



COOLING SECTOR STATUS REPORT TÜRKİYE

Analysis of the current market structure, trends, and insights on the refrigeration and air conditioning sector

December 2022



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Acronyms and Abbreviations

AB	Arab Bank
AC	Air conditioning
BSRIA	Building Services Research and Information Association
CAGR	Compound annual growth rate
CBJ	Central Bank of Jordan
CFC	Chlorofluorocarbons
CLASP	Collaborative Labelling and Appliance Standards Program
CO ₂	Carbon dioxide
COP	Coefficient of performance
DC	District cooling
EBRD	European Bank for Reconstruction and Development
ECA	Export Credit Agency
EE	Energy efficiency
EER	Energy efficiency ratio
EPBD	Energy Performance of Buildings Directive
EUR	Euro
GAM	Great Amman Municipality
GCI	Green Cooling Initiative
GDP	Gross domestic product
GHG	Greenhouse gas
GWP	Global warming potential
HAMCO	Household Appliances Manufacturing Company
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HFO	Hydrofluoroolefin
IEA	International Energy Agency
IFI	International Financing Institution
IKI	International Climate Initiative
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
JAB	Jordan Ahli Bank
JCS	Jordan Catering Supplies
JD	Jordan Dollar

JLGC	Jordan Loan Guarantee Corporation
JREEEF	Jordan Renewable Energy & Energy Efficiency Fund
kW	Kilowatt
LC	Letter of credit
m ²	Metres squared
MEMR	Ministry of Energy and Mineral Resources
MENA	Middle East and North Africa
MEP	Mechanical, engineering, and plumbing
MEPS	Minimum Energy Performance Standards
MP	Montreal Protocol
MT	Metric ton
Mtoe	Million tonnes of oil equivalent
MW	Megawatt
NCCAP	National Climate Change Action Plan
NDC	Nationally Determined Contributions
NEEAP	National Energy Efficiency Action Plan
NOU	National Ozone Unit
NPL	Non-performing loan
ODS	Ozone-depleting substance(s)
PHC	Privatization Holding Company
PTAC	Packaged terminal air conditioning (unit)
R1234ze	HFO-1234ze (unsaturated HFC, hydrofluoroolefin)
R134a	HFC-123a (tetrafluoroethane)
R22	HCFC-22 (chlorodifluoromethane)
R290	HC-290, Propane (hydrocarbon)
R32	HFC-32 (difluoromethane)
R404A	Mixture composed of HFCs: R143a (trifluoroethane), R125 (pentafluoroethane), R134a (tetrafluoroethane)
R407C	Mixture composed of HFCs: R32 (difluoromethane), R125 (pentafluoroethane), and 1,1,1,2-tetrafluoroethane
R410A	Mixture composed of HFCs: R32 (difluoromethane) and R125 (pentafluoroethane)
R600a	HC-600a, Isobutane (hydrocarbon)
R717	NH ₃ -717, Ammonia (natural refrigerant)
R718	Water (natural refrigerant)
R744	Carbon dioxide
RAC	Refrigeration and air conditioning

RCREEE	Regional Center for Renewable Energy and Energy Policy
RE	Renewable Energy
RTOC	Refrigeration, Air-Conditioning and Heat Pumps Technical Options Committee
R&D	Research and development
SME	Small and Micro Enterprises
TKB	Development Investment Bank of Türkiye
TSKB	Industrial Development Bank of Türkiye
UAC	Unitary Air Conditioning
UK	United Kingdom
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
US	United States
VRF	Variable refrigerant flow
W	Watt

1. Introduction

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

1.1. The Cool Up programme

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

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

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

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

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

The programme is divided into three pillars:

- ▶ Policy and regulation
- ▶ Technology and markets

¹ British Patrol 2018

- ▶ Financing and business models

1.2. Aim and scope of this report

This cooling sector status report is part of a series of reports produced by the Cool Up programme. It aims to provide an overview of the cooling sector, laying the foundation for further work to be used within the programme and to facilitate informed decision makers for all public and private sector stakeholders.

In the partner countries—Egypt, Jordan, Lebanon, and Türkiye—detailed cooling market studies, which are needed to understand the status quo and transform the AC and cooling market sustainably, are hardly available.

This cooling sector status report presents a compilation of the limited data available on the focus sectors,² specifically AC in residential and non-residential buildings and commercial refrigeration in non-residential buildings. While this report focuses on those sectors, for completeness, it briefly summarises the current policy landscape and outlines several types of policies and regulations (e.g., international protocols, national strategies, laws and standards, and code policy) as well as the finance landscape. The Cool Up programme will be detailing these programme components further in separate reports.

The report is structured as follows:

- ▶ **Chapter 2** provides a brief country overview, followed by high level summaries of the policy and the financial sectors.
- ▶ **Chapter 3** gives an overview about the measures that were used to guide Cool Up's activities including clarity in definitions, data scope, and limitations of the study.
- ▶ **Chapter 4** summarises the main findings of this report.
- ▶ **Chapters 5 and 6** focus on the sector status of the AC and the commercial refrigeration markets, presenting data on the building stock and market potential, market characteristics, and developments.
- ▶ **Chapter 7** discusses typical refrigerants used in the country.
- ▶ **Chapter 8** provides insights on the relevance of natural refrigerants, the importance of maintenance, and key factors that impact a purchase decision.

1.3. Kigali Amendment

Most cooling systems rely on refrigerants with high global warming potential (GWP), leading to high direct emissions from refrigerant leakage. Adopted in 1987, the Montreal Protocol phases out consumption and production of ozone-depleting substances (ODS)—most notably hydrochlorofluorocarbons (HCFCs)—in a stepwise manner, with different timelines for developed and developing countries (referred as Article 5 countries). Recognising the threat of fluorinated gases, hydrofluorocarbons (HFCs), to global climate change, in 2016, the international community decided in Kigali (Rwanda) on an amendment to the Montreal Protocol. The Kigali Amendment entered into force on 1 January 2019 and implements a global HFC phase-down to reduce HFC production and consumption by more than 80% over the next 30 years.

For the Cool Up partner countries—Egypt, Jordan, Lebanon, Türkiye³—the same HFC phase-down schedules apply under the Kigali Amendment (see **Table 1**).

² This report is not a part of national government reporting work under the Montreal Protocol; it does not present an official baseline report and it is not part of an HFC inventory.

³ These countries are considered developing (Article 5) countries under the Montreal Protocol. Article 5 countries follow different phase-out schedules than industrialized countries.

The baseline is determined as the country's average consumption of HFCs for 2020, 2021, and 2022 plus 65% of the baseline for HCFCs.

Table 1: Schedule of phase-down of HFC consumption in Cool Up partner countries

Steps	Reduction schedule
1	Freeze 100% of the baseline for 2024-2028
2	Phase down by 10% of the baseline for 2029-2034
3	Phase down by 30% of the baseline for 2035-2039
4	Phase down by 50% of the baseline for 2040-2044
5	Phase down by 80% of the baseline for 2045

The upcoming years represent numerous opportunities and challenges for cooling sector conversions and the introduction of sustainable and future-proof alternatives to ODS and HFCs.

In many countries in past years, HCFC replacement led to the introduction of HFCs in major cooling applications. However, with the reduction schedule for HFCs in the Kigali Amendment, HFCs no longer represent a sustainable alternative to ODS. Enabling the uptake of sustainable alternatives, such as natural refrigerants, prevents a switch from HCFCs to HFCs and from HFCs to environment friendly low GWP alternatives. This direct replacement early in the transition process is called leap frogging and creates opportunities for emissions reductions, energy savings, and investments in future-proof technology.

In the last decade, natural refrigerants and climate-friendly measures (referred as not-in-kind technologies⁴) have been researched extensively. Examples of such not-in-kind technologies are being commercially introduced worldwide (e.g., passive cooling of buildings). Additionally, technical solutions to boost system efficiency have been identified and established for applications relying on natural refrigerants.

⁴ Systems that do not rely on a vapor compression cycle using a gaseous refrigerant.

2. Overview

2.1. Setting the scene

Türkiye's energy consumption has steadily increased across all sectors, reaching 103 Mtoe in 2018 and contributing to net GHG emissions of 422.1 MtCO₂e (carbon dioxide) in 2019.⁵ In 2018, electricity demand in the residential and public and commercial sector combined accounted for 48% of Türkiye's total electricity consumption.⁶ Türkiye's efforts to phase-out ODS emphasise why it is an important, emerging actor for the European and Middle East heating, ventilation and air conditioning (HVAC) markets.

2.2. Macroeconomic overview

Türkiye has a GDP of 719.496 billion EUR⁷ or EUR 9,619 per capita in 2021.⁸ It imports the majority of its energy needs, 75% as of 2015, with natural gas making up the largest share of that.⁹ This high level of import dependence has moved Türkiye to diversify its energy supply, investing heavily in renewable energy (RE), tripling RE generation in the last decade, and investing in three new nuclear power plants.¹⁰

2.2.1. Electricity Consumption

In Türkiye the residential sector accounts for around 21% of total electricity consumption (2018), making it the third largest consuming sector behind industry (44%) and services (33%).¹¹ Electricity made up the bulk of energy consumption in the building sector at 52%, with fossil fuels (for cooking and heating) making up the rest.¹² Heating and cooling make up over one third of the energy used in buildings.¹³ The following table illustrates the distribution of electricity consumption in 2021.

⁵ International Energy Agency: County Report Türkiye. International Energy Agency. Available online at <https://www.iea.org/countries/turkiye>

⁶ International Energy Agency: Data & Statistics. International Energy Agency. Available online at <https://www.iea.org/data-and-statistics>

⁷ All data given in USD in the original source has been converted to EUR. 1 USD has been converted to 0.9993 EUR, based on European Central Bank, "Euro foreign exchange reference rates," at the time of publication.

⁸ World Bank: "Türkiye Country Context" (2022). <https://www.worldbank.org/en/country/turkey/overview>

⁹ World Bank: "Energy imports, net (% of energy use) – Türkiye" (2015). <https://data.worldbank.org/indicator/EG.IMP.CON.S.ZS?end=2015&locations=TR&start=1960&view=map&year=2015>

¹⁰ International Energy Agency (IEA): "Türkiye 2021: Energy Policy Review" (2021). https://iea.blob.core.windows.net/assets/cc499a7b-b72a-466c-88de-d792a9daff44/Turkey_2021_Energy_Policy_Review.pdf

¹¹ Ibid (same source as above)

¹² Patricolo, Claudia: "How Turkey is decarbonising its largest energy-consuming industry: the building sector" (2021). <https://ceenergynews.com/climate/how-turkey-is-decarbonising-its-largest-energy-consuming-industry-the-building-sector/>

¹³ Energypedia: "Turkey- Energy Efficiency in Buildings". https://energypedia.info/wiki/Turkey-_Energy_Efficiency_in_Buildings#cite_note-Assosiation_for_Energy_Efficiency:_http_.2F.2Fwww.enver.org.tr.2Fmodules.2Fmastop_publish.2F.3Ftac.3D17-2

Table 2: Distribution of electricity consumption in 2021 by sectors¹⁴

Sector	Electricity consumption (kWh)	Ratio	Net ratio (%) *
Industry	111,572,993,760	34%	44%
Losses	76,600,098,110	23%	-
Commercial buildings	61,360,984,470	19%	24%
Residential buildings	31,337,914,720	19%	24%
Agricultural irrigation	13,359,192,730	4%	5%
Lighting	5,402,816,210	2%	2%
Total	329,634,000,000	100%	100%

* The orange figures are for the case after the losses are distributed.

In the last two years electricity consumption in Türkiye has plateaued, mainly due to the corona crisis, after a growth rate of over 5% yearly for the period from 2010-2018.¹⁵ Demand, however, is expected to continue to grow yearly between 2.8% and 4.7% (base case) between 2021 and 2030.¹⁶

Electricity demand is primarily driven by the following:¹⁷

- ▶ Economic growth and increased industrial output
- ▶ Increases in population
- ▶ Increases in wealth and living standards
- ▶ Efficiency in electricity use
- ▶ Electrification, for example increase in electric heating in households or increase in number of electric vehicles
- ▶ Government policies

2.2.2. RAC Sector Emissions

The share of direct emissions from the building sector is 14.5% of energy related CO₂ emission, stemming from burning fuels for heating and cooking, while indirect emissions for cooling and electrical appliances account for 13.48% of energy related emissions.

