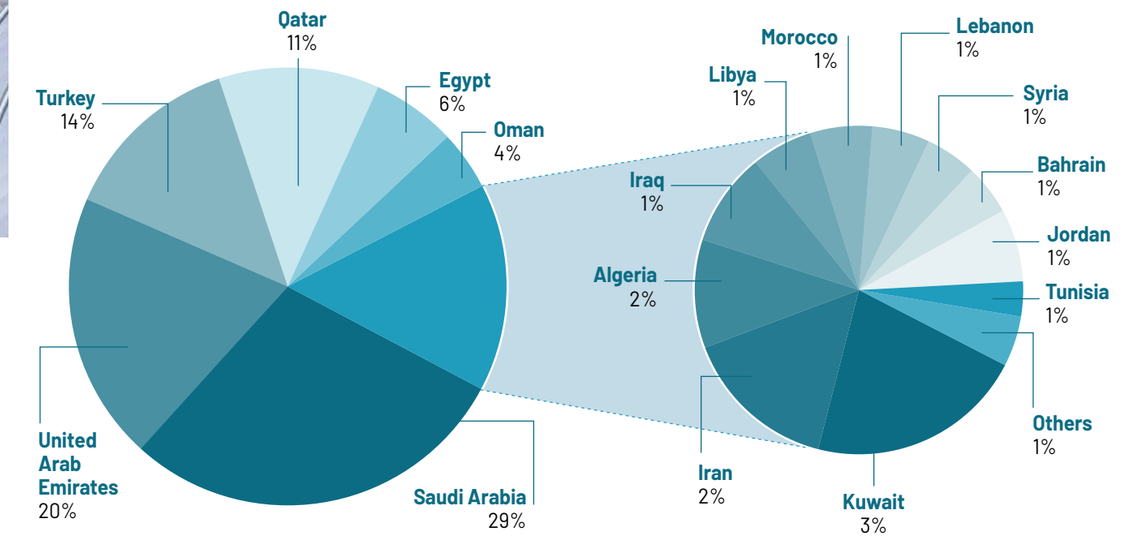


Figure 5: RAC market size breakdown by country[30]

Space cooling in the MENA region: A thriving market

The MENA region is no exception to the trend of increased cooling demand. It has been witnessing an increase in temperatures in summers that can exceed 50°C. Rapid urbanisation and population growth are expected to give rise to space cooling demand, which will put tremendous pressure on the urban infrastructure. The region accounted for almost 7% of the global demand for AC systems in 2018[31] with an unprecedented growth pace for space cooling. This can be attributed to several factors such as a rising standard of living, more frequent heat waves, population growth, and increasing construction rates to cope with housing demands. The total market size of RAC technologies in the region is estimated to have been around EUR 8 billion in 2018 with an expected annual growth rate of 5% until 2024.[32,33] The majority of the market share is distributed among Qatar, Saudi Arabia, Turkey, and the UAE.

Saudi Arabia has the largest market share with around 29% of the total market size of RAC technologies in the MENA region, with an estimated value of more than EUR 2.3 billion and an estimated market growth average of 8.1% annually during the forecast period 2021–2030.[34]

Most countries in the MENA region are net importers of space cooling devices, meaning that they import more than they export. In the last twenty years, local manufacturing of air conditioning systems developed significantly, and the market share of locally manufactured space cooling devices continues to increase. In this time, several countries such as UAE, Turkey, Saudi Arabia, and Jordan began exporting air conditioning units.[35]

30. RCREEE.
31. Ibid.
32. Ibid.
33. TrendEconomy, *Saudi Arabia | Imports and Exports.*
34. Prescient & Strategic Intelligence. "Saudi Arabia HVAC Market Research."
35. TrendEconomy, *Saudi Arabia | Imports and Exports.*

According to several surveys,[36] the UAE have by far the highest export volume of air conditioning systems with a total of EUR 642 million[37] in 2020 compared to Saudi Arabia with EUR 57 million.[38] The largest portion of exports go to Iraq (37%), Saudi Arabia (11%), and Oman (8%).[39]

Space cooling technologies: A diverse scene

Most of the conventional space cooling technologies on the global market are also available in the MENA region.

Typical space cooling technologies can be distinguished in central and decentral systems. Central systems are technologies with several transmission units served by a central cold production unit. They can be further distinguished into AC chillers, sorption water/brine chillers, and variable refrigerant flow (VRF)/multi-split systems. Decentral systems are cooling technologies where every transmission unit is served by one cold production unit. Typical decentral technologies are single split units, self-contained units, and movable compact units.

Decentral systems like single split units are the predominant technologies for small-scale commercial and residential applications, while central systems are used more for large-scale commercial applications. Currently, water-cooled chiller systems gain a lot of market uptake in line with the development of mega-scale district cooling plants in Saudi Arabia, Egypt,[40] and Dubai.

District cooling technologies are gaining momentum in terms of interest and the number of projects, with several local manufacturers providing integrated services around the system.

Central systems

AC chiller

Chillers are connected to distribution (air or water) or delivery systems (fan coil units or chilled beams or ceilings). Central cold generation units are part of a central AC system, which can be categorised into three groups:

- Compression water/brine chillers
- Compression direct expansion (DX) chillers (incl. packaged rooftop and central)
- Sorption water/brine chillers

VRF/multi-split systems

Multi-split systems consist of one outdoor and several indoor units. VRF systems are sophisticated multi-split systems. Several outdoor units can support many indoor units (up to 64). The indoor units can be regulated individually.

Decentral systems

Single split units

Consist of an indoor and an outdoor unit and provide AC for one indoor zone

Self-contained (window/wall) units

Include window-mounted, through-the-wall AC units, and packaged terminal air conditioning, or PTAC, units. All components are enclosed in a single box to provide AC for one indoor zone.

Movable compact units

Small portable AC units that can be placed on the floor or a table

36. Ibid.
37. TrendEconomy, *United Arab Emirates | Imports and Exports.*
38. TrendEconomy, *Saudi Arabia | Imports and Exports.*
39. TrendEconomy, *United Arab Emirates | Imports and Exports.*
40. UNIDO. 75th ExCom, *Feasibility Study.*

Based on several studies, interviews with experts, and discussions with stakeholders in the MENA region, it is clear the region is a diverse market where most AC technologies are available. The shares of those technologies differ from one country to another. Table 5 provides an overview of the predominant cooling technologies of different building types in the MENA region.[41] The Cool Up programme provides a country-specific outlook about the shares of those technologies in the market and the prospect scenarios of those systems for Egypt, Jordan, Lebanon and Turkey.

