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Market Study Results Review & Transformation Plan to Green Cooling Technologies in the Domestic & Retail Refrigeration Subsectors under the Food Cold Chain Sector in Viet Nam

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:
Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
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On behalf of the International Climate Initiative (IKI)

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2 Abbreviations

AC	Air Conditioning
BMUV	German Federal Ministry of Environment, Nature Conservation, Nuclear Safety and Consumer Protection
CO_2eq	Carbon dioxide equivalent
COP	Coefficient of Performance
COP	Conference of the Parties
COVID-19	Coronavirus disease 2019
DCC	Department of Climate Change
DOIT	Department of Industry and Trade
EE	Energy efficiency
ETP/UNOPS	United Nations Office for Project Services Southeast Asia Energy Transition Partnership
GCI	Green Cooling Initiative
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSO	General Statistics Office Viet Nam
GWP	Global Warming Potential
HC	Hydrocarbon
HCFC	Hydrochlorofluorocarbons
HEPS	High Energy Performance Standard
HFC	Hydrofluorocarbon
MARD	Ministry of Agriculture and Rural Development
MEPS	Minimum Energy Performance Standard
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MP	Montreal Protocol
NOU	National Ozone Unit
RAC	Refrigerant and Air Conditioning
USD	United States dollar

I. Introduction

The Green Cooling Initiative III (GCI III), spearheaded by the German Federal Ministry of Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), is a comprehensive and ambitious global endeavor designed to advance sustainable cooling practices worldwide. This initiative targets key countries, including Viet Nam, with the goal of promoting the adoption of energy-efficient cooling technologies that use natural refrigerants. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) plays a pivotal role as the primary implementing agency for this project.

In Viet Nam, GCI III is strategically aligned with the country’s overarching environmental and climate objectives, notably its ambitious commitment to achieving net-zero emissions by 2050. The initiative aims to facilitate a transformative shift to green cooling in Viet Nam’s cooling sector by focusing on critical areas such as capacity building, policy guidance, and support for market transitions. By doing so, GCI III seeks to establish Viet Nam’s cooling sector as a benchmark for climate-friendly innovation.

The project engages a broad spectrum of stakeholders to ensure its success, including political decision-makers, technology providers, manufacturers, end users, research institutions, and non-governmental organizations. Key partners in Viet Nam encompass various government bodies such as the Ministries of Natural Resources and Environment (MONRE), the Department of Climate Change, and the National Ozone Units (NOU).

Through these collaborative efforts, GCI III aims to bolster the ability of stakeholders to adopt and implement green cooling solutions effectively. This, in turn, contributes significantly to advancing Viet Nam’s sustainability agenda and achieving its climate targets, positioning the country as a leader in the global movement towards environmentally friendly cooling technologies.

This assignment centers on elaborating a market study and developing a transformation plan for green cooling technologies in the domestic and retail refrigeration subsectors under the food cold chain sector in Viet Nam.

1. Objective

Viet Nam, with a population exceeding 100 million, is recognized as one of the country’s most vulnerable to climate change. The rapid pace of its economic development has only exacerbated environmental risks and associated impacts. A significant contributor to these challenges is the cooling sector, which has become a leading source of greenhouse gas (GHG) emissions in the country. According to the National Green Cooling Program by United Nations Office for Project Services Southeast Asia Energy Transition Partnership (ETP/UNOPS), the cooling industry is responsible for nearly 60 million tons of GHG emissions annually, accounting for 10.7% of Viet Nam's total emissions[1].

The recent surge in demand for cold chain services in Viet Nam can be attributed to several key factors: Viet Nam's economic growth, driven by its strong export market for seafood and agricultural products has for one significantly increased the demand for cold chain to ensure the quality and safety of goods along its supply chain, including the domestic and retail refrigeration subsectors. Additionally, changing domestic consumption patterns, including the rise of online food shopping, higher consumption of imported and organic foods, and the expansion of franchise chains, have further fueled the need for enhanced cold storage and refrigeration services. The distribution of vaccines, pharmaceuticals, and biological products has also heightened the importance of cold chain, especially considering global health challenges.

According to the General Statistics Office (GSO) data from 2018 to 2022, there has been a notable increase in the production of domestic refrigeration appliances, specifically refrigerators and freezers with an increase of approximately 21%. This percentage increase highlights a robust growth trend in the domestic refrigeration sector, reflecting expanding market demand and advancements in technology over the five-year period.

The cold chain sector has also become a significant and rapidly expanding market in Viet Nam. According to FiinGroup, the participation of both domestic and international investors has been robust, leading to a 44.8% increase in the design capacity of cold storage facilities between 2020 and 2023. The logistics market for cold chains in Viet Nam reached a value of 211.2 million USD in 2023, with projections indicating a 70% increase in cold storage capacity over the next five years, from 1 million to 1.7 million pallets[2].

However, this rapid expansion is not without consequences. The growth of the cold chain and domestic refrigeration or refrigeration sector in general has led to a significant increase in energy consumption and GHG emissions. While the sector is essential for supporting Viet Nam's economic growth, it also poses a serious challenge to the environment.

For instance, in the first five months of the year, Viet Nam's seafood exports reached nearly 3.6 billion USD, a 6% increase compared to the same period in 2023[3]. The livestock industry also saw remarkable growth, with export values reaching 515 million USD in 2023, a 26.2% increase from 2022[4]. Yet, this success has come at the cost of increased reliance on energy-intensive cold chain and refrigeration services.

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[1] Bao Tai nguyen moi truong, 2023. Promoting emissions reduction in the cooling sector. https://baotainguyenmoitruong.vn/thuc-day-giam-phat-thai-trong-linh-vuc-lam-mat-365484.html

[2] Fiingroup, 2024. Viet Nam Cold Chain Market Report 2024. https://fiingroup.vn/NewsInsights/Detail/11065024

[3] Bao chinh phu, 2024. The seafood industry aims to export more than 10 billion USD. https://baochinhphu.vn/nganh-thuy-san-huong-toi-muc-tieu-xuat-khau-dat-hon-10-ty-usd-10224061108012156.htm

[4] Thanh Nien, 2024. Pork exports suddenly skyrocket, chicken waiting to be exported to UK and Korea. https://thanhnien.vn/xuat-khau-thit-heo-bat-ngo-tang-vot-thit-ga-cho-ngay-sang-anh-han-quoc-185240112181831136.htm

Moreover, changes in consumer behavior, driven by economic challenges following the COVID-19 pandemic, have led to greater acceptance of frozen foods, further increasing the demand for cold storage and refrigeration services. Data from the General Department of Customs indicates that the import value of livestock products in the first quarter of 2023 reached nearly 741 million USD, a 1.5% increase from the previous year, with significant growth in the import of frozen meat[5].

GHG emissions from the refrigeration sector not only stem from electricity consumption due to the increase of application but also from the use of refrigerants, with HFCs (Hydrofluorocarbons) being the most common in use. MONRE data reveals a steady increase in HFC consumption from 2015 to 2020, culminating in a sharp spike of over 6,000 tons in 2020. While COVID-19 temporarily reduced consumption in 2021, it rebounded in 2022. The average HFC consumption during this period reached 5,700 tons, equivalent to 10.7 million tons of CO_2eq.. Notably, a 2% increase in 2022 HFC consumption led to a 9% rise in CO_2 emissions, indicating a shift towards higher-emitting HFCs[6].

Table 1: List of refrigerants commonly used in Viet Nam

Type	Refrigerant	ODP	GWP 100 years
HFC	HFC-134a	-	1,430
	HFC-32	-	675
	R-404A	-	3,922
	R-407C	-	1,774
	R-410A	-	2,088
	R-507A	-	3,985
HCFC	HCFC-22	0.034	1,810
	HCFC-123	0.01	77
Natural refrigerants	HC-600a	-	3
	HC-290	-	3
	R-717 (NH_3)	-	0
	R-744 (CO_2)	-	1

**RTOC, 2018*[7]

At the Conference of the Parties (COP28) in late 2023, Viet Nam demonstrated its commitment by joining the Global Cooling Pledge, aiming to reduce GHG emissions in the global cooling sector by at least 68% by 2050 compared to 2022 levels. Furthermore, in June 2024, the Prime Minister endorsed Decision No. 496/QD-TTg, establishing a comprehensive national plan to manage and eliminate ozone-depleting substances and controlled GHGs. This plan aligns ozone

[5] Thanh Nien, 2024. Pork exports suddenly skyrocket, chicken waiting to be exported to UK and Korea. https://thanhnien.vn/xuat-khau-thit-heo-bat-ngo-tang-vot-thit-ga-cho-ngay-sang-anh-han-quoc-185240112181831136.htm

[6] DCC, 2023. Viet Nam keeps HFC consumption below 14 million tons of CO2 equivalent. http://www.dcc.gov.vn/tin-tuc/3999/Viet-Nam-giu-muc-tie%CC%82u-thu%CC%A3-HFC-duoi-14-trieu-tan-CO2-tuong-duong.html

[7] UNEP, 2018.Report of The Refrigeration, Air conditioning and Heat pumps technical options committee, 2018 Assessment. https://ozone.unep.org/sites/default/files/2019-04/RTOC-assessment-report-2018_0.pdf

layer protection, Montreal Protocol obligations, and sustainable cooling initiatives, underscoring Viet Nam's proactive approach to addressing climate change and promoting sustainable development.

Therefore, to reinforce Viet Nam's determination, the project aims to address this challenge through comprehensive policy analysis and the implementation of green cooling technologies, particularly within the refrigeration sector. To advance sustainability cooling in Viet Nam, it is essential to deploy integrated solutions that combine green cooling technologies with environmentally friendly and natural refrigerants. These efforts will not only bring Viet Nam closer to achieving its climate change goals but also fulfill its international commitments, particularly the target of net-zero emissions by 2050.

2. Scope of work

The Viet Namese cold chain industry, which includes domestic and retail refrigeration subsectors (convenience stores, supermarket, cash & carries), is pivotal for ensuring food security and fostering economic development. Nevertheless, the dependence on conventional cooling technologies presents notable challenges such as heightened GHG emissions, substantial energy consumption, and the Ozone Depletion Substances used in the conventional refrigerants. To effectively tackle these issues and pave the way for a sustainable future, this technical report explores the transformation of the sector through the integration of eco-friendly cooling technologies with the following scopes:

- Conduct a subsector analysis, i.e. market survey including primary data collection from the current status of domestic and retail refrigeration subsectors.
- Conduct a policy analysis relevant to the selected subsectors, domestic and retail refrigeration.
- Formulate a transformation plan based on balance between ambition, cost and technical availability.
- Presentation of transformation plan on a stakeholder workshop.