The Green Cooling Initiative (GCI) has developed an online model that provides RAC sector-specific data on installed technologies, sales, and emissions (and saving potential).¹⁸ The model categorizes 67% of overall RAC sector emission as indirect emission and 33% as direct ones. Of the RAC sector emissions,

¹⁴ T.C. ENERJİ PİYASASI DÜZENLEME KURUMU 2022

¹⁵ Enerdata: "Turkey country Information". <https://www.enerdata.net/estore/energy-market/turkey/>

¹⁶ PWC: "Overview of the Turkish Electricity Market for the Presidency of the Republic of Türkiye Investment Office" (2021). <https://www.invest.gov.tr/en/library/publications/lists/investpublications/overview-of-turkish-electricity-market.pdf>

¹⁷ Ibid

¹⁸ Green Cooling Initiative: "Türkiye" (2021). <https://www.green-cooling-initiative.org/country-data#!country-data-sheet/792/all-sectors>

the model allocates the largest share to mobile AC (passenger cars) at 34%, followed by commercial refrigeration (26%) and commercial and residential AC (13%) (see **Figure 1**). The rest of the sector emissions are attributed to commercial and residential chillers (6%), domestic refrigeration (12%) and others such as industrial and transport refrigeration (9%).¹⁹

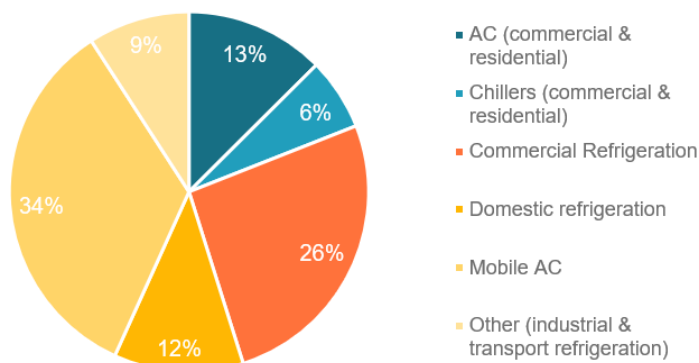


Figure 1: RAC sector emissions Türkiye (2016)

2.3. Policy landscape

Türkiye approved ratification of the Kigali Amendment in March 2021 and ratified on 10 November 2021.²⁰ The country has progressed in meeting its commitments relevant to the Montreal Protocol and its amendments through implementing several programs, laws, and other policy instruments such as codes and standards. For the regulatory analysis, the policy instruments governing the RAC and building sector in Türkiye were analysed to identify the key strengths and areas for improvement in phasing down HFCs, using natural refrigerants and reducing cooling demand.

The regulatory analysis shows that Türkiye has reached ODS and HCFC consumption limits as required by the Montreal Protocol phase-out schedule, but that this achievement has also resulted in an increase in HFC consumption. Türkiye has elaborated many national plans that contribute to reducing the consumption of ODS and HFCs, as well as increasing energy efficiency (EE) and cooling demand reduction. Specific plans include the National Climate Change Action Plan (NCCAP) 2011 – 2023 (2012), the Energy Efficiency Strategy (2012), the National Renewable Energy Action Plan for Türkiye (2014), the National Energy Efficiency Action Plan (NEEAP) 2017 – 2023 (2018), and Türkiye's Intended Nationally Determined Contribution (INDC) (2015), which will need to be updated to be in-line with the Paris Agreement. However, Türkiye has not developed a National Cooling Plan to integrate cooling aspects in Türkiye's overall climate strategies. Cooling is only specifically addressed in the NEEAP in Goal B which highlights the potential of "increase[ing] energy savings and the use of RE for heating & cooling by switching to central and district heating systems in mass housing complexes and large settlement units." Policies implementing these switches have not yet been specifically planned or executed.

Türkiye has also developed national legislation that covers multiple aspects of the ODS phase-out and HFC phase-down such as the regulation on Substances that Deplete the Ozone Layer which has been

¹⁹ Ibid

²⁰ United Nations Treaty Collection

implemented.²¹ The ODS phase-out schedule has been successfully implemented, import of HCFCs are already banned and according to the Art.6 (4)b of national ODS regulation, as of 1 January 2025, the use of R-22 in servicing will be banned either.²² This regulation is fully compliant with the Montreal Protocol-Kigali Amendment and with the EU Regulation 517/2014. The *Communiqué on the Certification of Natural and Legal Persons Who Intervene in Equipment Containing Fluorinated Greenhouse Gases or Operating Based on these Gases* sets standards for those who intervene in equipment containing fluorinated gases in force.

Türkiye has also taken a systemic approach to addressing EE and climate policy through adopting the Energy Efficiency Law in 2007 (last updated in 2019) and largely harmonising its building and product efficiency standards with the corresponding European Union (EU) Directives including the Directive on Energy Performance of Buildings Regulation (EPBD) (2017), the Regulation on Environmentally Friendly Design of Energy-Related Products (2010, revised in 2021) and the Regulation on labelling and standard product information of the consumption on energy and other resources by energy-related product (2011, revised in 2021). Most existing laws are well enforced and implemented but there is room for improvement in implementing measures to ensure results reporting, setting targets, and measuring target achievement. In addition, Türkiye is currently drafting a Climate Law to regulate climate change under a single piece of legislation that outlines a net zero target for 2053. At the level of standards and Minimum Energy Performance Standards (MEPS), there are several well elaborated MEPS and labels for most RAC appliances and buildings, most of which are also harmonised with EU standards. There is room for improvement to regularly review and strengthen MEPS as well as ensure MEPS and labelling policies are updated in line with future revisions of the EU Eco-design, Labelling and EPBD Frameworks.

Additionally, there are other barriers such as safety concerns related to the use of F-gas alternatives which should be addressed through awareness raising and capacity building. The level of awareness about natural refrigerants is not at desired levels amongst different stakeholders and therefore more awareness activities are needed.

Based on this analysis, some key policy recommendations have been derived to support the preparation of policy frameworks that guide the transition towards sustainable cooling and natural refrigerants use. There is a detailed report with full analysis and policy recommendations available on the [Cool Up website](#).

2.4. Finance landscape

Türkiye has a well-developed financial system of 55 banks out of which 34 are deposit/commercial banks, 15 are development banks and 6 are participation banks. Banks in Türkiye are the primary funding source for both the public and private sectors and have a capital adequacy ratio of 18.34%, well above the prudential requirement of 12%. According to the data published by the Banking Regulation and Supervision Agency, as of December 2021, the banking sector total assets have increased by 50.9% in nominal terms but only 16% in real terms net of year-over-year 2020 inflation of 36.08%. Traditionally, deposits dominate the funding structure of Türkiye's banking sector. To finance rapidly growing loans, the sector went for alternative funding sources from abroad as well as supporting its resource structure with the issuance of financial securities in 2020. The Non-Performing Loan (NPL) ratio that was 5.37% as of 2019 decreased to 4.08% in 2020 year-end by the support of the accelerated increase in the loan volume in 2020. The NPL ratio continued to decline gradually to become 3.16% as of the end of 2021. This shows that Türkiye's banks have good recovery rates.

²¹ European Parliament; Council of the European Union (9/16/2009): Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer (recast)

²² Ibid.

Türkiye has well-developed value chain for refrigeration and air conditioning systems with strong backing of commercial banks, and development financial institutions. Türkiye imports refrigerants, components, specialized RAC equipment (e.g., absorption chiller and freeze dryers) and ready assembled room air conditioners. Nearly all commercial banks in Türkiye offer Letter of Credits (LCs) to importers. In addition, loans are provided by foreign export credit agencies (ECA) where the importer's country risk is insured, offer long-term buying opportunities to importers.

Most Türkiye's commercial banks offer finance for manufacturing activities including new projects to working capital finance. Similarly, renovation of an existing plant and modernisation of the present machinery and equipment is financed through long-term loans. International Financial Institutions (IFIs) also offer specialized debts through their programmes and initiatives implemented through local commercial banks or institutions. Average tenure for medium to long-term loans may vary among banks but it is generally 7 to 10 years with grace periods of 2 to 3 years. Commercial banks also offer specialized/customised loans to Small and Medium-Sized Enterprises (SME) units. Leasing companies do offer services for equipment leasing to manufacturers.

The EU is the biggest export market for Türkiye. The white goods imported from Türkiye constitute 15% of the total import of EU as of 2019. Distribution of goods could be a significant part of the operation for corporate manufacturer firms with a huge sales volume, countrywide sales and exports. As far as financing of exports are concerned. Local commercial banks and Turk Eximbank, a specialized institution for trade finance that generally provide trade finance for exports. Turk Eximbank supports exporters, export-oriented manufacturers, overseas investors and contractors and companies conducting businesses that bring foreign currency earnings through short, medium, and long-term cash and non-cash loans.

As far as the direct distribution of HVACs for residential sector is concerned, manufacturers may make bulk sales directly or through wholesaler distributors to construction companies that make mass real estate development projects throughout Türkiye. Regarding the distribution stage of RAC products for commercial sector in addition to wholesaler distribution companies, manufacturers can sell directly to big corporate customers/buyers that operate as chain gross markets, private hospital chains, hotel chains, malls etc. Wholesaler distribution companies and, companies that make bulk purchases directly from manufacturers finance themselves through commercial banks, credit lines provided by IFIs and distributed via commercial banks. In that sense, in Türkiye working capital financing needs for selling expenses of both corporate, SME manufacturers and distributors are provided by local commercial banks in the form of working capital loans.

Retailers are the final link in the supply chain from producers to consumers. Retail sale operations result in receipt of cash against sales. In the case of a residential customer, the sale of RAC products (room AC or domestic refrigerator) takes place against cash or through a credit card. Financing of retailer firms can be considered to belong partly to corporate loans (chain-stores, outlets) and partly to commercial loans (retail sale agents, dealers etc) depending on the size of the retailer. Banks also offer cash management services for corporate retail clients.

Starting from the 2000's, the concept of sustainability started to become a part of the vision statements and business strategies of both the financial institutions and private companies in developed countries. Türkiye's financial institutions and firms also aligned their priorities on the similar lines and adopted sustainability as their priority. The first private development bank of Türkiye, Industrial Development Bank of Türkiye (TSKB) and its conjoint bank in public sector Development Investment Bank of Türkiye (TKB) were the first two banks that approach the credit appraisal process with an environmental accent. Most commercial banks provide financial assistance to renewable energy (RE) and EE projects. Among the commercial banks, Akbank at first took the lead in sustainable banking.

Türkiye has some grant programmes provided by the government for EE investments, including:

- ▶ Efficiency Increasing Projects (VAP)

- ▶ Voluntary Contracts
- ▶ 5th Region Incentives
- ▶ KOSGEB EE Support Programme
- ▶ Green technology Projects Support Program (YETEP)

Local financial institutions and banks extend credit lines specific to EE projects under variety of programme. Therefore, Türkiye can extend finance to sustainable cooling technology options with relative ease and minimum changes to existing operating structures within banks and institutions.

3. Methodology

The first step in developing the cooling sector status report was establishing an understanding of the status of the RAC sector. The following set of measures were used to guide programme activities to maintain clarity in definitions, data scope, and limitations of the study.