Table 5: Predominant cooling technologies in different building types

Building type	Dominant cooling technology
Commercial	Chillers (AHUs, FCUs), VRF
Offices	AHUs, FCUs, VRF, Indirect Evaporative Coolers
Hospitals	Packaged AHUs, Chillers, FCUs
Hospitality	AHUs, FCUs, VRF, Chillers
Industrial	Chillers (85% air cooled units, 15% water cooled in food)
Residential	Split ACs (70% fixed speed)
Educational	VRFs, Packaged AHUs
New districts / Urban areas	District systems

Further explanations:

- **AHU:** An air handling unit, commonly called an AHU, is the composition of elements mounted in large, accessible box-shaped units called modules, which house the appropriate ventilation requirements for purifying, AC, or renewing the indoor air in a building or premises. They are usually installed on the roof of buildings and, through ducts, the air is circulated to reach each of the rooms in the building in question.[42]
- **FCU:** A ceiling-mounted fan coil unit (FCU) is a simple unit consisting of a heating or cooling coil and fan. It is part of a heating, ventilation, and air conditioning (HVAC) system found in residential, commercial, and industrial buildings. [43]
- **VRF:** A variable refrigerant flow (VRF) is a large-scale ductless HVAC system that can perform at high capacity.[44]

41. Based on market studies, available reports, and experts' interviews with stakeholders in MENA region countries.
42. Airtècnics, 'What is an air handling unit (AHU)?'
43. VTS, "Fan Coil Unit (FCU)."
44. Coley, *What is a VRF System?*

In terms of best available technologies, which refers to high-performance technologies already in the market and that are more environmentally friendly compared to other products and technologies, VRF systems are often highlighted as a solution for countries in the MENA region. VRF systems can serve in abundant applications from single-/multi-family houses to medium-scale commercial applications. It is worth noting that the comparably high charges of fluorinated refrigerants required for VRF systems can result in an environmental risk, as with all other technologies using synthetic refrigerants, if they are not appropriately disposed. There are other promising early front-runner technologies, but those have not been used at scale in the market yet or are still considered a niche product serving a specific demand.

Those early front runner technologies in MENA include indirect evaporative coolers, variable flow chillers, modular-central stations, and small-scale thermal storage systems with a few pilot projects in Dubai, Egypt, and Saudi Arabia.

There are currently only a few good practice examples in the region of sustainable AC solutions that do not use environmentally harmful fluorinated refrigerants (e.g. natural refrigerants) or are supplied with renewable energy. Two good practice examples of sustainable cooling solutions are shown on the following pages.

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MARKET AND TECHNOLOGY LANDSCAPE

"This example shows that we can achieve the same or even better efficiency with a natural refrigerant at high ambient temperatures up to 50°C."

Markus Offermann,
Guidehouse RAC technologies expert

Regional example: Propane outperforms R407C in test of rooftop AC units

Saudi Arabia

Recent tests by Petra Engineering Industries Co. have shown that the performance of large-capacity commercial packaged rooftop AC systems with the natural refrigerant R290 (propane) outperforms the HFC synthetic refrigerant R407C.[45] According to Petra, several prototype units were tested to compare the energy performance, cooling capacity, refrigerant charge amounts, and costs. After several performance optimisations, the company found that its 88-kW prototype (25 TR) using R290 delivered a 2%-4% improvement in cooling performance compared to R407C (as a drop-in) at four ambient temperatures (25°C, 35°C, 46.1°C, and 50°C). Energy efficiency also improved between 4% and 9.5% at the same four ambient temperatures. In terms of cooling capacity for a 185 kW (52.6 TR) prototype, an improvement of between 3% and 6% was observed using R290 at the above temperatures compared to R407C (drop-in). The energy efficiency ratio improvement ranged from 7%-11%.

The company also noted that its 88 kW prototype required only 4.5 kg (9.9 lbs) of R290 refrigerant, compared to 8.5 kg (18.7 lbs) for R407C. The 185 kW prototype required 4 kg of R290 refrigerant, compared to 7.5 kg for R407C. Although the cost of the R290 component is about 10% higher compared to using R407C, Petra says these price differences could be eliminated through future mass production.

KEY FACTS

- **2%-4% improvement in cooling performance**
- **4%-9.5% improvement in energy efficiency**
- **3%-6% improvement in cooling capacity**
- **7%-11% energy efficiency ratio improvement**
- **Costs of R290 component 10% higher**

45. Yoshimoto, *Propane Outperforms R407C.*

"The university buildings have been specifically constructed to utilise natural light and ventilation."

KAUST designers

KAUST's five strategies of innovative cooling:

1. Structured like traditional Arabic cities, the campus is compressed as much as possible to minimise the amount of exterior envelope exposed to the sun and reduce outdoor walking distances.
2. Shaded and passively cooled circulation thoroughfares like traditional souks or Arabic markets.
3. The monumental roof system that spans across building masses to block sun on building facades and the pedestrian spine, to facilitate natural ventilation and to filter light inspired by Arabic Bedouin tents.
4. Passive ventilation strategies of traditional Arabic houses influenced the design of solar-powered wind towers that harness energy from the sun and wind to passively create air flow.
5. Similar to Arabic screening called mashrabiya, the campus shades windows and skylights with an integral shading system that reduces heat loads while creating dramatic, dappled light.

Regional example: King Abdullah University of Science and Technology[46]

Saudi Arabia

The King Abdullah University of Science and Technology (KAUST), envisioned by the late King Abdullah as "a source of knowledge and a bridge between people and cultures", is a global institution for higher education.

KAUST campus represents a mega project with its own large-scale housing, schools, stadium, golf course, and hospital. The iconic solar towers that create a passive pressure difference are part of the employed space cooling system in the campus and contribute to energy savings.

The two solar towers use the energy of the sun along with prevailing Red Sea winds to create a natural ventilation effect that provides a high level of comfort throughout the year for people using the spine areas. Approximately one million square feet of conditioned space through the pedestrian spine was converted into a volume that is conditioned through passive means for most of the year.

KEY FACTS

- **Total built up area: 600,000 m^2**
- **ECMs[47]: Heat recovery and solar towers, the campus is LEED Platinum**
- **Energy savings: 130,000 MWh/year**
- **Greenhouse gas emission reductions: 85,000 tCO_2e/year**
- **Innovative mechanical cooling system with heat recovery units**

46. Archello, *King Abdullah University of Science and Technology*; King Abdullah University of Science and Technology, "Green Campus;" Solar Design Associates, "King Abdullah University of Science and Technology."
47. ECMs: Energy Conservation Measure

Finance landscape

Overview of financing landscape

The financial services sector mainly comprises banking, capital markets, and insurance sectors. In more than half of the MENA countries, the banking sector is stable, well developed, adequately capitalised, profitable, and resilient to shocks. The top 30 commercial banks in the region are based in the Gulf Cooperation Council (GCC) countries, Turkey, and Egypt. As of June 2021, the top 50 banks in the Middle East had total assets of EUR 2.3 trillion, which is more than three times the estimated GDP of Saudi Arabia, the largest economy in the region.[48] The Qatar National Bank (QNB Group), founded in 1964, is a Qatari multinational commercial bank headquartered in Doha, Qatar with an asset base of EUR 260 million.[49] QNB Group remained the largest bank by assets in the MENA region for the six consecutive years ending with 2021.[50]

Three out of the top four banks have achieved their scale of assets due to mergers. The banking sector in the MENA region is on the path of a consolidation phase.

Most of these banks serve a wide range of customers, including individual retail customers, micro, small and medium enterprises, large-scale companies, and multinational corporate establishments.

Services include savings, deposits, debit and credit cards, loans of different types (from individual loans to business loans), guarantee products, and allied services. Banks offer appliance loans and housing loans to retail/ individual customers and equipment credit to businesses.

48. Forbes Middle East, *Top 50 Banks in The Middle East*.
49. Howat, *Top 10 Largest Banks in the Middle East and Africa*.
50. S&P Global Market Intelligence. "News & Insights."

Business loans are provided for setting up new industrial projects, expansions, diversifications, and large infrastructure projects. Loan products are designed to suit a broad cross-section of businesses.

Financing of refrigeration and space cooling solutions includes a wide variety of products and depends on multiple variants. Refrigeration and space cooling products and services cover a broad cross-section of end-use sectors, and hence customer segments, such as the residential sector, commercial sector, agriculture and food, health and pharmaceuticals, and government/public sectors.