3. Methodology

The methodology for conducting the subsector analysis will involve several key steps:

Desk review of the Market Study Findings and Current Technical Regulations and Policies: To develop the transformation plan, the Consultant based on the results of the previous assignment *"NC1-Elaborate a market study in the domestic and retail refrigeration subsectors under the food cold chain sector in Viet Nam for the development of a transformation plan to green cooling technologies."* and the review of current regulations, policies and institutional arrangements in Viet Nam. This assessment encompasses all legal, institutional, and policy aspects aimed at enhancing energy efficiency (EE), promoting low-carbon technologies, and increasing energy savings within the cooling sector, with a specific focus on the food cold chain subsector and EE in general. Besides, an exhaustive examination of scientific research about cooling technologies and practices is undertaken. Furthermore, valuable insights are acquired through the analysis of published reports and the study of refrigeration programs implemented in diverse countries, enabling us to glean knowledge from international experiences in terms of the current status of the subsector and also the future applicable technology.

Making use of Additional Data Collection from the Market Survey: Data collection is a crucial aspect of this analysis. To provide a comprehensive background of the subsector, the Consultant employed both bottom-up and top-down approaches:

– Bottom-up approach: Conducted a national data survey targeting enterprises within the sector to gather detailed information.
- Top-down approach: Collected secondary data from relevant ministries, statistical agencies, and other sources to supplement the primary data collected.

Making use of Data analysis from Market Study: After reviewing the collected data from previous market surveys (primary data collection), the Consultant conducted the data compilation to estimate the amount of equipment by type in subsector, the refrigerants used, annual energy consumption in subsector...

Stakeholder Consultation: Engaging with stakeholders is a crucial step in the methodology for subsector analysis. Direct consultations are conducted with line ministries, departments, industry associations, academic institutions, and entities involved in the refrigeration subsector. This collaborative approach ensures a comprehensive understanding of the subsector's needs and challenges, integrating valuable insights from all key players.

By following these methodological steps, the analysis aims to provide a comprehensive understanding of the subsector, including its current state, challenges, opportunities, and potential pathways for improvement towards more sustainable practices.

II. Existing regulation, policy and institutional related to Refrigeration sector, in particular Domestic and Commercial Refrigeration Subsectors

The purpose of reviewing existing regulations, policies, and institutional frameworks related to Viet Nam's refrigeration sector is to identify current gaps, challenges, and opportunities for improvement. This review ensures that the sector's development aligns with national and international environmental goals, such as energy efficiency and reduced greenhouse gas emissions. By understanding the existing landscape, stakeholders can formulate more effective strategies, support the adoption of green cooling technologies, and create a roadmap for sustainable growth. Additionally, this review aids in harmonizing the sector's regulatory environment with global best practices, promoting innovation, and ensuring long-term environmental and economic benefits.

1. Energy efficiency

1.1. Law on Energy Saving and Efficient Use of Energy

The Law on Energy Saving and Efficient Use of Energy – Law No. 50/2010/QH12 was issued by the National Assembly on June 17, 2010, and took effect from January 1, 2011, to foster the economical and efficient use of energy including equipment in the Refrigeration and Air conditioning sector. The promulgation of the Law on Energy Saving and Efficient Use of Energy is an important milestone in the process of building laws on economical and efficient use of energy in our country.

This Law provides measures for managing the economical and efficient use of energy for vehicles and equipment, including:

i. **Energy Efficiency Standards:** The government sets and announces energy performance standards and minimum EE levels for vehicles and equipment.

   In electrical appliances including domestic and commercial refrigeration appliances, the refrigerators must meet the Minimum EE requirements specified in the Viet Namese Standard TCVN 7828:2016 and TCVN 10289:2014 to avoid being classified as low-efficient equipment categories including refrigerators, refrigerator-freezers and freezers, commercial refrigerated cabinets. These equipment categories, if they do not meet the minimum EE requirements as described, will be banned from importing, manufacturing and sale in Viet Nam as per Decision No. 14/2023/QD-TTg, issued by the Prime Minister, dated 24 May 2023 and effectively from July 15, 2023.

ii. **Energy Labeling:** Vehicles and equipment must be labeled with energy consumption information before being marketed.
iii. **Public Disclosure:** Relevant energy use information for vehicles and equipment must be made public.
iv. **Elimination of Inefficient Products:** Vehicles and equipment that do not meet minimum EE standards must be phased out.
v. **Regulatory Enforcement:** Violations of these regulations will be penalized.

Energy Performance Standards Development:

- Energy performance standards are developed to promote energy conservation, environmental protection, and align with socio-economic development and technological advancement.

- The Ministry of Science and Technology (MOST) reviews and publishes these standards every five years.

Energy Labeling:

- Vehicles and equipment on the specified list must be labeled with energy information before sale.

- Manufacturers and importers are responsible for labeling after receiving certification from relevant authorities.
- The Ministry of Industry and Trade (MOIT) oversees the labeling process, including establishing the list of products that require labeling, setting label specifications, and defining testing and certification procedures. The refrigeration and air conditioning (RAC) equipment are included in the program, also.

Management of Low-Efficient Products:

- Products with energy performance below the minimum standards must be phased out according to a schedule set by the Prime Minister.
- The production and import of these low-efficiency products are prohibited.
- MOST, in coordination with MOIT, develops and proposes the list of products to be phased out.

The law is accompanied by additional documents that offer specific guidance for its enforcement and implementation. These documents are discussed in the subsequent sections.

1.2. Energy Efficiency Standards

TCVN 7828:2016: Refrigerator, Refrigerator-Freezer, and Freezer - Energy Efficiency

This standard replaced TCVN 7828:2013, specifies the minimum EE and energy consumption levels for refrigerators, refrigerator-freezers, and freezers up to 1000 liters using either natural convection or forced air circulation for cooling does not apply to absorption cooling devices, commercial refrigerated display cabinets, or specialized refrigeration equipment used in industrial or medical settings.

It establishes the minimum EE requirements and EE level for these appliances. EE is graded on a scale from 1 to 5, with Grade 1 being the least efficient and Grade 5 the most efficient. The grading is determined based on the Energy Performance Index (R), which compares the actual energy consumption to the maximum allowed energy consumption (Emax). Minimum Energy Performance Standard (MEPS) defined for different types of refrigerators and freezers, with specific formulas provided for calculating the maximum annual energy consumption based on adjusted volume.

TCVN 7829:2016: Refrigerators, Freezers, and Refrigerator-Freezers - Method for Determining Energy Efficiency

This standard provides methods to determine the EE of refrigerators, freezers, and refrigerator-freezers with a capacity of up to 1,000 liters and excludes certain specialized and commercial refrigeration devices. The calculation considers factors such as daily energy consumption, auxiliary equipment consumption, and load processing efficiency.

The standard specifies the procedures for measuring energy consumption and determining the capacity of these refrigeration devices under controlled conditions. It includes detailed requirements for ambient temperature, humidity, and electrical supply during testing, as well as guidelines for setting up and operating the equipment during the tests.

TCVN 10289:2014: Commercial Refrigerated Cabinets - Energy Efficiency

This national standard, TCVN 10289:2014, outlines the ***EE requirements for commercial refrigerated cabinets*** used to store and display food. The standard defines key terms such as "total energy consumption and energy efficiency" and ***sets minimum and high EE levels*** based on total energy consumption per display area. The standard also provides specific EE values for different types of refrigerated cabinets, including those with built-in condensers and remote condensers, and categorizes them based on their temperature settings (low or medium) and design features. The document ***excludes vending machines*** and refers to other relevant standards like TCVN 9982-1 for further definitions and test methods, however, EE standard for this type has not been developed yet.

TCVN 10290:2014: Commercial Refrigerated Cabinets - Method for Determination of Energy Efficiency

This standard outlines the methods for determining the energy consumption and display area of commercial refrigerated cabinets used for selling and displaying food. It specifies testing conditions, procedures, and equipment needed to measure the EE of these cabinets. The document includes detailed guidelines on setting up testing environments, such as required power sources, room climate, and equipment used for measurements. The standard is crucial for ensuring that commercial refrigeration units operate efficiently while maintaining food safety standards.

1.3. Energy Labelling

Decree No. 21/2011/ND-CP

Government Decree No. 21/2011/ND-CP, dated March 29, 2011, outlines the Law on Economical and Efficient Use of Energy and its implementing measures. The Decree outlines the regulations for energy labeling of energy-consuming vehicles and equipment. It requires that products on the designated list must be labeled before entering the market. MOIT is responsible for creating this list and implementing the labeling process. There are two types of energy labels:

- Comparative Label: Indicates the relative energy efficiency of a product using a star rating system (1-5 stars).
- Endorsement Label: Indicates that a product meets or exceeds the High Energy Performance Standard (HEPS).

Testing facilities must meet specific standards to be authorized to conduct EE tests for labeling. The application process for energy labeling includes providing technical specifications, energy performance test results, and a request for labeling. MOIT oversees the issuance of energy labeling certificates and enforces compliance.

Energy labels must be applied to products by manufacturers or importers. Labels must be renewed before expiration, and unauthorized labeling is prohibited. In cases of non-compliance, such as using fake labels or incorrect information, energy labeling can be suspended, and certificates can be revoked.

Annual reports on energy-labeled products are required from manufacturers and importers, with the information submitted to local industry departments and then to MOIT. Inspections are conducted to ensure compliance with labeling regulations. Additionally, vehicles and equipment that fail to meet minimum EE standards or safety regulations must be phased out and are prohibited from import and circulation.

Circular No. 36/2016/TT-BCT

Circular No. 36/2016/TT-BCT issued by MOIT, dated December 28, 2016, outlines the procedures for energy performance testing, registration, labeling, inspection, and potential revocation of equipment. Both domestic and foreign testing organizations must meet specific standards, and enterprises are required to register energy labels with the MOIT before marketing products. Labels must accurately reflect energy consumption and include key details.

The Circular also specifies the reporting and monitoring requirements for energy labelling. Manufacturers and importers must submit annual reports on the quantities and types of labelled equipment to MOIT and the Department of Industry and Trade (DOIT). To ensure compliance, both regular and irregular inspections may be conducted. Complaints about labels may result in independent testing, and MOIT has the authority to revoke labels if discrepancies are discovered, with such decisions published online. Additionally, the Circular provides detailed specifications for the energy label template, including its design and mandatory information.