3.1. Definitions

The programme uses the following definitions:

- ▶ Sustainable cooling is affordable and safe cooling that satisfies user needs with lowest possible impacts on the environment. Specifically, this implies the absence of environmentally harmful refrigerants (like fluorinated gases), a low energy demand (including a high efficiency), and at least readiness for a fully renewable energy supply.
- ▶ Direct greenhouse gas (GHG) emissions are related to refrigerant losses on each appliance (refrigerant leakage, operational and at disposal after end of life).
- ▶ Indirect GHG emissions are those related to the generation of the electricity used for cooling.
- ▶ RAC sector:
 - ▷ Refrigeration: Domestic, commercial, industrial, and transport refrigeration
 - ▷ AC: Residential and commercial AC manufacturing (including chiller)
 - ▷ Servicing sector for RAC
- ▶ AC (often referred to as A/C, or air con) is the process of removing heat and moisture from the interior. It is used in domestic and commercial environments.
- ▶ The commercial refrigeration scope includes stationary systems used to store and display food and beverages in retail (supermarkets, shops) and food service (restaurants, hotels) but not for processes. The United Nations Environment Programme (UNEP) defines commercial refrigeration systems as systems that usually include standalone, condensing, or centralised units that mostly do not exceed a capacity of 200 kW and keep temperatures between -25°C and 8°C.²³
- ▶ Commercial refrigeration cold storage includes commercial-scale cold storage rooms, which are usually equipped with condensing or centralised units and have capacities of up to 200 kW. These applications serve as storage for food and beverage products and differ from industrial-scale cold storage, which is used for the processing and storage of food and beverages or in the manufacturing process of petrochemicals, chemicals, and pharmaceuticals. Such systems can range in size from 5 MW to 30 MW.²⁴
- ▶ Synthetic refrigerants are substances of anthropogenic origin (they do not occur naturally). These include HCFCs and HFCs, among others.
- ▶ Natural refrigerants are non-synthetic refrigerants that can be found in nature.
- ▶ Energy efficiency ratio (EER) W/W measures the energy efficiency of cooling devices in watts (W). A higher EER rating corresponds to higher energy efficiency.
- ▶ Residential building sector consists of single and multifamily buildings.
- ▶ Non-residential building sector includes public and private offices, education, health and social, hotel and restaurant, wholesale and retail trade, and other buildings (e.g. sports facilities). Industrial, agricultural and fishery buildings and warehouses are not included.

²³ Definition based on United Nations Environment Programme (UNEP) 2015

²⁴ United Nations Environment Programme (UNEP) 2019

3.2. Building segments and equipment types in scope of the Cool Up programme

Cool Up focuses on the commercial and residential AC sector:

- ▶ Building segments: Focuses on residential buildings that cover single-family and multifamily buildings and on non-residential buildings, i.e., on public and private offices, education, health and social, hotel and restaurant, wholesale and retail trade, and other buildings (e.g. sports facilities).
- ▶ Equipment types (AC systems): Although there are many different technologies installed in the market, they can be clustered into the following key technology segments, which are used to depict the market characteristics.²⁵ AC systems can generally be divided into central and decentral systems.
 - ▷ Ducted air conditioning systems provide cooling (or heating) through a system of ducts. The central unit consists of a compressor, condenser, and an air handling unit, normally located in the attic or basement. Cool (or hot) air is distributed through a series of ducts and vents to the building. These systems are also called central air conditioning systems, which can be broadly segregated into two types, i.e., split central air conditioners (duct split) and packaged central air conditioners.²⁶
 - ▷ Splits units: Single split systems consist of an indoor and an outdoor unit and provide AC for one indoor zone.
 - ▷ Multi-split and variable refrigerant flow (VRF) 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, and the indoor units can be regulated individually.
 - ▷ Packaged units (e.g., rooftop): All components are enclosed in a single box. Packaged units are typically located outside (rooftop, terrace) and provide cooling by delivering conditioned air to one or more indoor zones.
 - ▷ Chillers: Central cold generation units as part of a central AC system, which can be categorised into three groups:
 1. Compression water-cooled chillers
 2. Compression air-cooled chillers
 3. Sorption (absorption or adsorption) chillers
 - ▷ Chillers are connected to water/brine distribution- and delivery systems (e.g., fan coil units or water/air heat-exchangers in air handling units).

Cool Up focuses on the commercial refrigeration sector. Domestic and industrial refrigeration are not included in the Cool Up programme scope.

- ▶ Building segments: Focuses on corner stores, restaurants, supermarkets, and hotels, including areas for cold storage.

²⁵ Primary sources for these definitions are:

United Nations Environment Programme (UNEP) Ozone Secretariat 2015c

United Nations Environment Programme (UNEP) Ozone Secretariat 2015d

United Nations Environment Programme (UNEP) Ozone Secretariat 2015e, 2015a

United Nations Environment Programme (UNEP) 2019

²⁶ CIELO 2019

- ▶ Equipment types (commercial refrigeration systems): Covers the three main types of equipment:²⁷ standalone equipment, condensing units, and centralised systems (for supermarkets). The different equipment types are used in different building segments:
 - ▷ Most medium to large supermarkets prefer to use centralised systems because they are usually more energy efficient than condensing units and plug-in cabinets. The size of the sales area of supermarkets that use a centralised refrigeration system range from 400 m² to up to 20,000 m².
 - ▷ Condensing units are commonly used in medium and small stores and can often be found in fast food outlets, restaurants, bars, and convenience stores. In comparison to a centralised system, they allow fewer cabinets to be connected to the system, take up less space, and are usually easier to install.
 - ▷ Standalone refrigeration systems are typically self-contained systems such as ice cream freezers, display cases, and vending machines. They are often referred to as plug-in units because they are closed systems, which do not require extensive installation.

3.3. Data collection approach

The data for this report was collected from various primary and secondary sources.

- ▶ **Primary data:** ISKID gathered the data through expert interviews.²⁸ The study was completed in collaboration with the representatives and experts of ISKID, from different companies and backgrounds. For each dataset, interviews were conducted with the relevant sector representatives and experts, via video calls, phone calls, e-mailing, and face-to-face. Apart from these interviews, annual sectoral statistics of ISKID were also utilised in the study to compare and ensure the collected data. Each dataset was discussed, compared, and mutually verified. Once the report was fully completed, the study was finalized with expert working groups' overall review. A total of 27 sector representatives and experts contributed to the study. With almost each of them, all the above-mentioned methods were used to gather the data.
- ▶ **Secondary data** was obtained from a diverse set of publications covering statistical sources and national documents (e.g. ODS survey Türkiye),²⁹ energy statistics,³⁰ market research companies (e.g. Building Services Research and Information Association - BSRIA),³¹ a literature review, and regional information such as the Collaborative Labelling and Appliance Standards Program (CLASP).³²

This data approach had limitations, such as partial lack of systematic approaches for data collection (e.g. data on HFC consumption, data basis for installed technologies, especially in the commercial refrigeration sector), difficulty accessing official data, missing background information to available data, and high ranges of data for the same point between different sources. Due the data situation in the mentioned RAC subsectors, this report acknowledges data gaps and data from different sources that results in discrepancies. To reduce the limitations, the Cool Up programme utilised various approaches such as analysis of different data sources, cross valuation, reliability analysis, and use of expert opinions.

However, the Minister of Environment, Urbanisation and Climate Change (MoEUCC) has developed two different databases to collect and use HFC data and they became functional as of February 2023; Business Reports Central Data Base (FARAVET) and Operators of Equipment's Central Data Base

²⁷ United Nations Environment Programme (UNEP) Ozone Secretariat 2015b

²⁸ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

²⁹ United Nations Industrial Development Organization (UNIDO) 2021b

³⁰ T.C. ENERJİ PİYASASI DÜZENLEME KURUMU 2022

³¹ The Building Services Research & Information Association (BSRIA) 2018

³² Waide et al. 2014

(EKOMVET) are two different but linked online systems which were developed to monitor and control every movement of HFCs and equipment reliant on HFCs. FARAVET is an online portal that collect annual reports from importers, exporters, users, manufacturers and also RRR and destruction facilities. The programme is designed to disburse annual quotas and give import and export licenses since it has a connection with the single window system of customs.

Operators of equipment which contains HFCs above five tonnes of CO₂ equivalence are responsible for registering their equipment to EKOMVET and keep records in logbooks. Operators also have a responsibility to check and register the F-Gas certification of their personnel into the system. EKOMVET has an online connection with the certification body of Türkiye that enables operators to check the validity of certificate numbers. Furthermore, the system is designed to send warnings on periodic leakage checks to operators according to the amount of HFC within the equipment.

Several strategies were used to handle the data limitations. If no country-specific values were available, data gaps were closed by using information from global studies such as those from the Intergovernmental Panel on Climate Change (IPCC),³³ International Energy Agency (IEA),³⁴ Technical and Economic Assessment Panel of the Montreal Protocol - Refrigeration, Air-Conditioning and Heat Pumps Technical Options Committee (TEAP/RTOC),³⁵ by using data from a global model developed by the Green Cooling Initiative (GCI),³⁶ and by using knowledge from expert interviews.

The global model developed by GCI³⁷ estimates data on installed equipment in the stock and sales data and provides projections for AC systems (also chiller AC) and commercial refrigeration systems; other RAC subsectors are also covered. Due to the global model approach, the country-specific values are afflicted with a different grade of uncertainty.

Key data parameters will be monitored throughout the programme duration and will be reflected in updates of programme activities and recommendations.

³³ Intergovernmental Panel on Climate Change (IPCC) 2007

³⁴ International Energy Agency (IEA) 2018

³⁵ Campbell et al. 2018; Waide et al. 2014

³⁶ Green Cooling Initiative 2021. The model estimates data on installed equipment in the stock (as well as sales figures) for AC cooling equipment and for the commercial refrigeration sector.

³⁷ Ibid

4. Summary

Türkiye's cooling sector market has substantial production capacity (especially for split AC and air handling units), considerable product diversification and specialisation, a highly qualified workforce, and an efficient supply chain and qualified logistics infrastructure. Türkiye's cooling market is enabled by its open market and fair competition conditions, as well as regulatory efforts to harmonize product standards, and an updated Türkiye's F-gas regulation harmonized with EU standards and regulations.³⁸ Türkiye is an important actor in the RAC market for EU countries as well as the MENA region and Russia. Türkiye has a customs union with the European Union and has free trade agreements with other Coop Up partner countries Egypt, Jordan, and Lebanon, contributing to its current role as a growing manufacturing and export hub for global and large-scale companies.

The AC market is driven by affordability (gross domestic product growth), new construction activities, climate change, the introduction of new technical regulations, and the availability of new technologies. The demand for different AC technologies is driven by installation in new buildings, first time installations in existing buildings (increasing share of air-conditioned rooms), and the replacement of defective AC systems. In the new construction sector, around 70% of all new apartments and 50% of new single-family buildings and almost all new office buildings, supermarket and retail, hotel and healthcare buildings install AC systems (90-100%). In the existing building stock, there is substantial growth potential for the cooling market in the residential sector, as about 85% of the residential floor area is not yet air conditioned.³⁹

In the past few years, the sales for heat pumps, variable refrigerant flow (VRF) systems, split systems, and indoor air quality systems have increased. In contrast, the sales numbers for chiller systems have decreased. Emerging trends include increased installations of heat pumps (monoblock), heat recovery and mini VRFs in single-family buildings; split systems in multifamily buildings; and VRF systems in healthcare buildings. Overarching trends include a focus on heat recovery, energy efficiency, eco-design compatible units and 100% fresh air systems.

Currently, installed AC systems in Türkiye have a significantly lower efficiency than the best available technology, and there is large potential for energy savings, i.e., AC systems installed in existing buildings have a coefficient of performance (COP) in the range of 2-2.5 (split systems).⁴⁰

In 2020, Türkiye produced AC systems in the value of 655 million USD, it imported AC systems in the value of 510 million USD and exported 310 million USD.⁴¹ The main countries of origin (import) were Germany, Italy, and China. The main countries of destination (export) Germany, Italy, France, the United Kingdom, and Turkic Republics (i.e., Azerbaijan, Kazakhstan, Kyrgyzstan, and Uzbekistan).⁴² The market volume in number of units sold was around 1.2 million AC systems of which the single split systems represented around 88% of the market. 70% of all single splits systems sold were produced domestically in 2018. Also, air handling units (AHU) are mainly produced locally. Chillers, fan coils, multi-splits and variable refrigerant flow systems (VRF) are produced locally and are imported.⁴³

³⁸ United Nations Industrial Development Organization (UNIDO)

³⁹ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022, "Survey and expert interviews among ISKID members"

⁴⁰ Ibid.