Financing sustainable cooling solutions offer climate change mitigation benefits in greater energy efficiency and lower greenhouse gas emissions.[51]

A broad cross-section of financing products such as loans, equity, and risk mitigation instruments such as guarantees are used depending upon the nature of the product and stage of the project.

Table 6: Overview of financing products available from different sources[52]

Sources of finance	Loans/Debt	Equity	Guarantees
Commercial banks	X		
Non-banking finance institutions	X		
Microfinance institutions	X		
National level finance institutions	X	X	
Bi/multilateral development banks	X(*)		X(*)
Private equity funds		X	
Guarantee agencies			X

((*) – Loans and guarantees are provided through intermediaries or governments and not directly to private customers or projects

Apart from commercial banks and local financial institutions, non-banking financing companies provide financing for cooling solutions. On the other hand, multilateral and bilateral development banks (also referred to as international financial institutions (IFIs)) provide loans and/or guarantees through intermediaries and governments, often at concessional interest rates. They also provide technical assistance and training to local financial institutions.

51. Sustainable Energy for All, *Financing Access to Cooling Solutions*.
52. Basel Agency for Sustainable Energy for UN Environment (BASE), *Manual of Financing Mechanisms*.

International financial institutions and programmes

The role of IFIs in sustainable development and sustainable energy financing in developing countries and transitional economies cannot be disputed. IFIs offer new products in the sustainability field such as renewable energy and energy efficiency. Such products promote sustainable development and help partner banks differentiate themselves. The most important characteristic of these institutions is high (AAA) credit ratings and a broad membership of borrowing and donor countries. These institutions operate independently but have shared objectives of poverty reduction and improving living conditions, promoting regional cooperation, and contributing to sustainable development.

IFIs focus on specific areas of development and have dedicated funds to support these areas. Some of these areas include energy efficiency and productivity improvement, circular economy, greening of the value chain, health, and infrastructure. IFIs also initiate regional programmes, initiatives, and dedicated funds to support regional agendas.

Figure 6 provides a list of countries in the MENA region and the respective IFIs that serve them. The IFIs include bilateral donors such as Agence Française de Développement (AFD) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), multilateral development banks (MDBs), and multilateral climate funds. It can be seen that France and Germany are the main bilateral donors to the region. Additionally, a variety of donors, France, Germany, the Netherlands, Sweden, and Japan, also channel their support to climate change mitigation and adaptation initiatives through the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), and multilateral climate funds, predominantly the Clean Technology Fund (CTF), and the Green Climate Fund (GCF).

The Islamic Development Bank also plays a role in climate change initiatives, co-financing projects with the EBRD and others. Each IFI has its own policy for grouping countries as per their focus regions. The EBRD focuses on the southern and eastern Mediterranean region and has become a key donor supporting a large number of projects across the region as well as large-scale projects in terms of the amount of finance required. The EBRD often partners with multilateral climate funds, including the GCF. In the MENA region, the African Development Bank (AfDB) provides financial assistance and services only to North African countries. Of these, Egypt and Morocco appear to be the preferred countries where the focus is notably on renewable energy and a limited number of projects related to climate change adaptation. Common topics addressed in such project include, for example, water resources and energy efficiency.

The MENA region is a crowded donor space due to its peculiar conditions and climate-sensitive geography.

While there are numerous development finance programmes and banks, we describe only a selection of these in the following paragraphs.

WB	World Bank
IBRD	International Bank for Reconstruction and Development
CTF	Clean Technology Fund
IFC	International Finance Corporation
AFD	Agence Française de Développement
AfDB	African Development Bank
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
KfW	Kreditanstalt für Wiederaufbau
GCF	Green Climate Fund
IsDB	Islamic Development Bank
JICA	Japan International Cooperation Agency
USAID	United States Agency for International Development
UNDP	United Nations Development Programme

Figure 6: List of IFIs in the MENA region

53. Cooper, *Donor Support For Climate Change*; Aid Atlas, "Explore global development finance;" Websites of IFIs and bilateral development agencies.

Table 7: Fragile and conflict-affected states

Yemen	Yemen has received support from the Least Developed Countries Fund with grants totalling EUR 14 million for two projects approved in 2013. Both of these are adaptation projects: one concerned with integrated water harvesting technologies, and one concerned with rural adaptation. • The United States Agency for International Development (USAID) is supporting access to water and sanitation. • GIZ supported the project Conservation and Sustainable Use of Biodiversity 2011–2018.
Iraq	• Major Development Assistance Committee donors are supporting water resources to restore access and support internally displaced persons. • USAID supports restoring critical infrastructure and services, including water and electricity, through its stabilisation support.
Syria	• Donor support to Syria primarily focuses on humanitarian and stabilisation activities, including providing essential services.
Libya	No multilateral climate finance projects are active in Libya, and key bilateral donors focus on stabilisation. • USAID's work in Libya focuses on stability with activities including democracy and governance, elections, public financial management, and humanitarian assistance. • GIZ's work focuses on municipal development and decentralisation, economic development and employment, dialogue processes in society, primary healthcare, and the political participation of young people. • GIZ is also supporting environmental laboratories to test drinking water quality.

EBRD

The EBRD was established in 1991, originally to help build and develop Central and Eastern Europe after the Cold War. It has played an essential role through investing almost EUR 150 billion in more than 6,000 projects. The EBRD promotes market-oriented economies and supports the entrepreneurial initiative, and it has been expanding its portfolio of countries and focusing on new areas (sectors) of operations.

The EBRD finances private-sector projects in the range of EUR 4.6 million to EUR 230.8 million in debt or equity. It extends its financial assistance to smaller projects through intermediaries or special programmes. A wide range of financial products include loans, equity, and guarantees. Apart from providing finance, the EBRD provides advisory services to small and medium-sized businesses for their success and growth.

EBRD *Green Cities initiative*

The **Green Cities** programme builds on the EBRD's proven track record in helping cities invest in sustainable municipal infrastructure.[54] Cities in the EBRD operational regions face challenges such as inadequate investment in urban infrastructure, solid waste management, poor air quality, demographic changes, and high energy and carbon intensity. Many cities in these regions are also particularly vulnerable to the impacts of climate change.

To address these challenges, the EBRD developed its Green Cities programme with a view to building a better and more sustainable future for cities and their residents.

The programme has three main components:

1. **Green City Action Plans (GCAPs):** The programme helps develop an action plan to prioritise environmental challenges. The programme works through policy interventions and sustainable infrastructure investments.
2. **Sustainable infrastructure investment:** This component facilitates and stimulates public or private green investments in water and wastewater, urban transport, district energy, energy efficiency in buildings, solid waste, and other interventions that improve the city's adaptation and resilience to climate shocks.
3. **Capacity building:** This component of the programme provides technical support to city administrators and local stakeholders to ensure that infrastructure investments and policy measures identified in GCAPs can be developed, implemented, and monitored effectively.

54. European Bank for Reconstruction and Development (EBRD) Green Cities, "About Green Cities."

World Bank

The International Bank for Reconstruction and Development (IBRD), a part of the World Bank Group institutions, is a global development cooperative owned by 189 member countries.

The IBRD is the most significant development bank in the world. It provides loans, guarantees, risk management products, and advisory services to middle-income and creditworthy low-income countries and coordinates responses to regional and global challenges.

The World Bank was formed in 1944 to help Europe rebuild after World War II. The International Development Association (IDA) provides interest-free loans (called credits) and grants to governments of the poorest countries.