Decision No. 04/2017/QD-TTg

Decision No. 04/2017/QD-TTg, issued by the Prime Minister, dated March 9, 2017, on the list of equipment and appliances to which the mandatory energy labeling and minimum EE standards are applied, and the roadmap to their implementation establishes mandatory energy labeling and MEPS for various equipment ***including refrigerators and commercial freezers.***

1.4. Prohibition of Low-Efficient Equipment

Decision No. 14/2023/QD-TTg

Decision No. 14/2023/QD-TTg, issued by the Prime Minister, dated 24 May 2023, promulgates the lists of low-efficiency equipment subject to elimination and low-efficiency generating sets banned from development and application roadmaps. Effective from July 15, 2023, this Decision lists low-efficiency equipment, including refrigerators, refrigerator-freezers and freezers, commercial refrigerated cabinets that are banned from import, manufacture, and sale in Viet Nam.

Refrigerators must meet the minimum EE requirements specified in TCVN 7828:2016 to avoid being classified as low-efficiency equipment. The following table details the list of Refrigeration sector equipment that are prohibited to import, manufacture, and trade equipment whose efficiency fails to satisfy the minimum EE prescribed in National Standards.

Table 2: List of Refrigeration sector equipment prohibited due to low efficiency energy

Name (equipment)	National Standard	Application roadmap
Refrigerators	TCVN 7828:2016	From April 1, 2025
Refrigerator-freezers and freezers	TCVN 7828:2013	From the effective date of this Decision to the end of March 31, 2025
	TCVN 7828:2016	From April 1, 2025
Commercial refrigerated cabinets	TCVN 10289:2014	From the effective date of this Decision

Source: Decision No. 14/2023/QD-TTg

MOST is responsible for leading and coordinating efforts to phase out low-efficiency equipment as well as developing and reviewing national EE standards. MOIT oversees compliance with these regulations, including import and export controls and guiding inspections. Additionally, other ministries, sectors, and local authorities are tasked with executing the phase-out and prohibition measures based on their specific roles and responsibilities.

2. Refrigerants

Viet Nam was among the first nations to ratify the Vienna Convention and Montreal Protocol, demonstrating its commitment to ozone layer protection since 1994. Over the years, Viet Nam has actively implemented measures to manage and eliminate ozone-depleting substances, strengthening its institutions and policies to fully comply with international obligations.

Law on Environmental Protection

The Law on Environmental Protection 2020 – Law No. 72/2020/QH14, enacted by the National Assembly on November 17, 2020, and effective from January 1, 2022, marks a significant advancement in enhancing environmental protection in Viet Nam. This law introduces comprehensive regulations to improve environmental sustainability and integrates measures across various sectors, including ozone layer protection activities. The promulgation of the Law on Environmental Protection 2020 represents a critical step in strengthening the legal framework for environmental conservation and sustainable development in the country.

Article 92 of this Law focuses on ozone layer protection and outlines measures to prevent ozone depletion and mitigate the harmful effects of ultraviolet radiation. It includes managing the production, trade, and disposal of ozone-depleting substances and GHGs in accordance with international treaties. The Ministry of Natural Resources and Environment (MONRE) serves as the national focal point for implementing the Vienna Convention and Montreal Protocol. As such, MONRE is tasked with overseeing the national plan for managing these substances, developing guidelines, and coordinating with other authorities. Ministries and local authorities are responsible for regulating these substances within their jurisdiction, while manufacturers and users must follow guidelines for the replacement and disposal of harmful substances.

Decree No. 06/2022/ND-CP

Government Decree No. 06/2022/ND-CP was issued on January 7, 2022, with the aim of mitigating GHG emissions and protecting the ozone layer.

The Decree sets out the basic contents of the roadmap for management and elimination of substances according to Viet Nam's responsibilities and obligations to implement the Montreal Protocol; responsibilities of organizations and individuals related to controlled substances; regulations on management principles and coordination responsibilities between government agencies in the management of controlled substances.

According to Decree No. 06/2022/ND-CP the HCFCs Phase-out schedule is detailed as follows:

- **2022-2024:** Consumption not exceeding 65% of baseline levels, corresponding to total national consumption not exceeding 2,600 tons/year.
- **2025-2029:** Consumption not exceeding 32.5% of baseline levels, corresponding to total national consumption not exceeding 1,300 tons/year.
- **2030-2039:** Annual average consumption not exceeding 2.5% of baseline levels, corresponding to the average annual national consumption not exceeding 100 tons/year.
- **2040 Onwards:** Import and export of HCFCs banned.

Controlled GHG are defined as Hydrofluorocarbons (HFCs) and will be controlled as of 2024 according to the following schedule:

- **2024-2028:** Consumption and production not exceeding baseline levels.
- **2029-2034:** Consumption and production not exceeding 90% of baseline levels.
- **2035-2039:** Consumption and production not exceeding 70% of baseline levels.
- **2040-2044:** Consumption and production not exceeding 50% of baseline levels.
- **2045 Onwards:** Consumption and production not exceeding 20% of baseline levels.

The baseline manufacture of HFCs is determined based on the average production of HFCs expressed as CO2 equivalent of the years 2020, 2021 and 2022. MONRE will announce baseline levels and consumption annually. In the **Decision No. 4134/QD-BTNMT** issued by MONRE at December 28th, 2023, the baseline of HFC **consumption** for the period **2024-2028** is **13,991,360 tCO2eq**, while baseline **production** level is **0**.

As for the **registration and reporting of controlled substances (refrigerants)**, organizations involved in the production, export, import, or possession of these substances are required to follow specific registration and reporting procedures. The scope of these regulations encompasses various activities including the production, import, and ownership of equipment containing or made from controlled substances, as well as the collection, recycling, reuse, and disposal of these substances. The registration process mandates that these organizations submit a registration dossier to the MONRE by December 31, 2022. Additionally, these organizations must report their use of controlled substances annually by January 15 using the specified form, and new organizations established after December 31, 2022, must comply with these registration and reporting requirements.

Regarding the procedures for **allocating, adjusting, and cancelling quotas** for controlled substances, organizations seeking quota adjustments must submit requests by July 10 each year. Decisions regarding quota allocations, adjustments, and cancellations serve as the basis for monitoring and controlling export and import activities, with relevant documentation required for customs processes.

Table 3: List of controlled HCHC and HFC substances according to Circular 01/2022/TT-BTNMT

Type of Refrigerant	Refrigerant	ODP	GWP
HCFC	HCFC-22	0.055	1,810
	HCFC-123	0,06	77
	HCFC-141	0.07	-
	HCFC-141b	0.11	725
	HCFC-142	0.07	-
	HCFC-142b	0.065	2,310
	HCFC-225	0.07	-
	HCFC-225ca	0.025	122
	HCFC-225cb	0.033	595
HFC	HFC-134	-	1,100
	HFC-134a	-	1,430
	HFC-143	-	353
	HFC-245fa	-	1,030
	HFC- 365mfc	-	794
	HFC-227ea	-	3,220
	HFC-236cb	-	1,340
	HFC-236ea	-	1,370
	HFC-236fa	-	9,810
	HFC-245ca	-	693
	HFC-43- 10mee	-	1,640
	HFC-32	-	675
	HFC-125	-	3,500
	HFC-143a	-	4,470
	HFC-41	-	92
	HFC-152	-	53
	HFC-23	-	14,800
HFC blends	R-401A	-	1,182

	R-401B	-	1,288
	R-404A	-	3,922
	R-406A	-	1,943
	R-407A	-	2,107
	R-407C	-	1,774
	R-407F	-	1,825
	R-407H	-	1,495
	R-408A	-	3,152
	R-409A	-	1,585
	R-410A	-	2,088
	R-415B	-	546
	R-417A	-	2,346
	R-422A	-	3,143
	R-422D	-	2,729
	R-427A	-	2,138
	R-438A	-	2,265
	R-448A	-	1,387
	R-449A	-	1,397
	R-449B	-	1,412
	R-450A	-	605
	R-452A	-	2,140
	R-452B	-	698
	R-454A	-	239
	R-454B	-	466
	R-454C	-	148
	R-466A	-	733
	R-507A	-	3,985
	R-508B	-	13,396
	R-513A	-	631
	R-513B	-	596

The collection, recycling, reuse, and disposal of controlled substances is also detailed in this Decision. Organizations involved in the production or import of equipment and products containing or made from controlled substances are required to follow specific guidelines for managing these substances. Starting January 1, 2024, these organizations must collect controlled substances from equipment and products when they are no longer in use. They are encouraged to recycle and reuse these substances where possible. ***If recycling or reuse is not feasible, the substances must be treated and disposed of according to hazardous waste regulations***. Annual reports on the usage of controlled substances must be submitted as specified.

Controlled substances generated from the installation, repair, or maintenance of equipment must be collected, transported, and stored in compliance with relevant regulations. If these substances can be recycled or reused, this should be done according to the MONRE's guidelines. If not, their transport, storage, and disposal must adhere to hazardous waste management laws. The detail for technical regulations on collection, transportation, storage, recycling, reuse and handling of controlled substances, which are mentioned in the Appendix III.2 and Appendix III.3 enclosed with the Circular No. 01/2022/TT-BTNMT, are provided in the **Circular No. 20/2023/TT-BTNMT** issued by MONRE on November 30th, 2023 about National technical regulation on collection, transportation, storage, recycling, reuse and handling of controlled substances.

Collection, transport, and storage of controlled substances must meet certain requirements, including having appropriate equipment such as recovery machines, containers, vacuum pumps, scales, leak detection devices, and safety tools. Technicians involved in these activities must hold relevant qualifications or certification from a training program accredited by the Ministry of Labour, Invalids, and Social Affairs, in collaboration with MONRE. Individuals owning equipment or products with controlled substances must deliver these to designated collection points or facilities without altering their form.

Decision No. 496/QD-TTg

Implementing the Law on Environmental Protection and Decree No. 06/2022/ND-CP of the Government regulating the reduction of GHG emissions and protection of the ozone layer, on 11 June 2024, the Prime Minister issued a National Plan on management and elimination of ozone-depleting substances and GHG substances controlled in Decision No. 496/QD-TTg. The objective of the national plan is to effectively manage and eliminate ozone-depleting substances and GHGs controlled according to the roadmap for implementing the Montreal Protocol through solutions to strengthen management and eliminate controlled substances, implement technology conversion and use substances with low or zero global warming potential (GWP) and deploy sustainable cooling solutions, striving to reduce emissions by 11.2 million tons of CO_2eq by 2045 from activities to eliminate controlled substances.

The national plan provides a HCFC and HFC Management and Phase-Out roadmap with more detailed information on quantity compared to Decree No. 06/2022/ND-CP which implementation is outlined as follows:

- **HCFCs**:
  - **By December 31, 2024:** Reduce consumption by 35% from baseline level, totaling no more than 2,600 tons/year.
  - **From 2025 to 2030:** Reduce consumption by 67.5% from baseline level, totaling no more than 1,300 tons/year.
  - **From 2030 to 2040:** Reduce consumption by 97.5% from baseline level, totaling no more than 100 tons/year.
  - **From January 1, 2040:** Achieve a 100% reduction from baseline.