⁴¹ Ibid.

⁴² Ibid.

⁴³ Ibid.

Also in the commercial refrigeration sector, the domestic market in Türkiye is dominated by local manufacturing. In 2020, Türkiye produced and sold around 75,000 units generating 150 million USD and imported 5000 units for 10 million USD, totalling a market size of 85,000 units and 160 million USD in 2020. The main countries of origin (import) are Italy and China. Türkiye also has a strong export market with around 40,000 units generating 80 million USD exported in 2020 mainly to Azerbaijan, Uzbekistan, Kazakhstan, Iraq, and UK. In terms of technologies, the market is dominated by standalone refrigerators and freezers (about 45% of share in sales) and condensing units (about 45% of share in sales). Central systems add up to about 10% of total sales in 2020.⁴⁴

Türkiye currently imports all refrigerants that are used. The import in 2021 added up to 10,000 tons (data provided by NOU).⁴⁵ HFC based refrigerants dominated the market with a share of 90% followed by 8% of natural refrigerants and 2% of HCFC refrigerants. The main refrigerant used in existing installed AC systems is R410A followed by R134a and R32. For new systems, the focus is shifting towards lower GWP refrigerants. R32 became the most relevant refrigerant in 2020 followed by R410A. As for commercial refrigeration, the main refrigerants used in existing standalone equipment, condensing units and for centralized systems is R404A. This is followed by R507A and R407A for standalone units and by R134a, and R22 for condensing units and centralized systems. As of 2020, new systems have shifted from the traditional high GWP refrigerants to lower GWP refrigerants; for instance, R449A, R448A, R513A and R290 were the dominant refrigerants sold in 2020 for standalone equipment, respectively. Similarly, R449A, R448A, R513A and R452B were the newly dominant sold refrigerants for central systems and condensing units. The government is promoting the transition to lower-GWP alternatives in RAC applications through both the recent publication of Türkiye's F-gas regulation, as well as by mobilising the required support from international agencies for the private sector to facilitate the shift to new technologies.⁴⁶

There are already various demonstrations of sustainable supermarket cooling systems (mostly transcritical CO₂), but projects for sustainable cooling with natural refrigerants in the air conditioning sector are limited.

The overall market for cooling equipment in Türkiye is expected to continue to grow. This strong market growth requires introducing sustainable cooling technologies and natural refrigerants early on as a direct replacement to prevent potential lock-in effects to environmentally harmful refrigerants. Perceived key challenges to the uptake of natural refrigerants include training, addressing safety issues, and associated costs.

Cool Up presents a unique opportunity to build on the regulatory framework currently in place, as well as Türkiye's well-established manufacturing sector and commercial banks, which can provide green finance to scale-up sustainable cooling technologies and the use of natural refrigerants. It is imperative that Cool Up raises awareness of the potential opportunities around natural refrigerants and reducing cooling demand.

⁴⁴ Ibid.

⁴⁵ Internal data for the submission to the Montreal Protocol Ozone Secretariat (under Article 7) provided by NOU

⁴⁶ Ibid.

5. Air conditioning market

- ▶ The overall market for cooling equipment is expected to continue to grow.⁴⁷
- ▶ The national AC market is dominated by local manufacturers and imported products.⁴⁸
- ▶ There is large potential for energy savings—installed equipment and new units installed have significantly lower efficiency than the best available technology.⁴⁹
- ▶ The main market drivers in the residential building sector are economic growth (affordability), climate change and new construction activities.⁵⁰
- ▶ Split systems (ductless) are the main system type in the overall market (installed and sold each year); in larger non-residential buildings, VRF systems are the main technology.⁵¹

5.1. Building stock and market potential

In Türkiye, residential buildings make up the majority (80%) of the total building floor area (2.8 billion m²). Of this residential floor area, 83% is floor area in apartments in multifamily housing while the rest is floor area in single-family housing. The highest share in non-residential floor area are wholesale and retail buildings (30%) followed by office buildings (26%), educational buildings (11%), and hotel and restaurant buildings (11%)(see **Figure 2**).

While the total building stock (number of buildings) in Türkiye was 11.6 million, the number of buildings built in 2021 was 138,500. The annual new construction rate in the construction sector was about 1.2% in 2021.⁵² In addition, 80.6% of buildings built in the first three quarters of 2022 were residential.⁵³

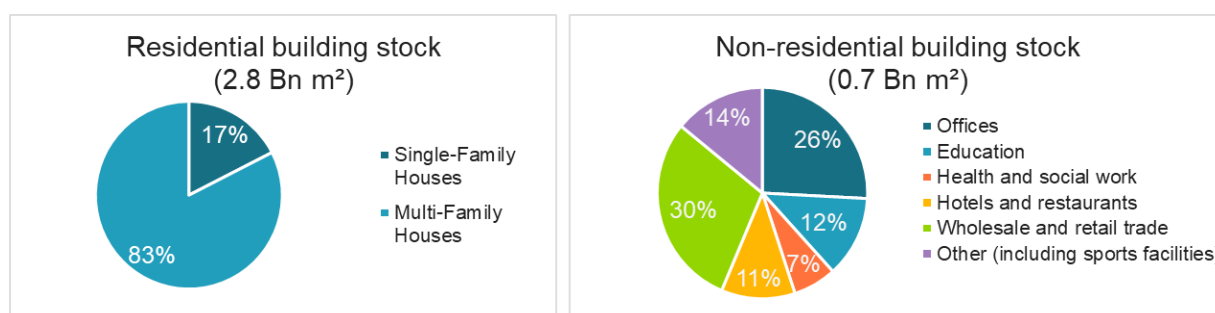


Figure 2: Building stock in Türkiye in 2020⁵⁴

Share of housing units and buildings that have an AC system installed

In the residential sector, approximately 25% of existing single-family buildings and 40% of existing apartments in multifamily buildings have an AC system installed.

⁴⁷ ISKID, 2022

⁴⁸ Ibid

⁴⁹ Ibid

⁵⁰ Ibid

⁵¹ Ibid

⁵² Türkiye İstatistik Kurumu (TÜİK), <https://www.tuik.gov.tr/>

⁵³ Ibid.

⁵⁴ Guidehouse 2021

In newly constructed buildings with single or multifamily residents, the share of buildings that have an AC are higher, at 50 and 70% respectively. In the housing units with an installed AC system, between 35-50% 43% of the rooms or floor area is air conditioned in existing buildings, and 50-70% of the floor area is air conditioned in new buildings.⁵⁵

The picture is different in the non-residential building sector. In existing buildings between 70% (office) to 95-100% (e.g., hotel) of buildings were equipped with at least one AC system. In these non-residential buildings with an installed AC system, between 50% (healthcare), 80% (office and retail) and 100% (office) of the floor area is air conditioned-. In newly constructed almost all newly constructed buildings (between 90-100% depending on building type) have at least one AC system, and between 50% (healthcare), 80% (office and retail) and 100% (office) of the floor area is air conditioned.⁵⁶

Table 3: Overview of share of buildings with an installed AC system and of the share of cooled floor area in these buildings per building type

	Existing building		New building (new construction)	
	Share of buildings with at least one AC systems	Share of conditioned floor space/ rooms in building with at least one AC system	Share of buildings with at least one AC systems	Share of conditioned floor space/ rooms in building with at least one AC system
Residential				
Single family	25%	50%	50%	70%
Multi family	40%	35%	70%	50%
Commercial				
Hotels	95%	100%	100%	100%
Offices	70%	80%	90%	90%
Retail, supermarket	95%	80%	95%	90%
Healthcare	100%	50%	100%	90%
Others (public, education, etc.)	30%	50%	60%	50%

A potential growth area for cooling equipment sales is floor area that is not air conditioned yet. This refers to housing unit and buildings with no installation yet (first time installation) and to buildings with an already installed systems, yet potential for increase of the cooled floor area (e.g., increase the share of air-conditioned rooms). In Türkiye in the residential sector around 85% of total floor area is not cooled. Additionally, the new construction sector is also a key potential growth area for sales that is not reflected in this illustration.

⁵⁵ ISKID, 2022

⁵⁶ ISKID, 2022

Table 4: Overview of total cooled floor area⁵⁷ per building type.

	Existing building	New building (new construction)
Residential		
Single family	12.5%	35%
Multi family	14%	35%
Commercial		
Hotels	95%	100%
Offices	56%	81%
Retail, supermarket	76%	86%
Healthcare	50%	90%
Others (public, education, etc.)	15%	30%

5.2. Market characteristics and developments

In Türkiye, several companies are manufacturing different types of AC appliances under different brand names. As of 2018, Arcelik and Vestel were the major local players in the single splits market, followed by BSH and Samsung in 2018. In the VRF market, Daikin, Mitsubishi Electric, MHI and Samsung held almost 70% of the market share in 2018. The rooftop market was dominated by Lennox, Ciat, and Untes. International players continue to dominate the chiller market. Local players hold higher penetration for sales of air handling units.⁵⁸

5.2.1. Predominant technologies

Although many different technologies are installed in the market, they can be clustered into the following technology segments, which are used to depict the market characteristics further:

- ▶ Single split systems
- ▶ Multi-split and VRF systems
- ▶ Packaged terminal AC (PTAC) (e.g., rooftop) systems
- ▶ AC chillers

For definitions of each segment, see Chapter 3.1.

Figure 3 shows the share number of units for types of AC units in the current building stock. The total number of AC systems installed in the building stock is estimated to be about 11 million in total.⁵⁹

⁵⁷ To calculate the cooled floor area the share of housing units or buildings is multiplied with the share of cooled floor area in these buildings.

⁵⁸ The Building Services Research & Information Association (BSRIA) 2019

⁵⁹ ISKID, 2022

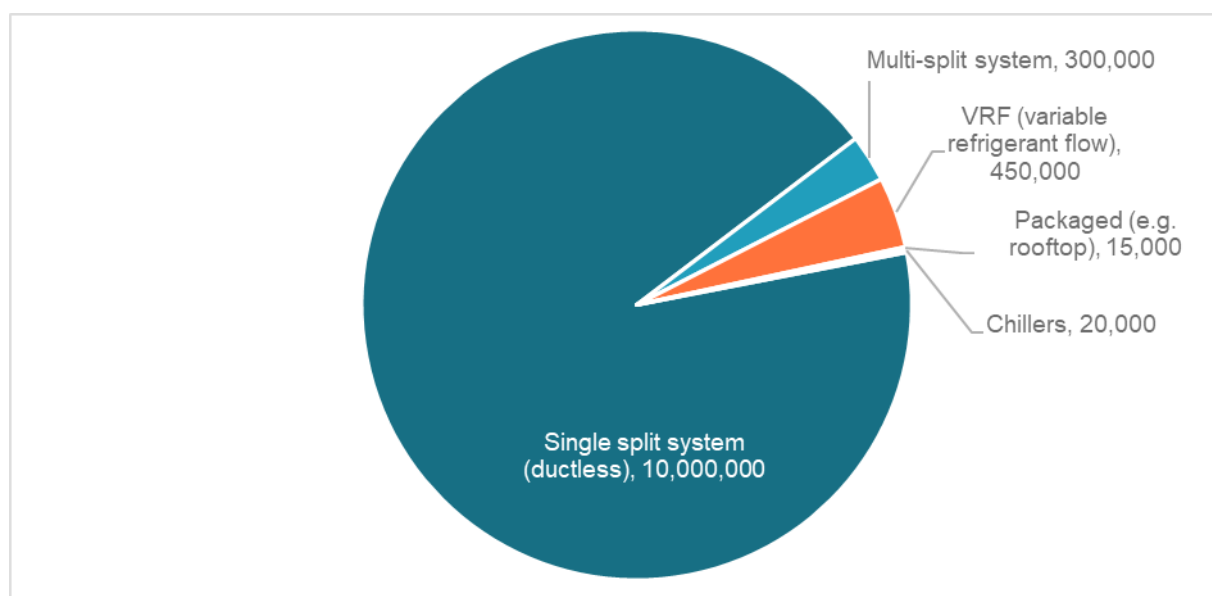


Figure 3: AC: Installed systems in the existing building stock

With about 10 million units, the single split system is the predominant AC system type installed in the current residential building stock in Türkiye, followed by the multi-split system, with about 300,000 units in residential buildings. VRF and chillers systems are the predominant AC system type installed in current office and hotel buildings, accounting for about 450,000 and 20,000 units, respectively. Chillers are also used predominantly in healthcare buildings and are used in a small share of hotel and office buildings. Packaged systems (e.g., rooftop) are relevant technologies in the retail building segment, although the total share is low with about 15,000 units.⁶⁰

Table 5 shows an overview of the most relevant technologies in the existing building stock per building segment.