The IBRD and IDA together form the World Bank, and they work closely with all institutions of the World Bank Group and the public and private sectors in developing countries to reduce poverty and build shared prosperity.

The World Bank has a broad cross-section of programmes and initiatives to support development areas and address climate change. The World Bank Group developed the Roadmap for Climate Action in the MENA region for the period 2021–2025, which aims to drive climate action and a green recovery in the region.

The roadmap outlines four key transformation areas to build low-carbon, resilient societies:

- Food systems, water security, and resilient natural capital
- Energy transition and low-carbon mobility
- Climate-smart cities and resilient coastal economies
- Sustainable finance for climate action

The roadmap builds on the World Bank's Climate Change Action Plan and commitment to boost climate action through the following proposed actions:

- The World Bank and IFC propose to invest EUR 9.2 billion to be used for climate-smart projects and policy reforms. It is expected this investment could leverage an additional EUR 1.8 billion through private-sector financing.
- The World Bank proposes to achieve a balance between investments in adaptation and mitigation. The World Bank Group envisages investing 50% of climate finance in interventions that help build resilience, guided by regional and country-specific demand.
- Integrating climate risk management
- Aligning financial flows with the Paris Agreement by fiscal year 2023.

The MENA roadmap unites climate action and development, strengthens institutions, overcomes barriers to private-sector engagement, fosters regional integration, and builds resilient and more inclusive societies.[55]

55. The World Bank, *Middle East & North Africa Climate Roadmap.*

National support programmes

Most of the countries in the MENA region include sustainability in their plans or constitutions. For example, sustainability is embedded in Morocco's 2011 Constitution, which describes sustainable development and environmental protection as fundamental rights for every citizen, alongside healthcare and social protection. Some countries have energy efficiency as their national priority policy, but energy finance and climate finance initiatives vary widely depending on national priorities. Table 8 provides an overview of sustainable finance practices in select countries of the MENA region.

The following paragraphs describe Bahrain's programmes and policies related to sustainable development finance and climate change finance.

Table 8: Sustainable finance practices in select countries of the MENA region[56]

	UAE	Egypt	Jordan	Morocco	Bahrain	Saudi Arabia
Sustainable development/green growth agenda	X	X	X	X	X	X
Sustainable finance framework	X	X	X	X	X	
ESG[57] guidelines	X	X	X	X	X	
Sustainability/ESG reporting	X	X	X	X	X	
Financial market innovations: green bonds	X	X		X		
Financial market innovations: Islamic bonds (conventional sukuk)	X	X	X	X	X	X
Sustainable finance awareness and educational initiatives	X	X	X	X	X	
Supportive regulatory framework: PPP[58] laws	X	X	X	X		X

The Kingdom of Bahrain launched its national policy framework in 2008 as one of the guiding principles of its Economic Vision 2030. This framework provides a strategy to support sustainable development and transition to a green economy. Vision 2030 proposes: a) increasing investment in technologies to reduce carbon emissions and pollution, b) improving energy efficiency, c) promoting the use of renewable energy, d) supporting green infrastructure, and e) encouraging the optimal use of water resources. Bahrain endorsed both its NEEAP and the National Renewable Energy Action Plan in 2017. These plans are aligned with international commitments under the Paris Agreement and UN Sustainable Development Agenda.

56. UNEP, *Promoting Sustainable Finance and Climate Finance.*
57. ESG: Environmental, social, and governance
58. PPP: Public-Private Partnerships

Most countries in the region are active in sustainable development and embed it in their respective national plans. Almost all countries listed above (except Saudi Arabia) have a sustainable finance framework.

Bahrain has more than 400 domestic, regional, and international licensed financial institutions, as it is a regional hub for the financial services industry and a global centre for Islamic finance. In the past few years, the financial sector has undergone a strategic transformation.

The Bahrain Association of Banks (BAB) established a permanent, sustainable development committee in 2018 to enhance the role of the banking sector and its contribution to sustainable development and economic growth. The committee promotes sustainable finance practices by increasing financial and investment flows to sectors such as sustainable energy, infrastructure, transport, green financing education, healthcare, and agricultural development.

The BAB signed a Memorandum of Understanding with the United Nations Development Programme (UNDP) in 2018 to promote sustainable finance practices in Bahrain. The BAB further proposes internalising sustainability into banks' operations and strategies by developing innovative green financing tools and disclosing and reporting on green activities.[59]

59. UNEP, *Promoting Sustainable Finance and Climate Finance*

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Climate finance

Thirteen climate funds were active in the MENA region during the period from 2003 to 2019. Climate finance from the multilateral climate funds in the MENA region during this period was concentrated on a small number of large projects, in the form of debts (on commercial terms) or concessional debts funded by the CTF.[60] The CTF is a multi-donor trust fund that promotes scaled-up financing for demonstration, deployment, and transfer of low-carbon technologies like renewable energy, energy efficiency, and clean transport in emerging market middle-income and developing economies.

The CTF has a financial corpus of about EUR 4 billion received through contributions by donors from Australia, Canada, France, Germany, Japan, Spain, Sweden, the United Kingdom, and the United States. CTF funding is deployed through MDBs including AfDB, ADB, EBRD, the AfDB, Asian Development Bank, EBRD, Inter-American Development Bank, and World Bank Group. The CTF has financed 19 country programmes and one regional programme with more than 90 individual projects all over the world. The CTF had approved a total of EUR 801 million in the MENA region for 13 projects in Egypt and Morocco and eight regional projects during the period from 2003 to 2019.

60. Watson and Schalatek, *Climate Finance Regional Briefing.*

The second largest multilateral climate fund supporting the MENA region is GCF. The GCF is an operating entity of the financial mechanism of the UN Framework Convention on Climate Change under the Paris Agreement. The GCF is the world's largest climate fund, mandated to support developing countries raise and realise their NDC ambitions towards low-emission, climate-resilient development pathways. The GCF is a legally independent institution and became fully operational in 2015. The GCF's Initial Resource Mobilisation in 2014 raised EUR 9.5 billion in pledges. As of 31 January 2022, 34 contributors have pledged EUR 9.2 billion for the first formal replenishment.

The GCF has supported three projects in Morocco for a total of EUR 90 million, two projects in Egypt with EUR 172 million, and one in Bahrain with EUR 2.1 million.

As of December 2021, the total amount of climate finance approved for GCF's more than 150 projects in the region was EUR 1.42 billion.[61] Most of the funding is for climate change mitigation projects. Mitigation projects mainly include energy efficiency and renewable energy projects. Egypt and Morocco have received the largest portions of approved funds. In addition to such multilateral climate funds, the MENA region also receives bilateral climate finance.

Table 9 provides the approved fund amounts for the top four funds in the MENA region (as per the approved amounts):

Table 9: Approved funds for climate finance in the MENA region from 2003 to 2021[62]

Top Funds Supporting MENA	(In USD millions)
Fund	**Amount approved**
Clean Technology Fund (CTF)	825.1
Green Climate Fund (GCF)	362.4
Global Environment Facility	152.1
Last Developed Countried Fund (LDCF)	44.1

61. Climate Funds Update, "Regions."
62. Ibid.

Regional example: The Morocco Sustainable Energy Financing Facility

The EBRD launched Sustainable Energy Financing Facilities (SEFFs) as part of its Sustainable Energy Initiative in 2006. The EBRD provided credit lines to financial institutions through these facilities, which provided debts to their business clients for investment in energy efficiency projects. The EBRD launched such facilities in 22 countries in 2006, to encourage businesses and individuals to invest in green and renewable energy. With the success of SEFF projects, the EBRD launched the programme in Morocco in 201463 in association with the AFD, KfW, EIB, and the European Union. The Morocco Sustainable Energy Financing Facility (MorSEFF) supports industrial companies' investments in energy efficient equipment.