- **HFCs:**
  - **From 2024 to 2029:** Maintain consumption at or below baseline level, totaling no more than 14.0 million tons CO_2eq.
  - **From 2029 to 2035:** Reduce consumption by 10% from baseline level, totaling no more than 12.6 million tons CO_2eq.
  - **From 2035 to 2040:** Reduce consumption by 30% from baseline level, totaling no more than 9.8 million tons CO_2eq.
  - **From 2040 to 2045**: Reduce consumption by 50% from baseline level, totaling no more than 7.0 million tons CO_2eq.
  - **From January 1, 2045:** Achieve an 80% reduction from baseline level, totaling no more than 2.8 million tons CO_2eq.

Regulation of Products and Equipment containing HCFCs and HFCs roadmap is also detailed:

- **By 2029:** Extend restrictions to various refrigeration equipment containing R-22, HFC-404A, HFC-410A, and others with high GWP values.
- **By 2035:** Further restrict production and import of equipment with HFC-410A and similar high-GWP substances.
- **By 2040:** Limit production and import of various high-GWP equipment, including commercial refrigeration.
- **By 2045:** Ban production and import of a wide range of equipment and products with substances exceeding specific GWP thresholds.

Furthermore, the national plan sets out a specific roadmap for implementation in each phase for target groups, clearly stating the responsibilities of ministries, branches, localities, socio-political organizations, socio-professional organizations, enterprises and individuals with activities related to controlled substances to achieve the set goals.

III. Current status of refrigeration subsector of Viet Nam

1. Domestic Refrigeration

The Domestic refrigeration category plays a vital role in everyday life, providing essential appliances for every household. This category is dominated by refrigerators and freezers, designed to keep food and drinks fresh. ***Most home refrigerators are factory-made, self-contained units that utilize a compressed air-based cooling system***. While beverage dispensers fall under the domestic refrigeration umbrella, they represent a small fraction of the overall market share.

Viet Nam's domestic refrigeration market is experiencing significant growth, fueled by a combination of economic and social factors. Rising disposable incomes and a burgeoning middle class are putting more money in people's pockets, allowing them to invest in appliances like refrigerators. Additionally, urbanization trends are seeing more individuals move to cities, where food storage needs are often met with the aid of refrigeration. In 2022, as mentioned in NC1 Market Study Report, the percentage of households owning refrigerators nationwide reaches 95%. As a result, ***the Viet Namese refrigerator market is projected to reach a value of USD 2.4 billion by 2029, with a steady growth rate of 5.6% per annum***[8].

The market for refrigerators in Viet Nam offers a diverse range of options catering to various consumer preferences and household requirements. According to the market survey, the main types of Domestic Refrigeration are as below:

Table 4: Refrigerator classification and general characteristics

Types of Refrigerators	**Common Features**	**Volume** (litter)	**Capacity** (W)	**Lifetime** (year)
Single-door	A basic and space-saving option with a single compartment for both refrigerated and frozen food.	<100	50 - 75	12
Double-door	Offers separate compartments for improved temperature control and EE.	<500	80 - 185	12
Side-by-side	Provides spacious side-by-side compartments for easy access to both sections.	>500	150 - 210	12

Based on the collected data in the NC1 Market Study Report, the summary of key information of Domestic Refrigeration in Viet Nam is shown in the table below:

Table 5: Summary of Domestic Refrigeration equipment in Viet Nam

Category	**Fridge + Freezer**
Average volume	Adjustment volume according to TCVN 7829:2016: 350 L Equivalent to: 250 L Refrigeration + 100 L Freezer
Lifetime of equipment	12 years *(Expert consultation)*
Refrigerant	Mainly HFC-134a and HC-600a
Initial charge amount	100gr with HFC-134a 55gr with HC-600a
Annual leakage rate	3% *(Expert consultation)*
Power consumption per year	450 kWh/year *(Calculate based on the average power consumption of available equipment from market survey)*

The trend of sale domestic refrigeration equipment in the period of 2011 – 2022 is shown in the below chart:

[8] https://www.vietdata.vn/post/Viet Nam-s-refrigeration-market-japanese-brands-lead-the-game

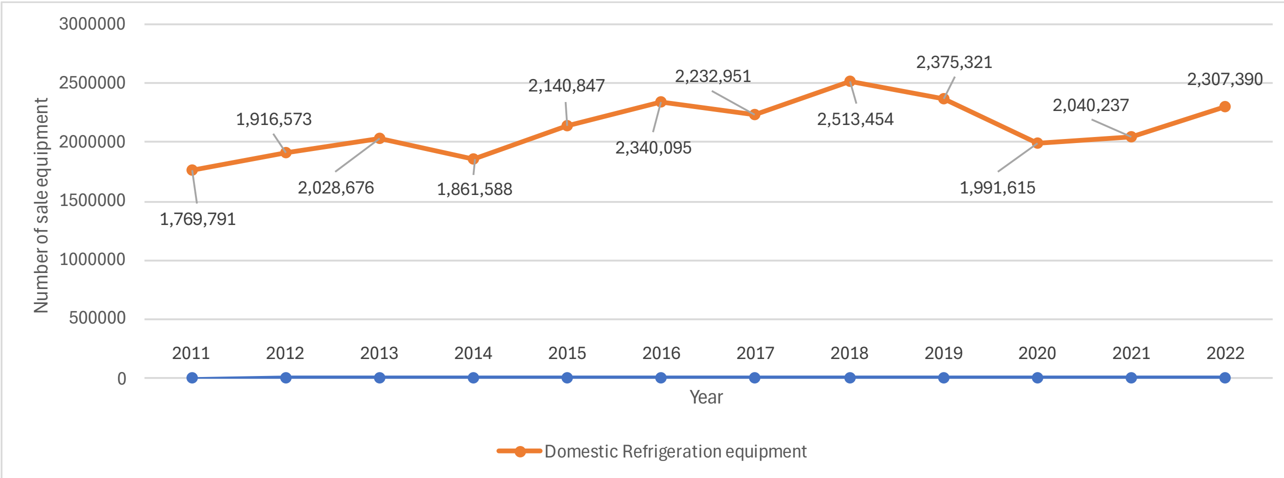

Figure 1: Sale of Domestic equipment in the period of 2011 – 2022

With the BAU and the estimated growth rate of the market, the projection of Domestic Refrigeration unit in stock in period of 2020 - 2030 is Figure 2 below. The projection is calculated by the sum of the sale products in 12 year-period as the lifetime of equipment. The sales of products in the period 2023 – 2030 are calculated based on the forecast for the collected data in the period 2015 – 2019. The Consultant did not use the data of 2020 – 2022 because this period is affected by the situation of COVID-19 pandemic, the growth rate is not applicable in those years. Up to 2030, the total number of Domestic Refrigeration equipment will increase up to 32 million units in use. This increase is 1.52 times compared to the total equipment in 2020.

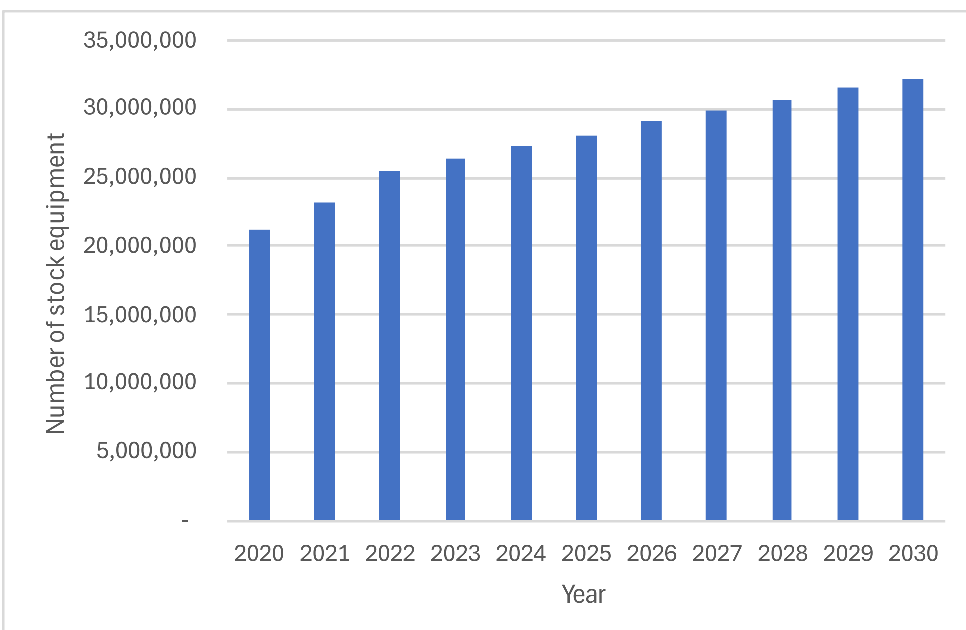

Figure 2: Projection of stock Domestic Refrigeration equipment in period of 2020-2030

Based on the data calculated for the stock equipment, the refrigerants consumption is also estimated and shown in the Figure below. The estimation is calculated with the assumption that the proportion of HC-600a equipment will be slowly increased and HFC-134a be slowly decreased but will keep a significant position in the period. Based on the collected data in 2023, the proportion of HFC-134a and HC-600a in Domestic Refrigeration is 79% and 21%, respectively. However, in 2030, the estimation of these refrigerants would be 68% and 32%, respectively.