Table 5: Overview of AC per segment⁶¹

	Predominant installed AC technology – large share*		Second predominant installed AC technology – small share*		Third predominant installed AC technology – very small share*		Neglected share*
	Single split ductless	Single split ducted	AC chiller	Packaged (e.g. rooftop)	Multi-split	VRF	WSHP**
Single-family							
Multi-family							
Hotel							
Office							
Retail (including supermarkets)							
Healthcare							

⁶⁰ ISKID

⁶¹ Ibid

* Market share refers to the share in the respective building segment and **not** to the whole market.

** Water source heat pump

Single split systems are mainly sold to the residential sector, but these system types are also sold to non-residential sector, especially to office buildings and small hotels, supermarkets, and stores. Central systems are typically sold to retail, office, and healthcare buildings. Chillers are typically sold to large hotels, large hospitals, and shopping malls. VRF are sold mainly to residential buildings (single-family buildings), retail and office buildings. **Table 6** provides an overview of the most relevant technologies in the new construction sector by building segment.⁶²

Table 6: Overview of AC systems installed in newly constructed buildings in each building segment⁶³

Predominant installed AC technology – large share*		Second predominant installed AC technology – small share*		Third predominant installed AC technology – very small share*		Neglected share*
	Single split ductless	Single split ducted	AC chiller	Packaged (e.g. rooftop)	Multi-split,	VRF
Single-family						
Multifamily						
Hotel						
Office						
Retail (including supermarkets)						
Healthcare						

* Market share refers to the share in the respective building segment and **not** to the whole market.

AC systems installed in the building stock have an energy efficiency ratio (EER W/W) in the range of 2-2.5 (split systems) respective 2.5-3 in the case of VRF (existing buildings)⁶⁴. Newly installed systems have an efficiency of about 2.34-2.60 (split systems) or higher (VRF, chiller and central ducted systems).⁶⁵ **Table 7** provides a detailed overview of the required minimum efficiency values of the technologies of new equipment according to cooling capacity of the system and GWP value of the coolant, and of the best available national and international technology.⁶⁶

⁶² Ibid

⁶³ Ibid

⁶⁴ Expert Interviews

⁶⁵ Republic of Turkey Official Gazette, 19 July 2013, No: 28712 (Lot 10)

⁶⁶ İSKİD AIRCONDITIONING AND REFRIGERATION MANUFACTURER'S ASSOCIATION İSKİD İklimlendirme Soğutma Klima İmalatçıları Derneği, "Survey and expert interviews among İSKİD members,"

Table 7 provides a detailed overview of the efficiency range of the technologies currently installed in the stock, of new equipment, and of the best available national and international technology.

Table 7: Efficiency of different AC systems⁶⁷

System type		Minimum Efficiency Values (EERmin)	Best available efficiency	
			National	International
Single splits	GWP > 150 Capacity < 6 kW	2.60	4.0 – 4.5	4.4 – 6.5
	GWP < 150 Capacity < 6 kW	2.34		
Multi-splits	GWP > 150 6 kW < Capacity < 12 kW	2.60		
	GWP < 150 6 kW < Capacity < 12 kW	2.34		
VRFs Chillers Central Ducted (e.g., rooftop)	GWP > 150 Capacity < 6 kW	4.60	4.5 – 5.25	4.3 – 6.1*
	GWP < 150 Capacity < 6 kW	4.14		
	GWP > 150 6 kW < Capacity < 12 kW	4.30		
	GWP < 150 6 kW < Capacity < 12 kW	3.87		

* EER 7/12°C//30/35°C according to EN 14511, EER only of the chiller not the whole AC system, for whole systems it will be significantly lower depending on type of distribution and transfer system ("air only," "air + water," or just "water")

Typical AC systems (excluding chillers) are replaced every 7-10 years.⁶⁸

5.2.2. Market trends and drivers

AC for residential and commercial applications has become popular in Türkiye due to the increase in economic development, population, and the harsh climatic condition in recent years.

The demand for different AC technologies is driven by installations in new buildings, new installations in existing buildings (to increase the share of air-conditioned rooms), and the replacement of dysfunctional AC systems. The potential area for sales growth in existing buildings is explained in Chapter 5.1.

The main sales drivers in the existing residential building segment are increasing affordability (GDP growth), growing population, and climate change (increase in temperature in summer, including temporal heat waves, and decrease in temperature in winter compared to average figures). These factors drive sales growth due to first-time installations in existing buildings.⁶⁹

The new construction sector is another significant market for the increase in AC system sales in the residential and the commercial sectors. The new construction sector is a key driver for sales growth in the non-residential building segment, which has a more saturated market in the existing building segment compared to the residential sector.

⁶⁷ Republic of Turkey Official Gazette, 19 July 2013, No: 28712 (Lot 10)

⁶⁸ CLASP 2020

⁶⁹ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği

Other factors influencing sales are the availability of new technologies such as inverters, the introduction of new technical regulations for eco-design, economic growth, the COVID-19 pandemic, new projects addressing efficient cooling systems, and new construction. For the replacement of old systems, the demand is mainly driven by the change in electricity prices, awareness about energy savings, and level of income. Most users in the residential sector replace their ACs only when the system reaches end of life.⁷⁰

On a technology level, the following trends can be observed for AC:

- ▶ Heat pump, VRF, split systems, and indoor air quality systems are strongly increasing in sales over the past few years.
- ▶ Chillers are seeing strong decreases in sales.
- ▶ Heat pumps, heat recovery, and mini VRF are becoming more prevalent in single-family residential buildings.
- ▶ Split units are becoming more widely used in multi-family residential buildings.
- ▶ VRF are becoming more widely used in healthcare buildings.




Table 8 summarises the impact of these drivers and the trends they create on a technology level.

Table 8: Trends in the AC sector and their impact on AC sales⁷¹

Technology	Main applications in the future	Market drivers	Emerging trends	Estimated impact on sales
Single split (ductless) Single split (ducted)	Residential (highest preference) Single family (highest preference) Multi family (highest preference)	Heat recovery and energy efficiency Longer lifetime Lower costs Easy installation	Eco-friendly gases are being used. Due to the acceleration of the construction sector in Türkiye, the usage of this technology increasing. Increasing number of new residentials and buildings in the cities	↑
Multi-splits	Residential (second highest preference) Single family (second highest preference) Multi family (second highest preference)	Energy Efficiency	Not popular due to higher initial cost; single splits dominate the market.	↓
VRF	Offices (highest preference), Hotels (highest preference) Healthcare (second highest preference)	Growth in the tourism sector and new-built hotels Rapid increase on the number of the hospitals	Become popular for new hotels. VRF usage has increased due to new hospital constructions after the COVID-19 outbreak.	↑

⁷⁰ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

⁷¹ Ibid

Technology	Main applications in the future	Market drivers	Emerging trends	Estimated impact on sales
Packaged (rooftop)	Retail (incl. supermarket.) (Second highest preference)	Increasing number of local supermarkets and stores	WSHP is going to replace the packaged rooftops.	
Chillers	Healthcare (Highest preference)	New constructions of hospitals, Malls and increasing industrial usage.	Investment in medical, retail and manufacturing sector.	
WSHP	Retail (incl. supermarket) (Highest preference)	Environmental reasons Energy efficiency Lower installation costs Small scale and less complex	Increasing number of local supermarkets and stores.	

5.2.3. Market size and structure

According to ISKID statistics the 2020 market volume was about 1 million units sold, adding up to about 825 million USD. Of these, 655 million USD were produced nationally.⁷² About 510 million USD were imported, mainly from Germany, Italy, and China.⁷³ 310 million USD were exported, mainly to Germany, Italy, France, the United Kingdom, and Turkic Republics (i.e., Azerbaijan, Kazakhstan, Kyrgyzstan, and Uzbekistan).⁷⁴

Available data for AC sales in 2021 shows that the total AC market volume was about 1.15 million. The market remains dominated by single split systems (ductless) with approximately 1,000,200 units, representing about 87% of the known market. Other technologies, such as fan coils (70,000), VRF systems (35,000), multi split (27,000), AHU (10,000), and chillers (1,500) account for approximately 155,000 units and represent about 14% of the current sales.⁷⁵

While heat pumps are still a developing industry and market in Türkiye, including through investments and product developments, the country closely follows the expansion of the technology around the world. According to ISKID's annual statistics, 5,000 heat pump were sold in Türkiye in 2019, 8,500 in 2020, and 11,000 in 2021. According to preliminary data for 2022, it could be predicted that the use and production of heat pumps in Türkiye will continue to increase rapidly.⁷⁶

Figure 4 illustrates the shares of the different AC systems in the market in 2021 in terms of the number of systems. Sales of multi split units are expected to grow further in popularity to meet the demand between light commercial splits and mini VRFs. Currently all multi split units sold in Türkiye are inverter-type systems, which already feature high energy-efficiency.⁷⁷

⁷² Ibid

⁷³ ISIB

⁷⁴ Ibid

⁷⁵ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

⁷⁶ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

⁷⁷ BSRIA

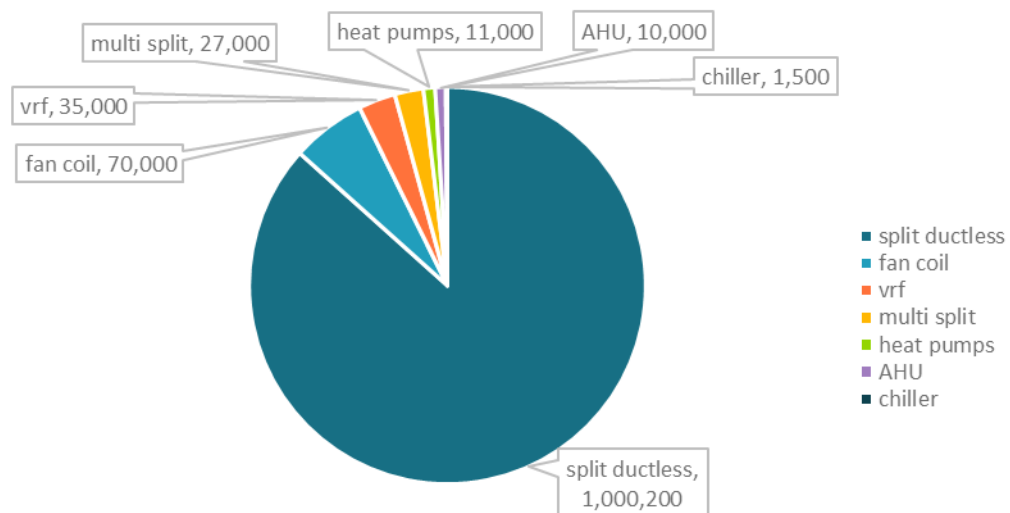


Figure 4: Share of AC units sold in 2021⁷⁸

In 2018 locally produced single split systems accounted for around 70% of total market sales. Most of the market growth can be attributed to the room AC market, mainly the single split system (mainly ductless, with inverted technology). The fastest growth rate is expected to take place in the heat pump, VRF, split systems, and indoor air quality systems market. In contrast, the market for chillers will stay stable or even shrink.⁷⁹

⁷⁸ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

⁷⁹ ISKID; The Building Services Research & Information Association December 2018

6. Commercial refrigeration market

- ▶ Due to recent inflation rates; especially cheaper supermarket chains dominate the commercial refrigeration sector in TR; other large market segments are hotels and restaurants.
- ▶ Supermarkets are more demanding to plug in units due to requirement for more flexibility in new investments.
- ▶ The main technologies are standalone (=plug-in) systems (50%) and condensing units (30%) and multi compressor systems (20%).
- ▶ Energy efficient products are more demanded for the main technologies like standalone systems and condensing units / centralised systems, since customers having more consciousness on energy topics.
- ▶ Lowering product prices, population growth, increase in electricity prices, the introduction of new technologies, economic growth are the main drivers for new installations.
- ▶ Food and beverage providers are the main suppliers of standalone refrigeration systems to supermarkets and quick service and casual restaurants.
- ▶ The Turkish commercial condensing units, centralised refrigeration and multi compressor refrigeration sector is dominated by local manufactures; commercial standalone refrigeration systems are also locally manufactured, thanks to locally produced evaporators and condensers; however, some imported cooling equipment (i.e., compressors, electrical parts, etc.) are used in the cooling circuits. Refrigerated cabinets are exported a lot.
- ▶ Turkish commercial standalone, condensing and centralised refrigeration sector is dominated by local manufactures with thanks to locally produced evaporators and condensers however some exported cooling equipment (i.e., compressors, electrical parts etc.) is used in the cooling circuits.