Initially, Moroccan banks were reluctant to participate in MorSEFF, despite a supportive regulatory environment, a well-developed financial sector, and an excellent existing base of financing for small and medium-sized enterprises. Later, the Banque Marocaine du Commerce Extérieur (BMCE) and Groupe Banque Populaire joined the programme and the first disbursement took place in 2015.

KEY FACTS

- **275 credit officers and 40 local engineers trained**
- **EUR 109.5 million worth of financial assistance**
- **Extra of EUR 40 million injected by EBRD in 2018**

63. EBRD, "Morocco SEFF (MorSEFF)."

Subsequently, the programme trained more than 275 credit officers and 40 local engineers in energy efficiency and energy efficiency financing. MorSEFF provided financial assistance of more than EUR 109.5 million worth of financing through its partner financial institutions. In 2018, the EBRD injected an extra EUR 40 million into the facility and admitted one more partner bank to MorSEFF.[64]

64. Holmberg and Gaston-Mathé, *Developments – Paving the Way.*

Outlook


Nabil Shahin


James Walters

Opinion piece

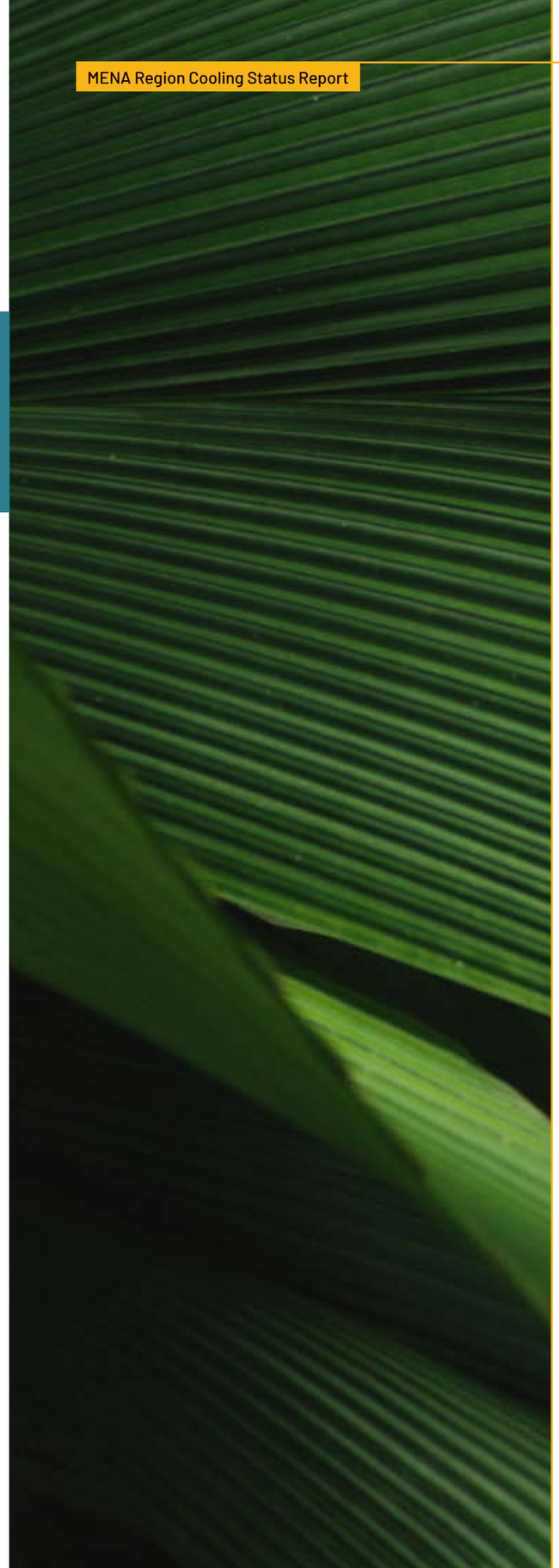
Interviewees:
Nabil Shahin and
James Walters (AHRI)

Nabil Shahin is the International Technical Director of AHRI and has 25 years of experience as an expert in RAC technologies and is currently based in the MENA region. James Walters is the Vice-President of International Affairs at AHRI.

AHRI is the Air-Conditioning, Heating, and Refrigeration Institute, a trade association representing manufacturers of HVACR and water heating equipment within the global industry. AHRI advocates on behalf of its members at all levels of government, working to ensure that members' interests are included in final drafts of legislation and regulations. AHRI also has a certification programme that is heavily relied upon by regulators and engineering consultants for accurate and unbiased evaluation of heating, water heating, ventilation, AC, and commercial refrigeration equipment. AHRI develops industry-recognised performance standards for industry equipment. These three pillars are at the core of a global organisation that is also viewed as a resource for industry shipment data, education and workforce information, refrigerant safe transition, and research. Lastly, AHRI believes in the importance of developing and marketing products that achieve increased energy efficiency and that decrease greenhouse gas emissions.

Guidehouse:
As an expert experienced in the region, what is your understanding and high-level perspective on sustainable cooling in the MENA region?

Nabil Shahin (AHRI):
As an effect of the oil crisis and also because electricity is still being partially subsidised in MENA countries particularly in GCC, the aim has been to basically tighten the belt on energy consumption and establish efficiency programmes for energy consumers such as air conditioning systems, which consume up to 70% of the total residential and commercial electricity in the MENA region. A lot of emphasis is also put on the energy and resource efficiency of lighting and other appliances, including water heaters, refrigerators, and washing machines. Recently GCC countries began removing subsidies on electricity to varying degrees. Saudi Arabia, for example is going in that direction. The UAE has already done it, except for the nationals of the country, which only comprise 11% of the population. Kuwait is still largely subsidising electricity, which makes it very cheap relative to the rest of the world. Qatar is also still subsidising its electricity, but only for nationals. The trend to lift subsidies is there and consumers and the industry are starting to feel it. As a result, the energy efficiency of products is becoming more important.



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In the air conditioning sector, we are working with standards established by national governments, which mostly adopt ISO and/or AHRI standards to establish rating, testing, and minimum energy efficiency levels. Establishing minimum energy efficiency standards began relatively recently in the MENA region, first by requiring energy efficiency labels on products such as HVAC, commercial refrigeration, and water heating systems. Recently, the seasonal energy efficiency ratio (SEER) is now in the focus for ACs, as it does not only evaluate the energy efficiency at one temperature point but rather the entire temperature range. For example, as a first step, Saudi Arabia is starting to require only SEER labelling, but not minimum SEER. Step 2 would be to establish minimum SEER. AHRI is working with multiple governments to help them with best business practices and market surveillance. There are already some municipalities or localities such as Abu Dhabi and Dubai, which have requirements in place that go beyond the federal or national requirements. They have also established programmes to provide rebates to consumers who buy highly efficient products. So there's a general direction and increased awareness regarding sustainability.