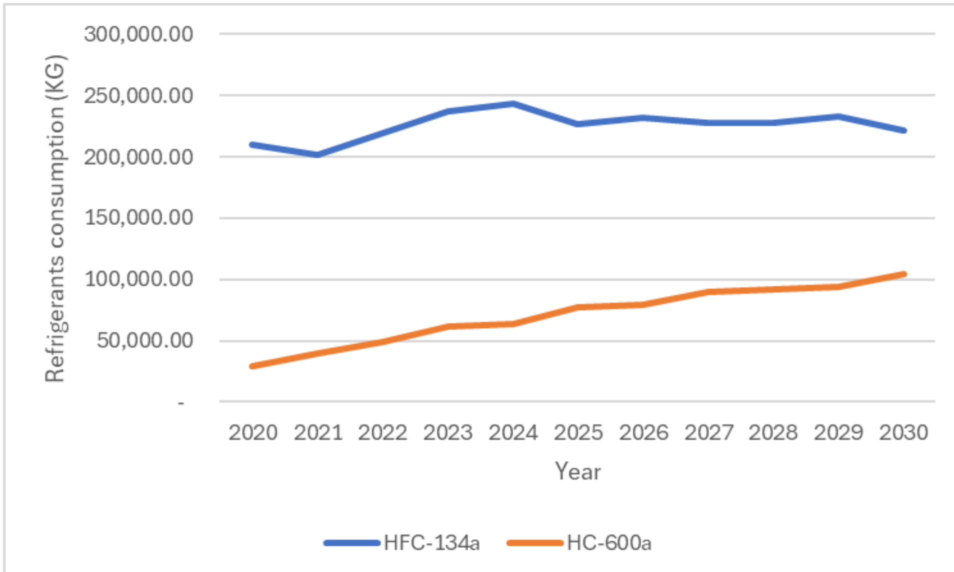

Figure 3: Refrigerants consumption in Domestics Refrigeration in period of 2020 - 2030

Even if the HFC-134a in this period has been slightly decreased, the demand for HFC-134a is still high and stable. This is due to the demand in the servicing sector, even if the life cycle of Domestic refrigeration equipment is normally 12 years, the households usually keep using the equipment even longer.

Based on the projection, the energy consumption of the Domestic Refrigeration subsector in the period 2020 – 2030 is shown in the chart below:

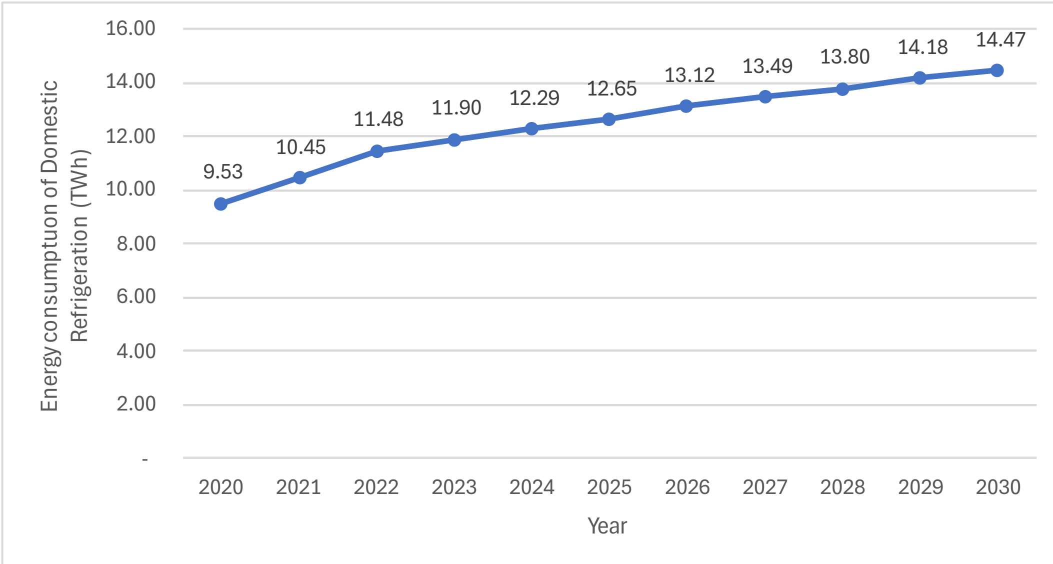

Figure 4: Energy consumption of Domestic Refrigeration in the period 2020 - 2030

The GHG emission from Domestic Refrigeration is also calculated based on direct and indirect emissions with IPCC guidelines 2006 and 2019.

Direct emission is calculated by the total emissions of the refrigerant charged in the first place at the manufacturer and the leakage of refrigerant during the operation and servicing. In Domestic Refrigeration subsector, the main refrigerants used are HFC-134a (GWP=1,430) and HC-600a (GWP=3).

Indirect emission is calculated based on energy consumption (electricity consumption). The grid emission factor in 2022 (0.676 tCO_2/MWh) published by MONRE will be used to calculate the GHG emissions.

Figure 5: Summary of GHG emissions of Domestic Refrigeration in period of 2020 – 2030

From the findings, even if there is the increasing in the total equipment in use as mentioned above, thanks to the improvement in EE (showing in increasing label-star-standard) and the shifting to use of natural refrigerant (HC-600a instead of HFC-134a), the ***GHG emissions of Domestics Refrigeration are not increased too much.*** *The projection shows the result at about* ***7.8 million tCO_2eq in 2030,*** *which is* ***20% more than in 2020*** *(about 6.4 million tCO_2eq).*

2. Commercial refrigeration

Commercial refrigeration refers to systems used to store, preserve, and display perishable goods in commercial settings such as retail stores, supermarkets, restaurants, and food storage facilities. These systems are critical for maintaining the quality and safety of food products, as well as ensuring that businesses comply with food safety regulations. ***In Viet Nam, commercial refrigeration plays a crucial role in the food cold chain, which spans from food production and processing to distribution and retail.***

Following the Draft of the Circular Regulation on Classification and Management of some types of commercial infrastructure by MOIT in 2022, the Viet Namese food cold chain in retails sub-sector could be divided into the different subsectors as below:

Table 6: Classification of food cold chain in retails subsector in Viet Nam

Subsectors	Size/floor area	Cooling capacity demand	Number of refrigerator/ store[9]	Name of some brands
Hypermarkets and shopping mall (Supermarket class I)	• Business area of 3,500m^2 or more • A list of business goods in many different industries of 20,000 items or more.	High, requiring robust cooling systems to maintain consistent temperatures in various sections (e.g., chilled food, frozen food, deli counters).	• 20-30 freezers • 20-30 fridges	• GO! • AEON mall • Lotter mart • Vincom mega mall • Mega market
Big supermarket (Supermarket class II)	• Business area of 2.000m^2 up to under 3,500m^2 • A list of business goods in many different industries of 10,000 items or more.	High, requiring robust cooling systems to maintain consistent temperatures in various sections (e.g., chilled food, frozen food, deli counters).	• 10-15 freezers • 10-15 fridges	• Mega market • Coopmart • Tops market • AEON citimart

[9] Estimated based on the survey's results.

Medium supermarket (Supermarket class III)	• Business area of $500m^2$ up to under $2,000m^2$ • A list of business goods in many different industries of 4,000 items or more.	Moderate, requiring efficient equipment to maintain appropriate temperatures for perishable goods.	• 5-7 freezers • 2-3 fridges	• Winmart • Lanchimart • Sakuko • Fujimart
Mini-mart and convenience store	• Business area of $80m^2$ up to under $500m^2$ • A list of business goods of 500 items or more.	Moderate, requiring efficient equipment to maintain appropriate temperatures for perishable goods.	• 2-4 freezers • 1-2 fridges	• Winmart+ • Homefarm • Bach Hoa Xanh • Coopmart • Circle K • T-mart • Family mart • Hapro foods • K-market • Soi Bien • Others

Due to the limited space of mini-marts and convenience stores (which are dominating the supermarket landscape as shown in NC1 report), it requires smaller, stand-alone refrigeration units like display refrigerators, chest freezers, and under-counter coolers. These units are easier to integrate into the store layout and cater to smaller display and storage needs compared to larger supermarkets.

With less emphasis on bulk storage and a focus on faster product turnover, the demand for large walk-in coolers and freezers commonly found in bigger supermarkets diminishes. As convenience stores often operate for extended hours, energy-efficient equipment becomes crucial to manage operating costs. This trend is likely to drive demand for equipment with features like variable-speed compressors, LED lighting, and improved insulation.

Over half of Viet Nam's commercial refrigeration equipment is domestically produced, primarily consisting of stand-alone units with capacities under 1,000 liters. Conversely, larger appliances and condensing units are mainly imported to serve the needs of big food stores and supermarkets. These condensing units represent a limited portion of the overall commercial refrigeration market.

The main types of Retail Refrigeration equipment are show in below table:

Table 7: Commercial refrigeration classification and general characteristics

Types of Refrigerators	**Common Features**	**Volume** (litter)	**Capacity** (W)	**Lifetime** (year)
Glass-door bottle cooler/ stand-alone unit	Upright units with glass doors for showcasing chilled beverages, snacks, and other grab-and-go items.	600 – 1,200	200 – 1,000	10
Freezers	Horizontal units with hinged lids, often used for frozen food storage in limited space.	500 – 1,000	200 – 1,000	10
Display cabinet (condensing/ non-stand-alone unit)	Walk-in coolers and freezers: Essential for bulk storage of food ingredients in restaurants and food processing facilities.	>1,000	700 – 2,000	10

The refrigerants were used in commercial refrigeration units in Viet Nam, including HFC-134a, R-404A, R-410A, R-507A, HCFC-22, HC-290, HC-600a. The average initial charge of refrigerant varied depending on the type of unit, with stand-alone units typically requiring 0.25 kg and condensing units requiring 1.2 kg, according to a market survey. This information suggests that the use of refrigerants in commercial refrigeration units in Viet Nam involved a diverse range of options and varying quantities based on the specific equipment.

Currently, ***for Freezers,*** as per finding from NC1 Report 2023, according to survey data of a quite modest sample size of 453 freezers surveyed in Hanoi, the number of refrigerators using HFC-134a refrigerant is the most common (47% of all surveyed units in Hanoi), followed by HC-290 (25%) and R-404A (22%). So, natural refrigerants such as HC-290 have penetrated one forth of the Hanoi surveyed freezers but HC-600a is still neglectable.