6.1. Market segments and predominant technologies

The predominant technology clusters for commercial refrigeration are standalone systems, condensing units, and centralised systems (for definitions, see Chapter 3.1).

Standalone refrigeration systems such as chest freezers are mainly used for small refrigeration applications in supermarkets, corner stores, fuel gas stations. Often free of charge, standalone reach-in refrigerators and freezers are provided by food and beverage industries. Quick service restaurants depend mainly on standalone units.⁸⁰

Condensing units are typically installed in medium and large supermarkets restaurants, hotels, bakeries, butcher shops. They are also popular in relatively small cold stores.⁸¹

The typical capacity size (electrical rated power) of a commercial standalone system is 1.1 kW. The typical capacity size of a condensing system is in the range of 4.5 kW and 20 kW and of a centralised system is around 50 kW.⁸²

Table 9 provides an overview of the building segment (use cases) and typical refrigeration systems used.

⁸⁰ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

⁸¹ Ibid

⁸² Ibid

Table 9: Commercial refrigeration segments in Türkiye⁸³

Building type (market segment)	Typical refrigeration systems, including number of units
Small-sized supermarket (up to 50 m²)	<ul style="list-style-type: none"> ▶ 1-2 plug in beverage cabinets one or two doors (some are provided by food and beverage industries) ▶ 1-2 remote vertical refrigerators ▶ 2-3 standalone reach-in refrigerators (some are provided by food and beverage industries) ▶ 2-3 multi decks with a condensing unit (small discount chain supermarkets) ▶ 1-2 plug-in island freezers ▶ In very small markets (up to 20 m²) only plug-in cabinets provided by food & beverage industries
Medium-sized supermarket (51 m² to 99 m²)	<ul style="list-style-type: none"> ▶ 1-2 plug in chest freezers ▶ 1-2 remote vertical refrigerators ▶ 1-2 plug in beverage cabinets one or two doors (some are provided by food and beverage industries) ▶ 4-7 standalone reach-in refrigerators and standalone reach-in freezers (some are provided by food and beverage industries) ▶ 2- 4 condensing refrigerators ▶ 4-6 multi decks (some are provided by beverage industries) ▶ 3-5 island freezers (it can be plug-in or condensing unit) ▶ 1-2 cold rooms up to 10 m² ▶ Condensing unit for multi decks
Large-sized supermarket (100 m²-250m²)	<ul style="list-style-type: none"> ▶ More than 8 remote vertical refrigerators (some are provided by food and beverage industries) ▶ 2-4 remote vertical freezers ▶ 3-5 standalone (plug in) chest freezers (some are provided by food industries) ▶ 2-4 remote serve over counters ▶ 2-4 plug-in pastry cabinets ▶ Up to 2 remote combined freezer cabinets ▶ More than 10 standalone reach-in refrigerators and standalone reach-in freezers (some are provided by food and beverage industries) ▶ 2-4 Cold Rooms ▶ 7-10 condensing refrigerators and freezers or 1 Centralised system ▶ More than 8 multi decks and island freezers (some are provided by beverage industries) ▶ 3-5 plug-in island freezers ▶ Up to 2 multi compressor cooling system for (+) cooling (multidecks and cold rooms) ▶ Up to 2 multi compressor cooling system for (-) cooling (island freezers and minus cold rooms)

⁸³ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

Building type (market segment)	Typical refrigeration systems, including number of units
Hypermarket	<ul style="list-style-type: none"> ▶ Number of systems is large and varies according to hypermarket size ▶ Remote serve over counters ▶ Remote refrigerators and cold rooms ▶ Deepfreeze rooms ▶ Pastry lines ▶ Plug in chest freezers ▶ Remote island freezers ▶ Remote combined freezer cabinets ▶ Centralised systems (provides cold rooms dedicated for refrigerating and freezing food and display refrigerators and freezers) ▶ More than 20 Standalone refrigerators and freezers (some are provided by food and beverage industries) ▶ More than 5 standalone chest freezers ▶ More than 10 Condensing refrigerators and freezers or 2 Centralised systems ▶ More than 5 Cold Rooms ▶ Plug-in multi decks (some are provided by beverage industries) and Plug-in freezer ▶ 20 – 25 multi decks ▶ 2 multi compressor cooling: one of them for cold rooms and multi decks with 0/+4 °C, one of them for cold rooms and multi decks with temperatures over +10 °C (meat preparation rooms, cold room corridors and multi decks and cold rooms for fruit and vegetables) ▶ 1 multi compressor cooling for freezers (island freezers and coldrooms)
Quick service restaurant (door-to-door only) such as pies, pastries, etc.	<ul style="list-style-type: none"> ▶ Remote refrigerators and freezers (some refrigerators are provided by food and beverage industries) ▶ Remote display refrigerator (less in number than the ones used in other types of restaurants) ▶ Standalone condensing units for refrigerators, freezers and display cabinets or central systems for refrigerators, freezers and display cabinets ▶ 3-4 Standalone refrigerators and freezers (some refrigerators are provided by food and beverage industries) ▶ Standalone display refrigerators ▶ 2-3 condensing refrigerators and freezers ▶ Standalone refrigerators and freezers (some refrigerators are provided by food and beverage industries)
Casual restaurants (seated and door-to-door), up to 80 seats	<p>Standalone types of freezers and refrigerators are used:</p> <ul style="list-style-type: none"> ▶ Up to 3 standalone (plug-in) refrigerators for beverages (provided by beverage industries) ▶ Remote vertical refrigerators and freezers ▶ Remote serve over counters ▶ Standalone condensing units for refrigerators, freezers and serve over counters or central systems for refrigerators, freezers and serve over counters ▶ 3-5 standalone refrigerators for meat and beverages (some provided by beverage industries) ▶ 1-2 standalone chest freezers ▶ 2-3 Cold Rooms ▶ Standalone display refrigeration ▶ 4-5 condensing refrigerators and freezers ▶ Standalone refrigerators and freezers

Building type (market segment)	Typical refrigeration systems, including number of units
Large restaurants (seated), more than 80 seats	<ul style="list-style-type: none"> ▶ 1-6 standalone (plug in) or remote refrigerators for beverages (some are provided by beverage industries) ▶ 1-6 remote serve over counters ▶ 1-3 remote vertical freezers ▶ Standalone condensing units for refrigerators, freezers and serve over counters or central systems for refrigerators, freezers and serve over counters ▶ 4-8 standalone refrigerators for meat and beverages (some are provided by beverage industries) ▶ 3-4 standalone chest freezers ▶ 3-4 Cold rooms ▶ 5-6 condensing refrigerators and freezers ▶ Up to 6 standalone display refrigeration units ▶ Up to 3 standalone freezers ▶ Condensing (cold rooms) (for more than 250 seats)
Three-star hotels	<ul style="list-style-type: none"> ▶ 1-2 plug in beverage cabinets ▶ Plug-in chest type freezers ▶ Remote vertical refrigerators ▶ Standalone condensing units for refrigerators ▶ Few standalone refrigerators and freezers ▶ 4-6 Cold rooms ▶ 5-6 condensing refrigerators and freezers or Central system.
Four-star hotels	<ul style="list-style-type: none"> ▶ Plug in beverage cabinets ▶ Plug-in chest type freezers ▶ Remote vertical refrigerators ▶ Remote serve over counters ▶ Standalone condensing units for refrigerators, freezers and serve over counters or central systems for refrigerators, freezers and serve over counters ▶ 5-10 Cold rooms ▶ 8-10 condensing refrigerators and freezers or Central system. ▶ Up to 30 standalone refrigerators and freezers ▶ Few condensing units (cold rooms)
Five-star hotels	<ul style="list-style-type: none"> ▶ More than 10 standalone (plug-in) refrigerators and freezers ▶ Few remote units ▶ Cold rooms (more than 10 condensing type; the numbers increase as the hotel capacity increases) ▶ Few standalone refrigerators and freezers ▶ More than 10 Cold rooms ▶ More than 10 condensing refrigerators and freezers or Central system. ▶ Few condensing units

6.2. Market trends and drivers

Due to the growing population and commercial sector expansion, the demand for commercial refrigeration in Türkiye is expected to continue to increase.

The demand for new installations of different commercial refrigeration systems depends on the following key drivers: population growth, introduction of new technologies, economic growth, COVID-19 pandemic, and new construction activities.

The replacement segment is driven by the change in electricity prices, increasing awareness of energy savings, and economic feasibility.

In supermarkets, the new installation and replacement (mainly) of standalone systems is driven by the interest of installing more energy efficient systems as well as more nature friendly systems.⁸⁴

Energy saving systems and nature friendly systems are strongly increasing in sales over the past few years and are becoming more widely used across commercial buildings.⁸⁵

Table 10 summarises the emerging trends for different building types and market segments.

Table 10: Emerging trends for different market segments⁸⁶

Building type (market segment)	Main refrigeration system types used	Emerging trends
Case 1: small-sized supermarkets	Chest refrigerator and freezer	Most supermarkets now install few larger appliances instead of several smaller ones
	Standalone reach-in refrigerator	Most popular in big and small cities, and their numbers increase every year due to population growth and urbanisation rate increase
	Remote refrigerator	
	Plug-in beverage cabinets	
Case 2: medium-sized supermarkets	Top 1 standalone reach-in refrigerator and reach-in freezer	They are suffering from competition against bigger markets. Energy class and location becoming more important for them in the coming years.
	Top 2 Vertical refrigerators and freezers	
	Top 3 condensing reach-in refrigerator (rack system)	Most popular in big cities
	Top 4 standalone (Plug in) chest freezers	
Case 3: large-sized supermarkets	Top 1 standalone reach-in refrigerator and reach in freezer	Most popular in Türkiye with their competitive prices and their numbers increase every year due to increasing demand from customers. Energy class becoming more important for them in the coming years.
	Top 2 Remote (standalone) chest freezer	
	Top 3 condensing or centralised reach-in refrigerator (rack system)	Only found in big cities
	Top 4 Remote refrigerators and plug in freezers	Most popular in big and small cities, and their numbers increase every year due to population growth and urbanisation rate increase
	Top 5 Remote serve over counters	
	Top 6 Remote combined condensing reach-in open and closed freezer cabinet	

⁸⁴ Ibid

⁸⁵ Ibid

⁸⁶ İSKİD Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

6.3. Market size and structure

In the commercial refrigeration sector, the domestic market in Türkiye is dominated by local manufacturing. In 2020, Türkiye produced and sold around 75,000 commercial refrigeration units generating 150 million USD and imported 5000 units for 10 million USD, totalling a market size of 85,000 units and 160 million USD in 2020. The main countries of origin (import) are Italy and China. Türkiye also has a strong export market with around 40,000 units generating 80 million USD exported in 2020 mainly to Azerbaijan, Uzbekistan, Kazakhstan, Iraq, and UK. In terms of technologies, the market is dominated by standalone refrigerators and freezers (about 45% of share in sales) and condensing units (about 45% of share in sales). Central systems add up to about 10% of total sales in 2020.⁸⁷

The Green cooling initiative (GCI) model estimates the total number of commercial refrigeration systems installed in Türkiye to be about 1.4 Mio units.⁸⁸ Based on the work from cool coalition the share of standalone systems is estimated to be 63%, the share of condensing units to be 36% and the share of central systems to be less than 1%.⁸⁹

Çağlayan Soğutma, Kaplanlar, Nurdil, Diktaş, Uğur and others are the main local manufacturers. Türkiye has more than 10 big companies manufacturing different types and models of domestic, commercial, and industrial refrigerators (see **Table 11**).⁹⁰

Some companies produce mostly refrigerated cabinets, some produce mostly refrigeration systems, and some produce both.