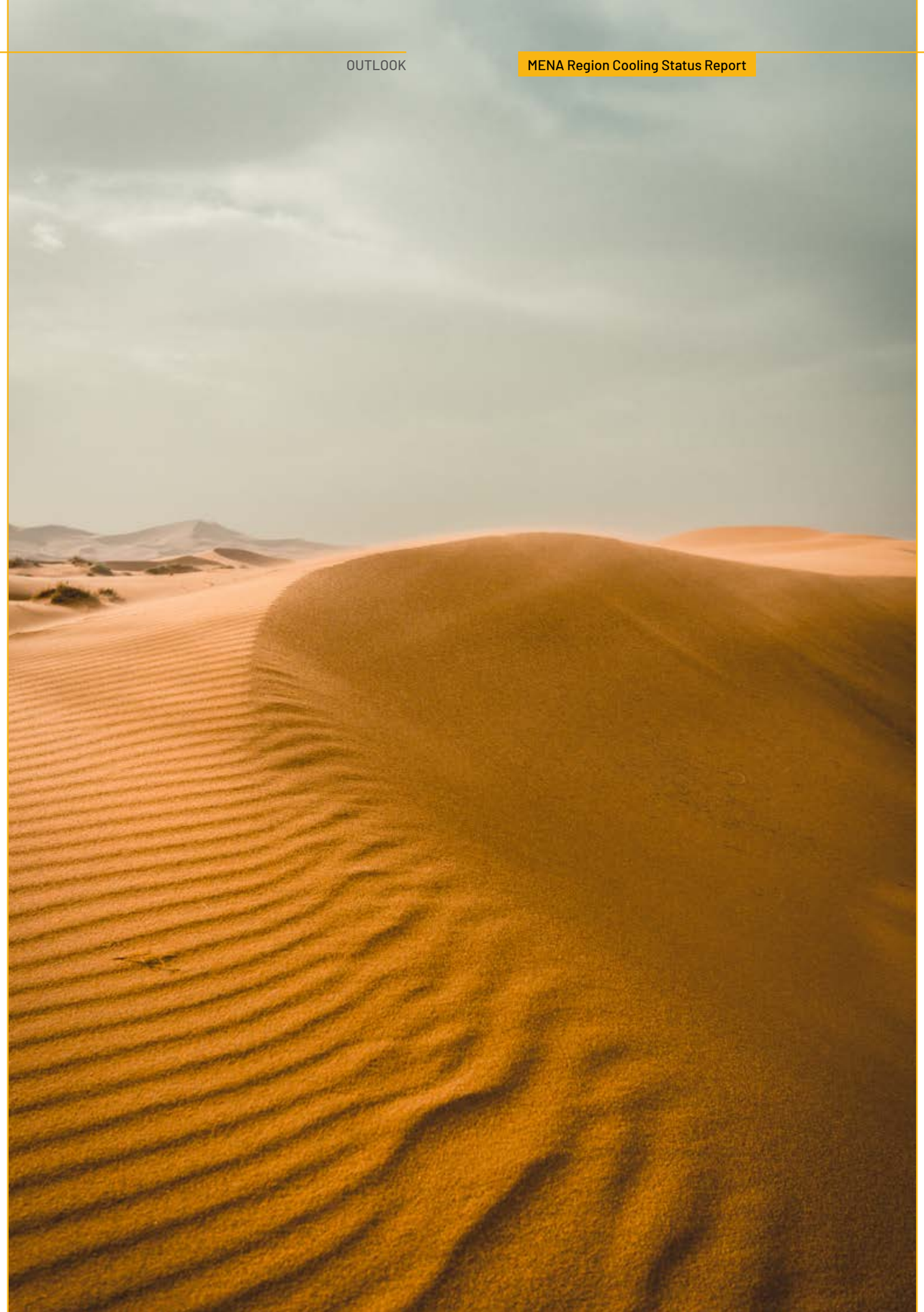
Guidehouse:
What is your personal perspective or AHRI's position as a global industry player in the MENA region and in the global cooling market? What do you think the cooling market will look like in five to ten years?

Nabil Shahin (AHRI):
In terms of cooling products such as air conditioners, this region has unique requirements. The design of air conditioners in this region is different than those sold in the rest of the world. The reason for this is that temperatures in the region can reach 52°C and capacity is usually just measured at high temperatures of around 46°C. Most of the companies that want to market and sell in this

region have to design special, high-ambient products. We also have local manufacturers. For example, in Saudi Arabia there are three local, major manufacturers as well as factories for international manufacturers. Also, in the UAE, there are a couple of major manufacturers and several mid-size manufacturers. Other MENA countries such as Bahrain, Kuwait, Jordan, and Egypt have several local and international manufacturers, as well. When these governments develop new regulations or standards, they are naturally sensitive about the needs of the local manufacturers.

As the technology evolves, we are moving towards inverter technology. Local manufacturers here are still a bit limited when it comes to these new technologies, although they strive to quickly adapt and adopt. So, we see a shift toward more highly energy efficient products that employ, for example, variable speed motors and advanced control systems compared to the conventional fixed speed, simple controls systems. The latest International Energy Agency report on the Middle East stated that there are 60 million air conditioning units installed, mostly in the GCC region, and that number is forecast to grow to 210 million by 2050. That is a huge increase, especially considering that in countries like Saudi Arabia the average energy efficiency of purchased ACs is close to the minimum, even though highly efficient systems are available on their local market. Again, governments realise that they need to work on consumer awareness, which is why they are beginning to implement energy efficiency awareness programmes and gradually raise minimum energy efficiency requirements.

Guidehouse:
Yes, exactly. The MENA region is in line with the global trend. The AHRI office is relatively new in the MENA region, right?



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Nabil Shahin (AHRI):
Yes, our presence in this region as an office is relatively new, but we have always been in touch with the governments due to the importance of the cooling sector in this region. Our Dubai-based team will help the industry address increasing regulatory requirements and demand for AHRI standards and certification programmes across the region.

Guidehouse:
What sustainability trends do you observe in the MENA region?

Nabil Shahin (AHRI):
The countries leading in such activities are Saudi Arabia and the UAE. They have many government initiatives to make consumers more aware of the energy savings they can achieve by adopting energy efficiency practices, in regards to both equipment and building envelopes. For example, Saudi Arabia has spent considerable effort on educating end users regarding roof insulation that can help them reduce their overall energy consumption. The UAE is probably the best in terms of building envelope. It has relatively strict requirements and codes on insulation, glass, and other building envelope energy efficiency measures and practices. Sustainable building projects are beginning to be take off in these countries. We are also noticing increased activities by green building organisations licencing more and more buildings in the residential and commercial sectors. Also new Energy Service Companies (ECSOs) are being established and are financing multiple projects in the region that have already yielded a substantial reduction in power consumption in UAE and Saudi Arabia. These focus mainly on replacing outdated HVAC equipment and LED lighting and paying for the cost of equipment from the savings or the difference in electricity consumption.

Guidehouse:
And how is the RAC market developing in terms of sustainability?

Nabil Shahin (AHRI):
In the air conditioner market, we see a big push toward inverter technology. Unlike in Europe, the market share for inverter technology in the MENA region is still very low, around 25% or less, but it is gaining importance. A lot of leading manufacturers are now heavily advertising the benefits of the new inverter technology such as VRF, which has grown its market share in recent years. The MENA region is also known for being a leader in the sustainable district cooling projects, especially in countries like UAE. District cooling is expected to continue to gain ground and spread to more countries across the region.

Guidehouse:
What about natural refrigerants? What do you see as the drivers for natural refrigerants?

Nabil Shahin (AHRI):
Currently there is not much know-how when it comes to new refrigerants in the region. AHRI is doing a lot of research on new refrigerants, including on high ambient temperature effects on the new refrigerant alternatives. It is a combined effort of manufacturers, testing bodies, governments, academia, and others. One important element for manufacturers in MENA is how the new refrigerant is going to behave under high ambient conditions because the local conditions are different than in the rest of the world. For some of these new refrigerants, at high ambient conditions, the capacity and efficiency both drop, so they have to take that into consideration. For example, when the switch was made from R22 to R410A, R22 was a better refrigerant when it came to high ambient conditions than R410A. This is one aspect that's important to local manufacturers. The other is that the region is in a kind of 'wait and monitor' mode to see where the US and Europe are going to head in terms of GWP levels, as well as what the major global manufactures will adopt as

new refrigerants. This is also dictated by major HVAC component suppliers, e.g., compressors, as no one in the region manufactures their own compressors. Currently, there is not much emphasis on natural refrigerants as this is influenced by economic factors among others. But their main concern, again, is how the refrigerant behaves in high ambient conditions. Other factors also have to be considered when choosing a new refrigerant, such as safety, flammability, toxicity, cost, availability, efficiency, capacity system pressure, and GWP values.

Guidehouse:
Is the mix of refrigerants to reach the targets of the Kigali Amendment discussed in countries of the region?

James Walters (AHRI):
Looking at the world from the MENA region, and considering that we still have 85 countries who come in later to possibly comply with Kigali, there's an inherent confusion. Article 5 countries watch what's going on in Europe and in the United States. The regulatory schemes and the political pressures behind those regulatory schemes are two very different things. For Article 5 countries, the question is which of those regions has the best solution. This difference in approach is a constant variable in how one approaches the issue of refrigerants. For example, consider that AHRI has members all across the globe. Our Asian members work both in Europe and the United States. Their approach to each market is often not determined by just the marketplace, but also by governmental regulations. This is a very important to keep in mind.

Another thing that occurs is that you often have an inherent conflict between climate change priorities and ventilation cooling priorities. For example, in the MENA region, where you have a great deal of money with new construction, you're often able to take a whole building approach, which would just be undoable in New York City, unless it were a new building. And if you see pictures of new apartments, you will most likely see room air conditioners and windows, one after another - not even mini splits. It really depends on the region that you're in.

Nabil Shahin (AHRI):
At the same time, there is not as much research to understand this issue in the MENA region as there is, for example, in the United States or Europe, so it's difficult to make an informed decision. The region is currently working on building their capacity in the governments and local organisations to where they can make their own decisions. This is a direction that we see in Saudi Arabia and UAE, for example, where they want to rely on national experts to make decisions, to be more informed, and to understand what's going on, but I think it will take time. There is a great deal of research on refrigerants happening at AHRI and in Europe. It doesn't conflict but a great deal depends on the attitude of each government, so we need to channel our efforts to education and awareness raising.

Guidehouse:
Thank you very much for your time.

References

Ahmadalipour, Ali, and Hamid Moradkhani. "Escalating Heat-Stress Mortality Risk Due To Global Warming In The Middle East And North Africa (MENA)." *Environment International* 117 (2018): 215-225. https://doi.org/10.1016/j.envint.2018.05.014.

Aid Atlas. "Explore global development finance." Stockholm Environment Institute (SEI), n.d. https://aid-atlas.org/.

Airtècnics, "What is an air handling unit (AHU)?" Accessed May 04, 2022. https://www.airtecnics.com/news/what-is-an-air-handling-unit-ahu.

Alkishriwi, Nouri. *Energy Efficiency Opportunity in Libya.* Mitigation Enabling Energy Transition in the MEDiterranean region (meetMED), October 3, 2018. https://meetmed.org/wp-content/uploads/2018/09/Energy-Efficiency-Opportunities-in-Libya-Nouri-Alkishriwi-REAoL.pdf.

Archello. *King Abdullah University of Science and Technology.* Archello Condiciones Intimidad, n.d. https://archello.com/es/project/king-abdullah-university-of-science-and-technology.

BASE. *Manual of Financing Mechanisms and Business Models for Energy Efficiency.* Basel Agency for Sustainable Energy (BASE), 2019. https://energy-base.org/app/uploads/2020/03/11.Manual-of-Financing-Mechanisms-and-Business-Models-for-Energy-Efficiency-2019.pdf.

Borghesi, Simone, and Ticci, Eisa. "Climate Change in the MENA Region: Environmental Risks, Socioeconomic Effects and Policy Challenges for the Future." *In IEMed Mediterranean Yearbook 2019*, 289-292. Barcelona, European Institute of the Mediterranean (IEMed), 2019. https://www.iemed.org/publication/climate-change-in-the-mena-region-environmental-risks-socioeconomic-effects-and-policy-challenges-for-the-future.

British Petroleum. *BP Energy Outlook – 2018 Edition.* © BP p.l.c., 2018. https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2018.pdf.

Climate Funds Update. "Regions." Accessed April 13, 2022. https://climatefundsupdate.org/data-dashboard/regions/.

Coley, Matt. *What is a VRF System? Top Myths and Facts About VRF Explained.* Ferguson, January 23, 2018. https://www.ferguson.com/content/trade-talk/tricks-of-the-trade/what-is-a-vrf-system.

Cooper, Rachel. *Donor Support For Climate Change in MENA.* Brighton, K4D Helpdesk Report, November 18, 2020. https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/15795/903_Donor_support_for_climate_change_in_MENA.pdf?sequence=1&isAllowed=y.

EBRD Green Cities. "About Green Cities." European Bank for Reconstruction and Development (EBRD). Accessed April 13, 2022. https://www.ebrdgreencities.com/about.

EBRD. "Morocco SEFF (MorSEFF)." European Bank for Reconstruction and Development (EBRD). Accessed April 13, 2022. https://www.ebrd.com/work-with-us/projects/psd/morocco-seff-morseff.html.

Economist Intelligence. *The Cooling Imperative. Forecasting the Size and Source of Future Cooling Demand.* The Economist Intelligence Unit, December 11, 2019. https://www.eiu.com/n/the-cooling-imperative/.

EPA. International Actions - *The Montreal Protocol on Substances that Deplete the Ozone Layer.* United States Environmental Protection Agency (EPA), February 26, 2020. https://www.epa.gov/ozone-layer-protection/international-actions-montreal-protocol-substances-deplete-ozone-layer.

Forbes Middle East. *Top 50 Banks in The Middle East*. June 16, 2021. https://www.forbesmiddleeast.com/lists/top-50-banks-in-the-middle-east/.

Holmberg, Anne-Sofia, and Mathilde Gaston-Mathé. Developments – *Paving the Way for Green Energy Financing in the Mediterranean.* DAI, November 15, 2019. https://dai-global-developments.com/articles/paving-the-way-for-green-energy-financing-in-the-mediterranean.

Howat, Evelyn. *Top 10 Largest Banks in the Middle East and Africa.* FinTech, January 13, 2022. https://fintechmagazine.com/top10/top-10-largest-banks-middle-east-and-africa.

IEA. "Cooling." International Energy Agency (IEA), 2021. https://www.iea.org/reports/cooling.

JRAIA. *World Air Conditioner Demand by Region.* The Japan Refrigeration and Air Conditioning Industry Association (JRAIA), 2019. https://www.jraia.or.jp/english/World_AC_Demand.pdf.

King Abdullah University of Science and Technology. "Green Campus." Accessed April 13, 2022. https://www.kaust.edu.sa/en/about/green-campus.