Table 11: Main local refrigeration manufacturing companies⁹¹

No.	Company name
1	Ahmet Yar Refrigeration
2	Kaplanlar
3	Nurdil
4	Frenoks
5	IBS Cooling
6	Frigo Mekanik
7	Uğur Refrigeration
8	Cantaş
9	Messan
10	Barlas Refrigeration
11	Savaşlar
12	Ay-pas Refrigeration
13	Sevel
14	Greencooler (Öztas Metal)

⁸⁷ Ibid

⁸⁸ Data derived from the GCI model (Green Cooling Initiative 2021). The model calculates the number of systems in use via an indicator (number of system per capita: 0.0114).

⁸⁹ Green Cooling Initiative 2021

⁹⁰ İSKİD AIRCONDITIONING AND REFRIGERATION MANUFACTURER'S ASSOCIATION İSKİD İklimlendirme Soğutma Klima İmalatçıları Derneği, "Survey and expert interviews among İSKİD members,"

⁹¹ İSKİD Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

No.	Company name
15	Başarır Soğutma
16	Klimasan
17	Ergül Teknik
18	Çözüm Soğutma
19	Envoytec
20	Erkasis
21	Çağlayan Refrigeration
22	Uğur Freezers
23	Diktaş
24	Efe Cooling
25	Alaska
26	Şenocak Freezers

7. The refrigerant market

- ▶ All synthetic refrigerants are imported to Türkiye.
- ▶ R410A is the main refrigerant in existing air conditioning equipment and is increasingly substituted by R32.
- ▶ R404A and R134a continue to be the main refrigerants in existing commercial refrigeration equipment. HFC-HFO blends such as R448A, R449A and R513A are introduced in new equipment as well as R290 in the case of stand-alone units.
- ▶ The barriers that hinder the uptake of natural refrigerants (perceived by the end user) are safety issues and related costs; these need to be addressed.

Türkiye currently imports all refrigerants that are used domestically or for first fill of newly manufactured products. **Figure 5** represents the comparable amount of imported and exported ODS and ODS alternatives in tonnes per year in 2019, 2020 (both from the ODS alternative survey)⁹² and 2021 (data provided by NOU).⁹³ HFC based refrigerants dominate the market with a share of 90% followed by 8% of natural refrigerants and 2% of HCFC refrigerants.

Based on data provided by ISKID, domestic demand (more precisely consumption) in 2020 added up to 9,000 tonnes.⁹⁴ Similarly, the ODS alternative survey⁹⁵ covering 2019 and 2020 import, export, and use data indicated that total imports destined for use in the RAC sector amount to provides similar estimates and establishes the RAC import to be approximately 8,500 tonnes, which appears to align well with the ISKID figure mentioned above.⁹⁶

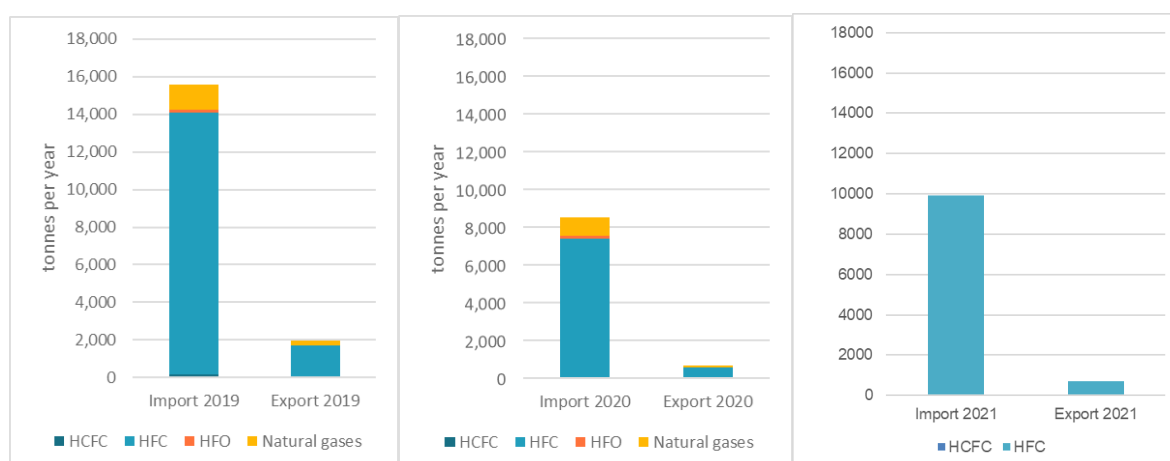


Figure 5: Comparable amounts of ODS and ODS alternatives imported and exported in tonnes per year in 2019 until 2021.

Note: For 2021, quantities concerning HFOs and natural refrigerants were not available in the data made available.

⁹² United Nations Industrial Development Organization (UNIDO) 2021a

⁹³ Internal data for the submission to the Montreal Protocol Ozone Secretariat (under Article 7) provided by NOU

⁹⁴ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği

⁹⁵ United Nations Industrial Development Organization (UNIDO) 2021a

⁹⁶ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği

The servicing sector accounts to 65-70% of the total consumption.⁹⁷

According to the survey, the market experienced a significant decrease of refrigerants being imported to the country looking at the year-on-year change from 2019 to 2020. In more detail, total import has declined from approximately 15,500 tons in 2019 to 8,500 in 2020. Accordingly, the export has been reduced from 2,000 tons to 700. While most of the refrigerants have diminished by factor two, the greatest reduction appeared in the import of R22 (147 tons compared to 33 tons), although its' export has increased over that period. Overall, the drastic decrease in imports can likely largely be explained by the overall negative effects of the Covid-19 pandemic on the overall economic situation globally.

A significant amount of imported ODS is used for domestic purposes. For the manufacture of domestic and commercial plug-in units, hydrocarbons such as R290 and R600a are commonly imported and used. In contrast, refrigerant grade R717 and R744 are imported to much smaller extent (compare import/export data provided in ODS alternatives survey 2021, p.15). The servicing sector accounts to 65-70% of the total consumption.⁹⁸ In AC systems, the main refrigerant used in existing installed AC systems is R410A followed by R134a (in chillers) and R32. For new systems, the focus is shifting towards refrigerants with lower GWPs. Lately, R32 became the most sold refrigerant in 2020 followed by R410A. Türkiye's producers of split type A/C units are increasingly using R32 applications instead of R410A, not only because of the GWP effect but also because of the energy efficiency gains compared to old HCFC and HFC equipment. Chiller manufactures still prefer to use R134a and R410A in their applications.⁷⁷

In commercial refrigeration systems, the main refrigerants used in existing equipment and systems is R404A, followed by R507A and R407A for standalone units and by R134a and R22 for condensing units and centralized systems. As of 2020, new commercial refrigeration systems are shifting from the traditional high GWP refrigerants to lower GWP refrigerants, mainly R449A, R448A, R513A, R290 in the case of standalone systems and R452B in the case of centralized systems and condensing units are used. Commercial refrigeration in Türkiye is dominated by R404A, as the refrigerant as such as well as components are easily available everywhere.

HCs and HFO blends are also used by many producers and customers, but are only for equipment exports, mainly into the EU.⁹⁹ Table 12 shows an overview of the predominant refrigerants used in existing and new commercial refrigeration systems.¹⁰⁰

⁹⁷ United Nations Industrial Development Organization (UNIDO) 2021a

⁹⁸ United Nations Industrial Development Organization (UNIDO)

⁹⁹ Ibid

¹⁰⁰ Ibid

Table 12: Overview of refrigerants used in existing systems and in new systems¹⁰¹

Predominant used refrigerant- large share*			Second predominant used refrigerant – small share*			Third predominant used refrigerant – very small share*				Neglected share*		
			410A	134 A	R 32	404 A	507 A	407 A	448 A	449 A	513 A	R 22
AC	All systems	Existing										
		New										
Commercial refrigeration	Standalone systems	Existing										
		New										
	Condensing units & centralized system	Existing										
		New										

The government is promoting the transition to low-GWP alternatives in RAC applications through both the recent publication of Türkiye's F-gas regulation, as well as by mobilising the required support from international agencies for the private sector to facilitate the shift to new technologies. There are already various demonstrations of sustainable supermarket cooling systems (mostly trans critical CO₂), but projects for sustainable cooling with natural refrigerants in the air conditioning sector are lacking.

Table 13 summarises the quantities of HFC refrigerants used in the manufacture of RAC applications in 2020. It is shown clearly that natural refrigerants are only used in domestic and small commercial refrigeration units. CO₂ and ammonia have no relevant shares in any equipment type.¹⁰²

Table 13: Quantities of HFC refrigerants used in RAC applications in 2020**Commercial refrigeration**

Applications*	Refrigerant charge (kg)	Alternatives	Use (KG)	
			2019	2020
Domestic refrigerators and freezers	0.1-0.3	HFC134a	25.000	17.000
		HC-600a	871137	536986
		Others (specify)	0	0
Commercial refrigeration systems (stand alone, condensing units, and small/medium centralized systems)	0.1-200	HFC134a	67900	79400
		HC290	20.972	19.512
		R404A	76650	70350
		R449/448	59000	109391
		R407A/C/F	3500	2500

¹⁰¹ JSKID¹⁰² United Nations Industrial Development Organization (UNIDO)

Applications*	Refrigerant charge (kg)	Alternatives	Use (KG)	
			2019	2020
		HG-600a	281163	32489
Large systems (cold storage, supermarket)	250-5,000	R717	0	0
		R507A	0	0
		R434A	197.600	145.600
		R744	0	0
		HCs	0	0
		R407A/C/F	0	0
Industrial chiller system	100-2,00	HFC134a	79.500	47.700
		R407C	4.000	3.500
		R410A	0.00	0.00
		R717	0.00	0.00
		HCs	0.00	0.00
		R407A/C/F	0.00	0.00

Stationary air-conditioning

Applications*	Refrigerant charge (kg)	Alternatives	Use (KG)	
			2019	2020
Room air conditioning (including small split air conditioning)	0.2-30.1-0.3	R410A	285.160	190.135
		R407C	0	0
		HFC-161	0	0
		HFC32	621.905	1.002.145
		HFC290	0	0
		Others	0	0
Other air conditioning (including split, multi-split and variable refrigerant flow systems, ducted and package rooftop)	3-100	R410A	0	0
		R407C	0	0
		HFC-161	0	0
		HFC32	0	0
		HFC290	0	0
		CO2	0	0
		Others (R545B)	2.550	4.250
Chillers (small/medium sized water chillers, large sized water chillers)	500-13,000250-5,000	R407C	38.588	27.460
		R410A	12.0000	14.000
		HFC290	0	0
		HC1270	0	0
		HFC134a	75.000	140.000
		HFC32	0	0
		R717	0	0
		ZE/ZD	89	1.297
		R514A (XP30)		

Türkiye's government is committed to the Montreal Protocol (MP) and its amendments. Since 1991, the national regulation has been set up to prohibit import and re-export of HCFCs as bulk refrigerants or any refrigeration and AC systems charged with these substances. The regulation also prohibits the production of new units of RAC equipment using ODS under the control of MP. As a result of the mentioned provisions, all of the imported bulk refrigerants (except the quantities for servicing) and the RAC units for household and commercial uses include HFCs, low GWP, and natural refrigerants.

Türkiye's success in implementing an HCFC phase-out plan as well as strategies to reduce energy demand and increase EE, demonstrate that there is capacity to turn to addressing HFCs and cooling demand reduction. Because of the ODS phase-out, the consumption of HFCs has increased significantly, resulting in a need to develop an HFC phase-down plan. The refrigeration sector will now have to adapt to the recently published Türkiye's F-gas regulation prohibits placing on the market of high GWP refrigerants in refrigerators and freezers for commercial use from 2025 onwards and limiting the GWP of refrigerants in these units to 150 from 2029 onwards.¹⁰³ For new larger systems, it is relevant to note that of 1 January 2025, stationary refrigeration equipment, that contains, or whose functioning relies upon, HFCs with GWP of 2,500 or more except equipment intended for application designed to cool products to temperatures below (-50°C), is prohibited.¹⁰⁴

The overall market for cooling equipment in Türkiye is expected to continue growing. This strong market growth requires introducing sustainable cooling technologies and natural refrigerants early on as a direct replacement to prevent potential lock-in effects to harmful refrigerants.

¹⁰³ United Nations Industrial Development Organization (UNIDO)

¹⁰⁴ Ibid

8. Further cooling sector insights

8.1. Most relevant natural refrigerants

With no or only negligible GWP, natural refrigerants are a sustainable and future-proof option in compression cooling. Further advantages of natural refrigerants are their low and stable costs, high efficiency,¹⁰⁵ and availability. However, some challenges associated with the handling of natural refrigerants exist— e.g., the flammability of hydrocarbons (e.g., R290, propane). Potential safety concerns must be addressed by certain measures related to RAC systems. For example, setting requirements for systems exceeding a certain capacity to place the flammable gas in a machinery room, permit access only for trained technicians, and for ventilation and leak detection. The qualification and skills of technical personnel to install, repair, service, and maintain RAC equipment and systems are of key relevance, especially for natural refrigerants. Based on their chemical and physical properties, additional technical know-how and practical experience is needed to handle natural refrigerants safely. The existing experience of RAC technicians in developing countries primarily includes handling HCFCs and HFCs but not, or to a limited extent, natural refrigerants.

Due to the lack of regulation, the motivation to transition to natural refrigerants is low in conventional HFC industries. Additionally, the sales volumes of the limited number of RAC systems relying on natural refrigerants available on the markets are low.

Table 14 summarises the main application areas and key characteristics of the most relevant natural refrigerants.

Table 14: Key characteristics of the most relevant natural refrigerants^{106, 107}

Refrigerant	GWP (100 yrs)	Main areas of application	Advantages	Challenges
R290 (Propane)	3	<ul style="list-style-type: none"> ▶ Room AC units (monoblock and split units) ▶ Small chillers ▶ Plug-in commercial refrigeration 	<ul style="list-style-type: none"> ▶ High efficiency ▶ No significant cost upcharge ▶ Available 	<ul style="list-style-type: none"> ▶ Highly flammable (=>charge limits)
R600a (Isobutane)	3	<ul style="list-style-type: none"> ▶ Standalone refrigerators 	<ul style="list-style-type: none"> ▶ High energy efficiency ▶ Common technology 	<ul style="list-style-type: none"> ▶ Highly flammable (but due to low charges and good sealing of main applications not a major issue)
R717 (Ammonia)	0	<ul style="list-style-type: none"> ▶ Chillers ▶ Central refrigeration systems 	<ul style="list-style-type: none"> ▶ Excellent efficiency for low temperature applications (well below 0°C) ▶ Easy to operate and maintain ▶ Low operating pressure 	<ul style="list-style-type: none"> ▶ Toxic (but low risk, as it can be smelled far before reaching critical concentration) ▶ Corrosive to copper, brass, and bronze ▶ Highly flammable (=>charge limits)

¹⁰⁵ Specifically, propane (R290) and ammonia (R717) have better thermal properties than conventional refrigerants.

¹⁰⁶ Azar und Nosbers 2018

¹⁰⁷ Intergovernmental Panel on Climate Change (IPCC) 2007

Refrigerant	GWP (100 yrs)	Main areas of application	Advantages	Challenges
R744 (Carbon dioxide)	1	<ul style="list-style-type: none"> ▶ Supermarket refrigeration ▶ Combined systems (heating and cooling) 	<ul style="list-style-type: none"> ▶ Not flammable ▶ High temperature fluid for heat recovery ▶ Non-toxic ▶ Low maintenance systems ▶ Non-corrosive 	<ul style="list-style-type: none"> ▶ Requires more complex systems due to high discharge pressures ▶ Very low critical temperature (31 °C)

8.2. High leakage rates and poor maintenance

- ▶ Improving maintenance is important to reduce leakage rates and improve energy efficiency in the future.
- ▶ Current leakage rates are rather high in the commercial refrigeration sector (up to annual 20%-40% in condensing units and centralised systems).
- ▶ Absence of end-of-life management of refrigerants typically results in 100% release of the refrigerant into the atmosphere during disposal.
- ▶ There is high demand for raising awareness and building capacity for those involved in the disposal process of refrigerants.
- ▶ There is demand for installing monitoring and evaluation mechanisms and needed facilities to ensure safe disposal of the refrigerants.

Regular maintenance is an important factor for reducing direct emissions from RAC equipment. Poor maintenance results in high(er) refrigerant leakage rates and a lower equipment efficiency. The typical maintenance practice in the RAC sector is a regular (mostly annual) service for filter replacement, electrical check-ups, regular cleaning, and refrigerant charge checking. Especially for smaller AC systems, the typical maintenance not on an annual basis; rather, it is on an ad hoc basis, typically caused by a technical malfunction of the system itself. During maintenance, often the complete refrigerant charge is released into the atmosphere, and the system needs to be completely recharged (exception are large systems, which may have a liquid receiver).¹⁰⁸

The recent publication of Türkiye's F-gas regulation addresses leak checking.¹⁰⁹

One key challenge is building the capacity of cooling service technicians and other market participants such as AC installers, service companies and repair technicians to address leakage, improving maintenance skills.¹¹⁰

Supermarket owners stress that no regular or professional maintenance is typically performed on commercial refrigeration systems; it depends on the sales company's maintenance and replacement plans. The most performed maintenance measure for systems is to clean the condensing units, which depends on the climate (dusty or not) and is typically completed annually as part of the after sales support provided by the manufacturer.¹¹¹

According to interviews in the partner countries, the annual leakage rates in the different countries are between 5% and 10% for AC systems; for chillers (system), it is about 15%-20% and 20%-40% for large

¹⁰⁸ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

¹⁰⁹ Özge TÖMÖZ GÜNDÜZ

¹¹⁰ National Ozone Unit Lebanon 2021

¹¹¹ ISKID Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

commercial refrigeration systems (standalone systems have low leakage rates in most cases).¹¹² Available studies provide values in the same order of magnitude.¹¹³ The demand for RAC servicing on a national level can be estimated to be around 40%-60% of the whole subsector (AC and commercial refrigeration) consumption.¹¹⁴

At the end of their technical lifetime, AC systems are usually disassembled to reuse some parts or components as spare parts for other systems. Refrigerants are not disposed properly; instead, they are released without any precautions. This absence of end-of-life (waste) management legislation results in high refrigerant emissions into the atmosphere at the disposal stage, which can, depending on the annual leakage rate, easily add up to a multiple of the initial charge amount.¹¹⁵

Key challenges to improving end-of-life management are the lack of:

- ▶ Awareness of those involved in the disposal process of refrigerants on safety measures.
- ▶ Monitoring and evaluation mechanisms.
- ▶ Needed facilities and resources that ensure the safe disposal of the refrigerants.

Major challenges for safe disposal include the lack of:

- ▶ Storage space for used refrigerants.
- ▶ Proper equipment for refrigerant treatment among technicians.
- ▶ Awareness among installers and technicians.
- ▶ Mandatory regulations for safe disposal.¹¹⁶

8.3. Key factors for purchase decision

- ▶ The upfront investment cost is a key driver for the purchase decision of a certain AC system type.
- ▶ Homeowners in existing buildings often make purchase decisions based on consultations with installers or other trusted persons.
- ▶ In new homes, the views of architects and MEP consultants impact the type of installed AC systems.
- ▶ In larger non-residential buildings, international standards impact the type of AC systems installed.
- ▶ Related to commercial refrigeration, many brands provide their own refrigeration system for the distribution of their products in supermarkets (mainly standalone systems).

¹¹² Ibid

¹¹³ See for example:

National Ozone Unit Lebanon 2021

CLASP 2020

United Nations Environment Programme (UNEP) 2015 For AC systems, the UNEP factsheets with its global scope consider the typical leakage rates 1%-6 %; for commercial refrigeration systems and for standalone equipment to be 5%-20%; for the condensing unit and centralized systems to be in the same order of magnitude.

Intergovernmental Panel on Climate Change (IPCC) 2007

National Ozone Unit Lebanon 2021

¹¹⁴ Assumption based on:

Government of Turkey 2021

United Nations Industrial Development Organization (UNIDO) 2018

United Nations Environment Programme (UNEP) 2015

¹¹⁵ İSKİD Air Conditioning and Refrigeration Manufacturer's Association - İklimlendirme Soğutma Klima İmalatçıları Derneği 2022

¹¹⁶ Ibid

8.3.1. Air conditioning sector

Most interviewed market actors consider cost, especially the upfront investment cost, to be the main criterion affecting purchase decisions for AC and commercial refrigeration systems. Other factors influencing the purchase decision include the reliability and ease of maintenance and, for AC systems specifically, personal recommendations (from installers or sellers).¹¹⁷

Because the type of actor taking certain purchase decisions may differ depending on the type of building, relevant characteristics are further discussed as follows.

For existing residential buildings with homeowners, the owners usually decide which AC system to buy, often based on consultations with installers or other trusted persons. In new homes, views of architects, MEP consultants, and building standards that need to be followed impact the purchase decision, although the ultimate decision is taken by the homeowner.¹¹⁸

In existing rental homes, property owners usually decide about new AC installations for furnished apartments. While the apartment owners are faced with the investment cost, they do not directly benefit from the installation, so their ability to charge the cost from the tenants is a key factor in the decision to install new AC. For new, large rental apartment blocks, this decision can be influenced by planners, architects, or consultants. Depending on the market, the ability to recuperate investment via rent plays a significant role.¹¹⁹

In existing non-residential buildings, purchase decisions for new AC systems are made by the company or business using the building based on recommendations from the contracted MEP consultants or following the country standards of the large companies. In new buildings, architects, planners, or consultants decide what system will be installed.¹²⁰

In large supermarkets, restaurants, or hotels, decisions about which AC systems to buy can be predetermined by existing (sometimes international) standards of the parent company depending on recommendations from contracted MEP consultants. In small independent supermarkets, restaurants, hotels, or corner stores, these decisions are made by the store owner directly, sometimes based on advice from sellers, installers, or MEP consultants.¹²¹

8.3.2. Commercial refrigeration sector

Large brands often provide their equipment to stores and supermarkets and mainly follow their own guidelines and standards for each store's size and needs. These new installations and replacements are mainly standalone systems and depend on the plans and preferences of suppliers and manufacturers in the food and beverage industries that provide these systems, which are mainly dedicated to their own products.

In large supermarkets, restaurants, or hotels, purchase decisions can be predetermined by existing (sometimes international) standards of the parent company depending on recommendations from contracted MEP consultants. In small independent supermarkets, restaurants, hotels, or corner stores, these decisions are made by the store owner directly, sometimes based on advice from sellers, installers,

¹¹⁷ Ibid

¹¹⁸ Ibid

¹¹⁹ Ibid

¹²⁰ Ibid

¹²¹ Ibid

or consultants influenced by factors such as cost, size, reliability, brand name, and ease of maintenance.¹²²

¹²² Ibid

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