Kingdom of Bahrain. *National Energy Efficiency Action Plan (NEEAP).* Sustainable Energy Unit, Kingdom of Bahrain, 2017. https://www.sea.gov.bh/wp-content/uploads/2018/04/02_NEEAP_full-report.pdf.

Ministry of Energy. "Saudi Energy Efficiency Program." Accessed April 13, 2022. https://www.moenergy.gov.sa/en/OurPrograms/SPFEE/Pages/Initiatives.aspx.

Offermann, Markus, Berhard von Manteuffel, Julia Blume, Daniel Kühler. „Klimaschonende Klimatisierung (Heizen und Kühlen) mit natürlichen Kältemitteln – Konzepte für Nichtwohngebäude mit Serverräumen/Rechenzentren." Umweltbundesamt (2016) https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/climate_change_18_2016_klimaschonende_klimatisierung_0.pdf

Ozone Secretariat. *Vienna Convention and its Montreal Protocol.* United Nations Environment Programme (UNEP), March 31, 2017. https://sustainabledevelopment.un.org/index.page=view&type=30022&nr=603&menu=3170.

Ozone Secretariat. *Kigali Amendment Hits Milestone 100th Ratification, Boosting Climate Action.* United Nations Environment Programme (UNEP), July 14, 2020. https://ozone.unep.org/kigali-amendment-hits-milestone-100th-ratification-boosting-climate-action.

Prescient & Strategic Intelligence. "Saudi Arabia HVAC Market Research Report: By Offering (Equipment, Service), End-User (Commercial, Industrial, Residential) – Industry Revenue Estimation Report, 2022-2030." P&S Intelligence, 2022. https://www.psmarketresearch.com/market-analysis/saudi-arabia-hvac-market.

RCREEE. *Overcoming Challenges in Preparing the Second Phase of the National Energy Efficiency Action Plan in Algeria.* Regional Center for Renewable Energy and Energy Efficiency's (RCREEE), n.d. https://www.rcreee.org/events/overcoming-

MENA Region Cooling Status Report OUTLOOK

challenges-preparing-second-phase-national-energy-efficiency-action-plan-algeria.

Shaheen, Lotus. *First District Cooling Regulation in the MENA Region.* Solarthermalworld, November 18, 2019. https://solarthermalworld.org/news/first-district-cooling-regulation-mena-region/.

Solar Design Associates. "King Abdullah University of Science and Technology." Accessed April 13, 2022. http://solardesign.com/portfolio/king-abdullah-university-science-technology/.

Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). "Climate Change 2007: The Physical Science Basis." Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press (2007) https://www.ipcc.ch/report/ar4/wg1/

Sustainable Energy for All. *Financing Access to Cooling Solutions.* March 31, 2020. https://www.seforall.org/data-and-evidence/financing-access-to-cooling-solutions.

Sustainable Energy for All. *National Cooling Action Plans.* May 5, 2021. https://www.seforall.org/data-stories/national-cooling-action-plans.

S&P Global Market Intelligence. "News & Insights." Accessed April 21, 2022. https://www.spglobal.com/marketintelligence/en/news-insights/ [permission required to access page].

The World Bank. *Middle East & North Africa Climate Roadmap.* World Bank Group, January 25, 2022. https://www.worldbank.org/en/region/mena/publication/middle-east-north-africa-climate-roadmap.

Theodoridi, Christina. *Senate to Consider Kigali Amendment Ratification.* NRDC, November 16, 2021. https://www.nrdc.org/experts/christina-theodoridi/senate-consider-kigali-amendment-ratification.

TrendEconomy. *Saudi Arabia | Imports and Exports | World | Air Conditioning Machines, Comprising a Motor-Driven Fan and Elements for Changing the Temperature and Humidity | Value (US$) and Value Growth, YoY (%) | 2009 - 2020.* November 14, 2021. https://trendeconomy.com/data/h2/SaudiArabia/8415.

TrendEconomy. *United Arab Emirates | Imports and Exports | World | Air Conditioning Machines, Comprising a Motor-Driven Fan and Elements for Changing the Temperature and Humidity | Value (US$) and Value Growth, YoY (%) | 2009 - 2020.* November 14, 2021. https://trendeconomy.com/data/h2/UnitedArabEmirates/8415.

UN Climate Change. *Nationally Determined Contributions (NDCs).* United Nations, n.d. https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs.

UNDP. *Guidance for Integrating Efficient Cooling in National Policies in Lebanon.* United Nations Development Programme (UNDP), May 19, 2021. https://www.lb.undp.org/content/lebanon/en/home/library/guidance-for-integrating-efficient-cooling-in-national-policies-.html.

UNEP. *Promoting Sustainable Finance and Climate Finance in the Arab Region.* United Nations Environment Programme (UNEP), 2021. https://www.unepfi.org/publications/climate-change-publications/promoting-sustainable-finance-and-climate-finance-in-the-arab-region-2/.

UNEP. *The Kigali Amendment to the Montreal Protocol: HFC Phase-Down.* OzonAction Fact Sheet. United Nations Environment Programme (UNEP), 2016. https://wedocs.unep.org/bitstream/handle/20.500.11822/26589/HFC_Phasedown_EN.pdf?sequence=1&isAllowed=y.

UNIDO. *75th ExCom, Feasibility Study District Cooling in Egypt - New Capital (Cairo).* United Nations Industrial Development Organization (UNIDO), 2019. https://open.unido.org/api/documents/14633373/download/75th%20ExCom,%20Feasibility%20Study%20District%20Cooling%20in%20Egypt%20-%20New%20Capital%20(Cairo)%20-%20Project%20Document.pdf.

Velders, Guus J.M., David W. Fahey, and John S. Daniel. "Hydrofluorocarbon (HFC) Scenarios, Climate Effects and the Montreal Protocol." In *AGU Fall Meeting Abstracts* Vol. 2016 (2016): A41J-02. https://ui.adsabs.harvard.edu/abs/2016AGUFM.A41J..02V/abstract.

Velders, Guus J.M., David W. Fahey, John S. Daniel, Stephen O. Andersen, and Mack McFarland. "Future Atmospheric Abundances and Climate Forcings from Scenarios of Global and Regional Hydrofluorocarbon (HFC) Emissions." *Atmospheric Environment* 123, Part. A (2015): 200-209. https://doi.org/10.1016/j.atmosenv.2015.10.071.

VTS. "Fan Coil Unit (FCU)." Accessed April 13, 2022. https://vtsgroup.com/fan-coil-unit-fcu.

Watson, Charlene, and Liane Schalatek. *Climate Finance Regional Briefing: Middle East and North Africa.* Climate Funds Update, 2019. https://climatefundsupdate.org/wp-content/plugins/download-attachments/includes/download.php?id=5206.

Xu, Yangyang, Durwood Zaelke, Guus J.M. Velders, and Veerabhadran Ramanathan. "The Role of HFCs in Mitigating 21st Century Climate Change." *Atmospheric Chemistry and Physics* 13, no. 12 (2013): 6083-6089. https://doi.org/10.5194/acp-13-6083-2013.

Yoshimoto, Devin. *Propane Outperforms R407C in Test of Rooftop AC Units.* Accelerate24.news, July 16, 2020. https://accelerate24.news/regions/global/propane-outperforms-r407c-in-test-of-rooftop-ac-units/2020/.

ZAWYA. "Abu Dhabi's District Cooling Regulatory Framework Activated." April 15, 2021. https://www.zawya.com/en/press-release/abu-dhabis-district-cooling-regulatory-framework-activated-jusynsy0.

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