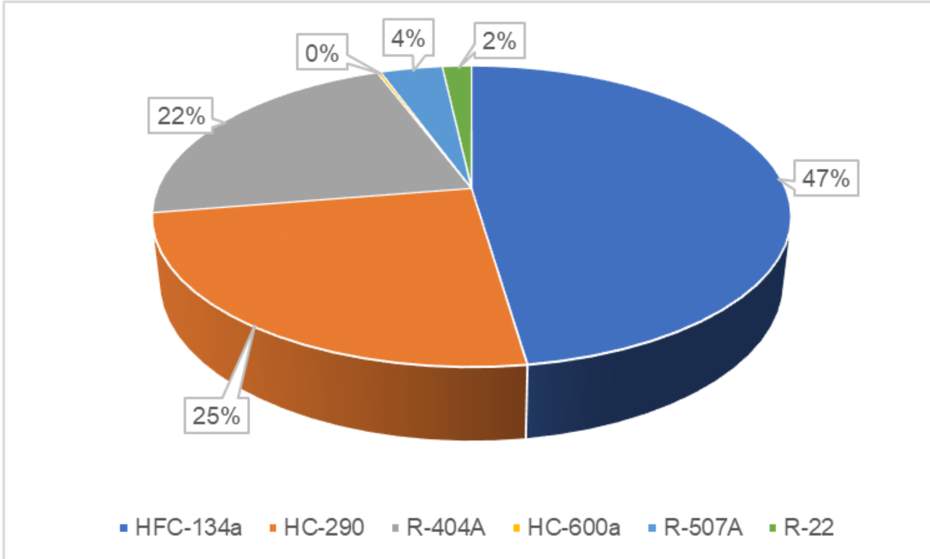

Figure 6: Ratio of main types of refrigerants used in Freezer in Ha Noi

Table 8: Findings from Market survey of Refrigerants used in Freezers in Viet Nam

Hanoi		
Refrigerant	**No. of surveyed equipment in Hanoi**	**Share**
HFC-134a	216	47%
HC-290	112	25%
R-404A	99	22%
HC-600a	1	0%
R-507A	17	4%
HCFC-22	8	2%
Total	453	
Ho Chi Minh City		
Refrigerant	**No. of surveyed equipment**	**Share**
R-404A	77	26%
HFC-134a	66	22%
HCFC-22	51	17%
HC-600a	39	13%
HC-290	26	9%
R-410A	22	7%
R-744	9	3%
HC-290	3	1%
R600a	1	0%
Total	294	

Respective figures for Ho Chi Minh City (with 294 freezers surveyed), the most refrigerants used were R-404A (26%), followed by HFC-134a (22%). Natural refrigerants such as HC-600a and HC-290 have already entered the HCM City freezer market with 17% and 9% share respectively.

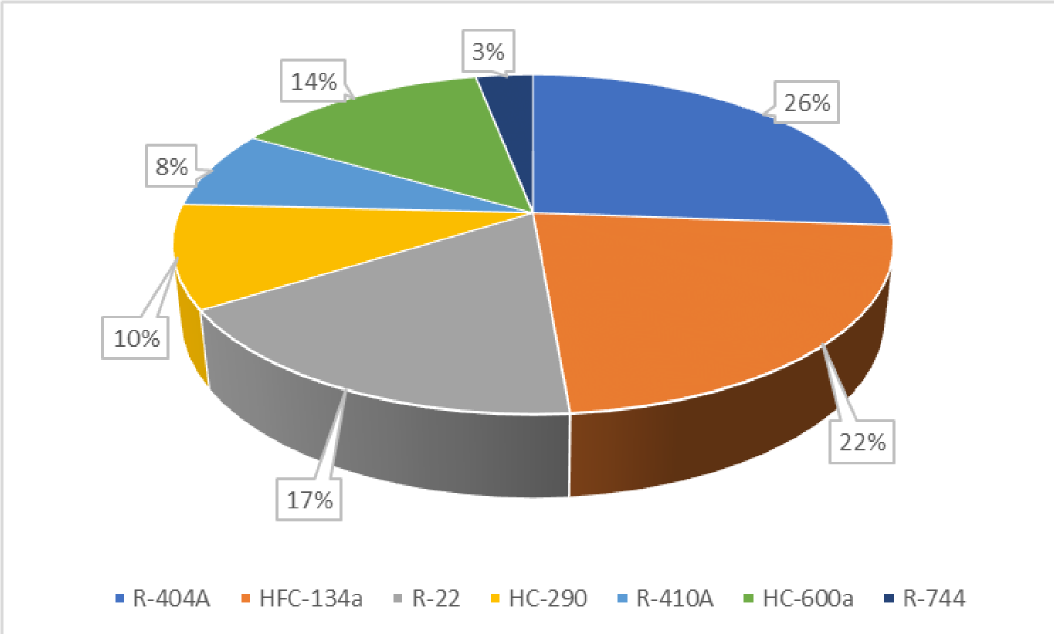

Figure 7: Ratio of main types of refrigerants used in 294 surveyed Freezers in Ho Chi Minh

Similarly, for ***Display cabinet/Glass-door cooler***: Based on the survey data of 293 units surveyed in Hanoi, 57% of refrigerators surveyed employs R-404A refrigerant, trailed by HFC-134a (21%) and HC-290 (7%) and HCFC-22 (7%). Natural refrigerants such as HC-290 and HC-600a have just entered the HCM City 's display cabinets/Glass-door cooler market with 7% and 2% shares respectively.

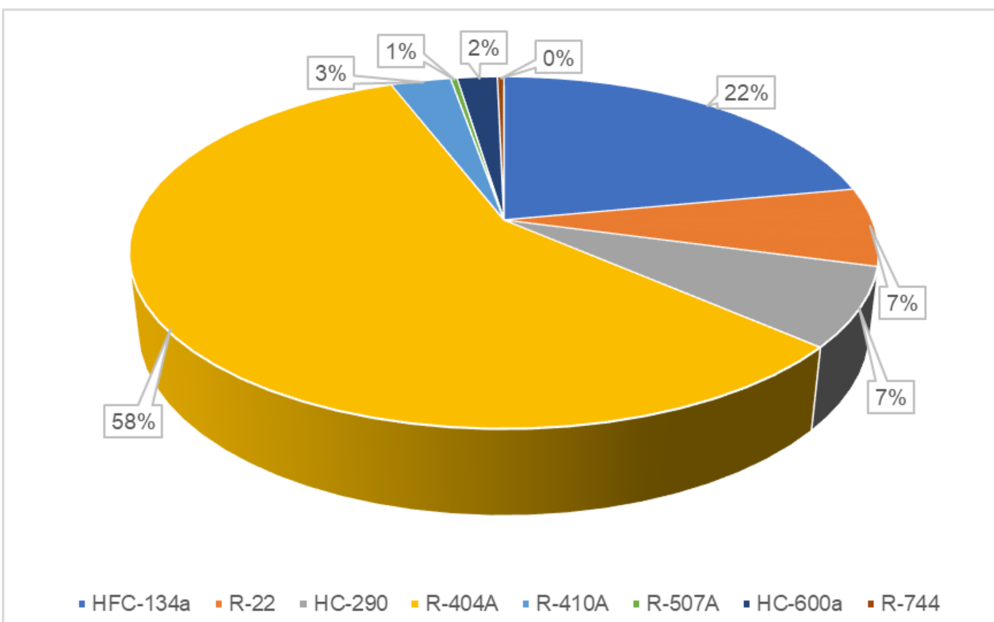

Figure 8: Ratio of main types of refrigerants used in Display cabinet/Glass-door cooler in Ho Chi Minh City

Table 9: Findings from Market survey of Refrigerants used in Display cabinet/Glass-door cooler in Viet Nam

Hanoi		
Refrigerant	**No. of surveyed equipment**	Share
R-404A	168	58%
HFC-134a	64	22%
HCFC-22	21	7%
HC-290	21	7%
R-410A	9	3%
HC-600a	6	2%
R-507A	1	0%
R-744	1	0%
Total surveyed	291	100%
Ho Chi Minh City		
Refrigerant	**No. of surveyed equipment**	Share
HFC-134a	107	47%
HC-290	53	23%
R-404A	38	17%
HC-290A	12	5%
HC-600a	11	5%
R32	6	3%
R-507A	2	1%
Total	229	100%

Respective figures for Ho Chi Minh City (with 229 display cabinets/Glass-door cooler surveyed), the most refrigerants used were HFC-134a (47%), followed by R290 (23%) and R-404A (17%). Natural refrigerants such as HC-290 have penetrated nearly one fourth of the HCM City display cabinets/Glass-door cooler market surveyed and R600 has just entered the market with 5% of the total 229 units surveyed.

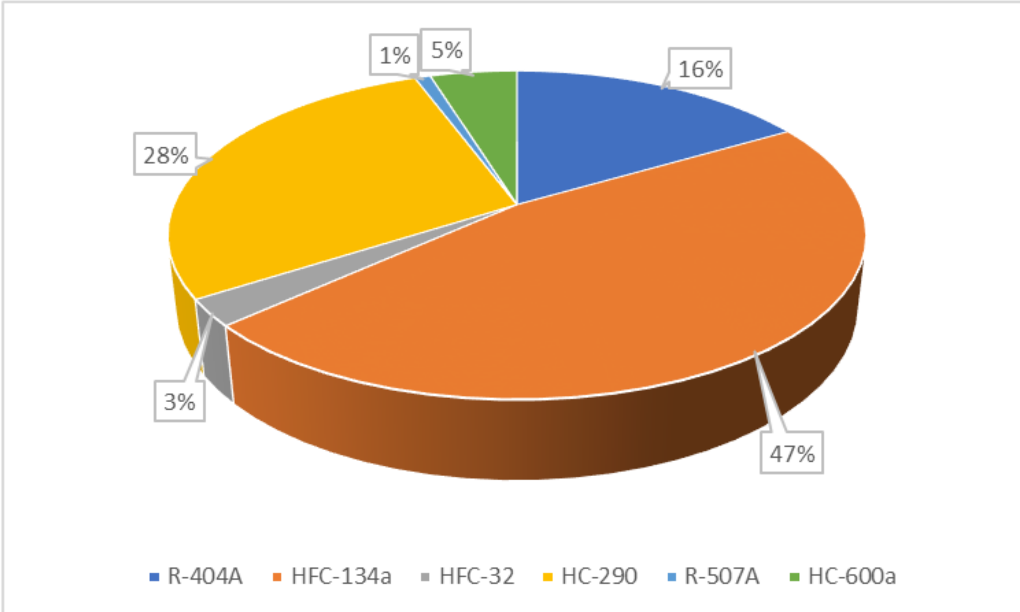

Figure 9: Ratio of main types of refrigerants used in Display cabinet/Glass-door cooler in Ho Chi Minh City

Based on the collected data in NC1 Report, the summary of key information of Commercial Refrigeration in Viet Nam is shown in the table below:

Table 10: Summary of Commercial Refrigeration equipment in Viet Nam

Category	**Stand alone**	**Condensing Unit**
Volume (L)	500 *(based on market survey)*	1,800 *(based on market survey)*
Lifetime	10 *(expert consultation)*	10 *(expert consultation)*
Power consumption (kWh/year)	1,000 *(Calculate based on the average power consumption of available equipment from market survey)*	3,500 *(Calculate based on the average power consumption of available equipment from market survey)*
Average initial charge amount (kg)	0.25 *(Market survey, expert consultation)*	1.2 *(Market survey, expert consultation)*
Annual leakage	7% *(expert consultation)*	7% *(expert consultation)*
Refrigerants	HFC-134a, R-404A, R-410A, R-507A, HC-290, HC-600a, R-22	

According to the results of NC1 report, the projection of sale Commercial Refrigeration equipment in the period of 2020-2030 is shown in the chart below:

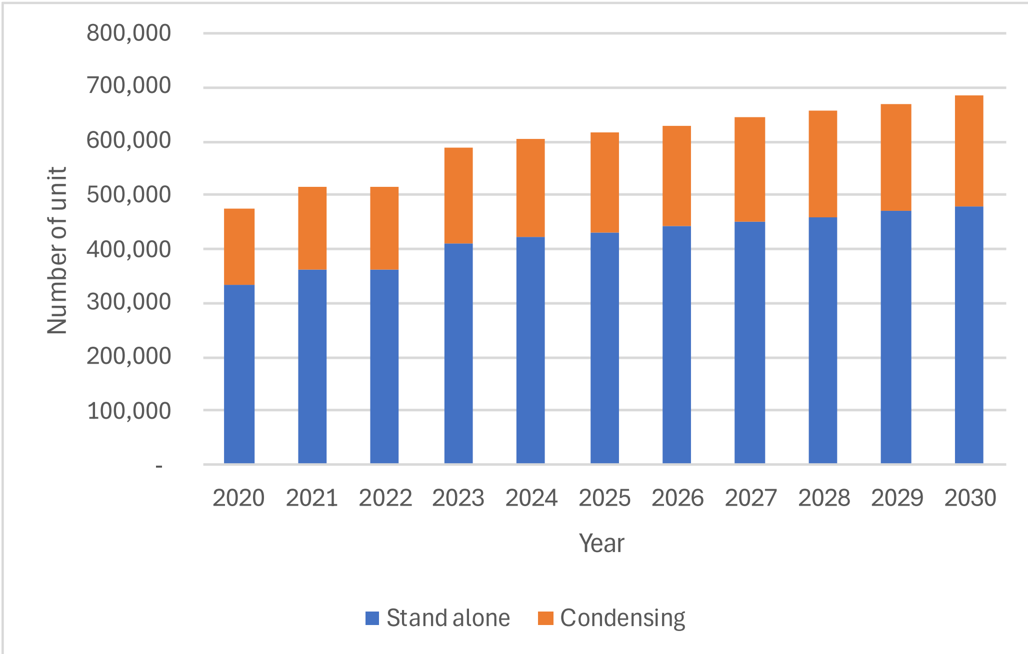

Figure 10: Sale equipment of Commercial Refrigeration divided by Stand alone and Condensing unit

Along with that, the projection of number equipment in stock for the period of 2020-2030 is as follows:

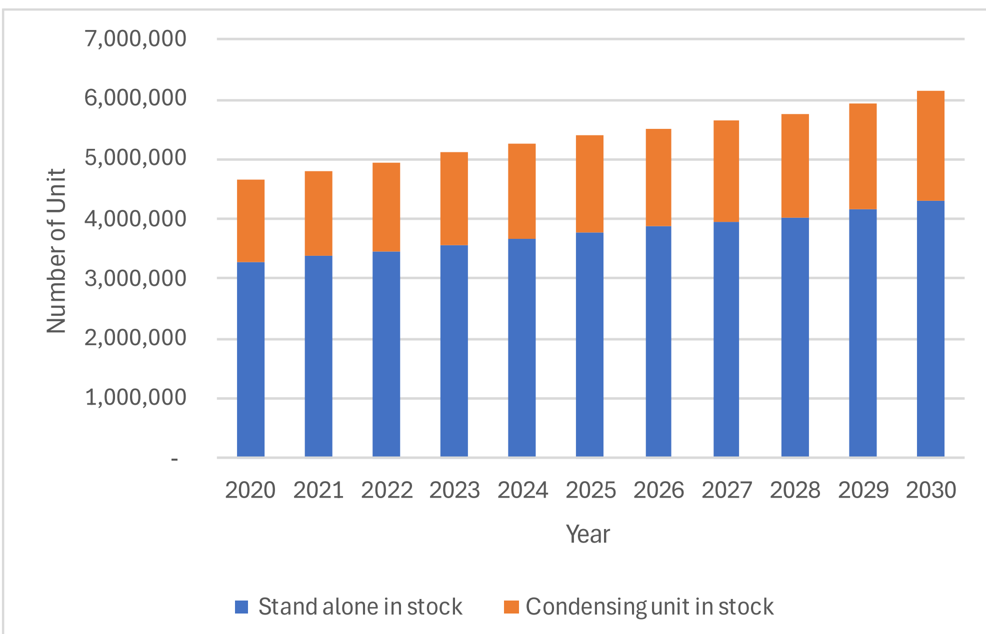

Figure 11: Projection of number Commercial Refrigeration equipment in stock for period 2020-2030

As a result, the number of equipment will slowly increase from 4.6 million in 2020 to 6.1 million in 2030.

Similar to Domestic Refrigeration subsector, the estimation of refrigerants consumption in Commercial subsector is shown as below:

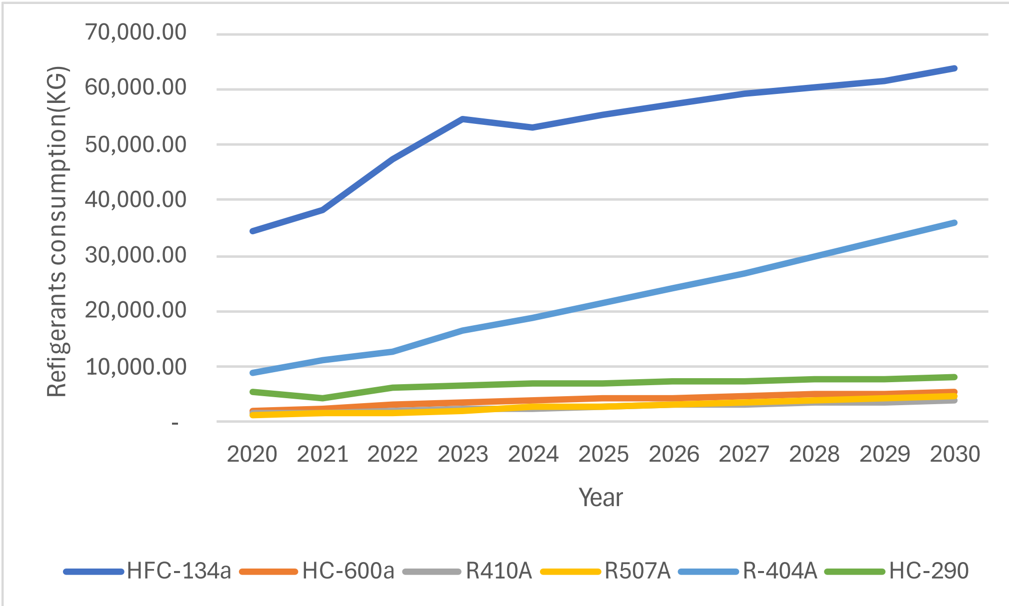

Figure 12: Refrigerants consumption in Commercial Refrigeration in period of 2020 – 2030

As the survey, the main refrigerant in Commercial subsector is HFC-134a due to the large amount of stand-alone and condensing using it. Besides that, R-404A also took a significant position with a lot of condensing system using this refrigerant. HC-290 is also used but with its flammability, the consumption for an HC-290 system usually is smaller than the HFC and HCFC refrigerant. This leads to the small amount of HC-290 in the subsector.

The energy consumption of the subsector is as follows:

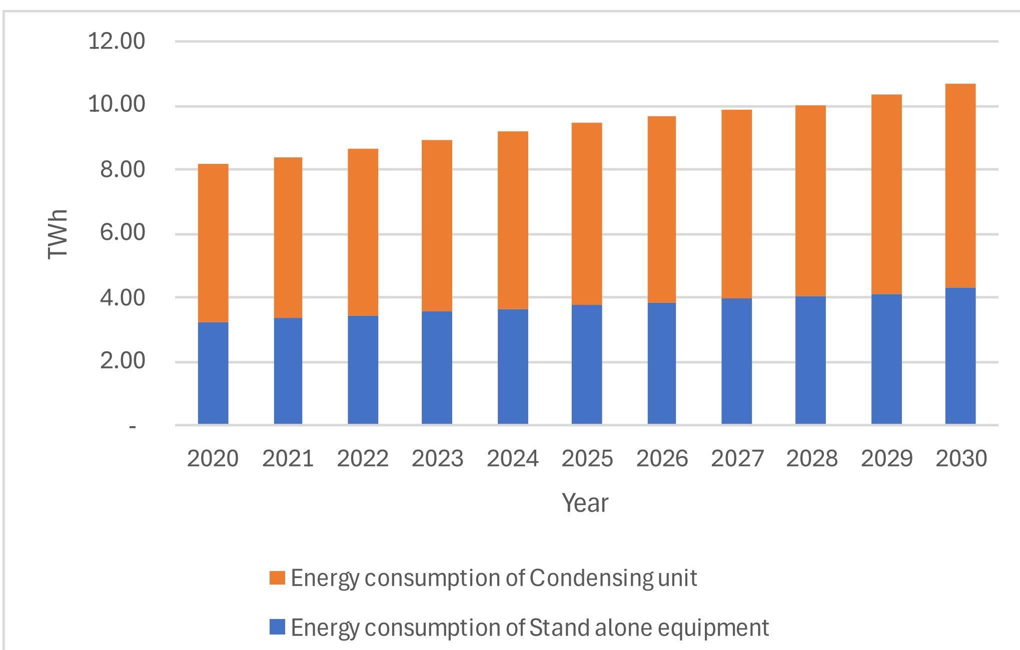

Figure 13: Energy consumption by each kind of equipment of Commercial Refrigeration

Based on the energy consumption and the calculating of *refrigerants used in the sub sector which mainly are HFC-134a (GWP=1,430), R-404A (GWP=3,922), R410A (GWP= 2,088), R-507A (GWP =3,985), R-22 (GWP= 1,810), HC-290 (GWP =3) and HC-600a (GWP= 3)*. The GHG emissions of the subsector is shown as in the chart below:

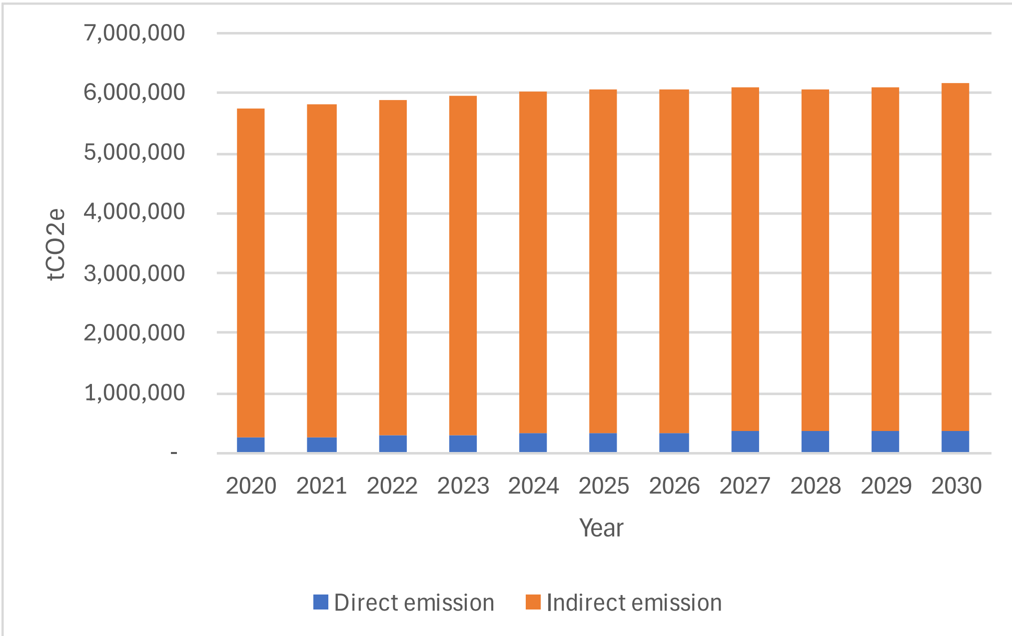

Figure 14: GHG emissions of Commercial Refrigeration subsector in period of 2020 – 2030

Not the same as the Domestic Refrigeration subsector, Commercial Refrigeration have a quite stable emissions level over the period of study. The reason is due to the Condensing systems which are using R-404A, R-410A and R-507A may not be converted for the short period of time.

3. Servicing sector

Currently, there are approx. 200 vocational colleagues in Viet Nam providing training courses focused on the installation and maintenance of Refrigeration and Air Conditioning (RAC) equipment[10]. On average, each institution enrolls approximately more than 150-200 students annually in these programs. During the survey, the Consultant estimated more than 35,000 technicians over the country working on the servicing sector. However, despite this training capacity, the demand for skilled technicians in the market consistently exceeds the available workforce, creating a significant gap. This shortage highlights the need for continuous efforts in vocational education and training to meet the growing demands of the refrigeration sector. The existing disparity between the number of trained students and the industry's high demand for skilled technicians poses a significant challenge, which underscores the importance of expanding and improving the training infrastructure to adequately prepare technicians for the workforce.

[10] Based on desk review on the list of vocational institution and interview with experts

Manufacturers of refrigeration appliances sold in the Viet Namese market typically have their own technician training programs specifically designed for their products. These training programs are usually exclusive to the brand and do not cover a wider range of systems. The typical servicing shop in this sector employs 5 to 8 workers. Despite the extensive network of servicing shops across the country, the overall skill level of technicians in the refrigeration sector remains a significant concern, as many technicians lack the necessary qualifications and certifications to meet industry standards. It is common practice for shops to hire untrained workers without any formal qualifications, relying heavily on "learning by doing," especially during the peak demand season.

Technicians working in the refrigeration sector are frequently deficient in essential knowledge regarding safety practices, environmental impacts, and professional responsibilities. Much of their training comes informally, often learned on the job from more experienced colleagues rather than through formal education programs. As a result, widespread improper practices, such as the intentional discharge of refrigerants into the atmosphere are common in many servicing shops. These practices not only pose environmental hazards but also violate international standards regarding refrigerant management and safety, further emphasizing the need for structured, certified training for all technicians in the sector.

The maintenance and repair facilities for refrigeration equipment are typically equipped with basic tools required for servicing, including refrigerants manifold, vacuum pumps, flare kits, and refrigerant weight scales. The quantity and quality of these tools often depend on the size and capacity of the servicing facility. However, some critical tools, such as gas detectors for identifying refrigerant leaks, are in limited supply, which forces technicians to resort to manual leak detection methods, like using soap bubbles to locate leaks. In the case of large refrigeration systems, it is a common practice to perform seal tests by injecting nitrogen into the system to evaluate the integrity of welds and ensure airtightness. While most shops are equipped with fundamental tools, there is a clear need to ensure wider access to advanced leak detection methods, such as the use of gas detectors, to improve safety and operational efficiency.

These existing practices present both environmental and safety challenges, raising concerns that underscore the urgency of implementing comprehensive training programs and formal certification for technicians. Without proper training, technicians often resort to unsafe methods that contribute to environmental degradation, such as refrigerant leaks that damage the ozone layer and exacerbate global warming. By promoting standardized training, certification, and the adoption of best practices, the refrigeration sector in Viet Nam can move towards a more sustainable and environmentally responsible future. Expanding access to advanced tools and modern diagnostic technologies, along with ensuring adherence to proper protocols, will help mitigate risks, protect the environment, and foster a safer, more efficient industry. The Green Cooling Initiative III, among other development projects implemented recently in the sector, have been trying to fill these gaps by providing tools and equipment and hands-on practical trainings on safe use of natural refrigerants to trainers and students from vocational colleges in Hanoi. These efforts place the basis for vocational curriculum updates in these vocational colleges.

IV. Future options

1. Green cooling technology options

1.1. Refrigerants

1.1.1. Stand-alone equipment

Stand-alone equipment, also referred to as plug-in or self-contained equipment, is extensively applied in convenience stores and mini supermarkets. This type of equipment in recent years has converted extensively from high GWP refrigerants to natural hydrocarbon refrigerants, specifically HC-600a and HC-290.

However, their utilization presents challenges, primarily due to the flammability of HC-600a and HC-290, hence only employed in small commercial refrigeration units. This characteristic demands meticulous handling, stringent safety measures, and strict compliance with regulations. The flammability requires manufacturers to invest in specialized equipment and training for handling these refrigerants safely, adding complexity and costs to the manufacturing operations.

1.1.2. Remote systems

Remote systems are systems with condensing units placed away from the retail space, traditionally relying heavily on refrigerants such as R-22, R-404A, and HFC-134a. In recent years, with the shift towards more environmentally friendly refrigerants, remote systems have seen the increase of R-744 and HC-290 adoption in their application.

R-744 is the ideal refrigerant with very low GWP, non-flammable characteristics and excellent performance. However, the high-pressure nature of R-744 while operating necessitates specialized equipment and rigorous safety protocols. The complexities in servicing and maintenance further pose challenges, impacting the overall efficiency and reliability of these systems. While cost remains the barrier for the widespread adoption of R-744 condensing units, the increasing production capacity and financial incentives signal potential advancements in overcoming this challenge.

Meanwhile, the utilization of HC-290 in medium-sized commercial refrigeration systems is noteworthy. Specifically designed for remote setups, HC-290 faces the same challenges as stand-alone systems, primarily centered around its flammability, making the operation and maintenance process more complex with stringent safety standards. Despite that, HC-290 is still an attractive option due to its high efficiency and environmental trade.

1.1.3. Centralized systems

Centralized systems stand out as preferred options for large supermarkets, offering high efficiency and extensive space coverage. Although there is a continued use of R-22 and high GWP refrigerants owing to their cost-effectiveness and straightforward operation, there is a shift towards adopting more environmentally friendly alternatives in response to climate concerns and new regulations.

R-744 emerges as a promising environmentally friendly alternative for the Centralized (Pack) Systems. Despite its positive environmental attributes, the utilization of R-744 faces notable barriers like those encountered in remote systems. The high upfront costs associated with the complexities of system design, specialized equipment requirements, and potential safety concerns present substantial challenges for manufacturers aiming to incorporate R-744 into centralized systems. However, as the industry emphasizes sustainability, these challenges are viewed as resolvable with ongoing advancements in technology and growing recognition of the long-term environmental benefits. With the fast adoption in developed countries, the cost of these systems is being reduced and the safety protocols are being perfected, ready to be widely applied soon.

Concurrently, HC-290 is also an option when it comes to centralized secondary or chiller systems catering to larger commercial spaces. The challenges confronted closely resemble remote systems, stressing the imperative for manufacturers to address safety concerns and ensure compliance with evolving standards diligently. As the industry moves towards greener refrigeration options, manufacturers must tackle the challenges of safely integrating HC-290. This contributes to better environmental practices in larger commercial setups.

1.1.4. Challenges Faced by Manufacturers

Manufacturers in the commercial refrigeration sector face a multitude of challenges in adopting green cooling technologies. Ensuring safety compliance is crucial, necessitating investments in robust safety measures, employee training, and compliance frameworks for handling flammable refrigerants responsibly, leading to increased operational complexity and costs. Navigating regulatory obstacles poses another challenge, requiring constant attention to evolving regulations and standards, and active engagement with regulatory bodies to ensure ongoing compliance. The high initial costs associated with green technologies, though promising long-term benefits, urges manufacturers to find a balance between economic viability and environmental considerations. The transition to advanced refrigerants involves complex system designs, demanding investments in research and development, specialized engineering, and technical expertise. Additionally, addressing service and maintenance complexity in these intricate systems requires comprehensive training and support for technicians. Addressing these challenges calls for an intense approach, integrating technological innovation, regulatory engagement, and effective communication for the successful adoption of green cooling technologies in the commercial sector.

1.2. Energy-reducing technologies

1.2.1. Variable Speed Compressors and Fans:

Variable speed compressors and fans offer enhanced EE and precise control in various commercial refrigeration setups. By adjusting their speed based on demand, these technologies optimize performance, resulting in significant energy savings. Their versatility and proven effectiveness make them common choices for enhancing the overall sustainability of refrigeration systems. While these technologies provide clear advantages, the practical implications include initial costs and potential reliability concerns. Manufacturers must weigh these factors against the long-term benefits of improved efficiency. Moreover, Operating conditions in the compressor compartment can weaken power electronic elements, impacting working ability. Additionally, their complex technology poses challenges in terms of maintenance, since the repairs are more complex and the number of high qualified technicians in Viet Nam are low. Furthermore, the high initial investment cost is a significant drawback, with capital recovery efficiency varying based on load consumption characteristics and the number of compressed air pumps, leading to potential economic considerations for businesses.

Fans can improve the efficiency of heat exchange within the refrigeration system. By enhancing air circulation, they facilitate quicker cooling and reduce the workload on the refrigeration equipment, leading to energy savings. This is an easy and economical solution which is widely favorable by business to apply, however it still poses some drawbacks. The operation of fans can generate noise, which may be a consideration in environments where noise levels need to be minimized, such as in retail spaces or customer-facing areas. Fans require regular maintenance to ensure optimal performance. Accumulation of dust or debris on fan blades can reduce efficiency and may lead to increased energy consumption. In smaller refrigeration units or those with limited space, the installation of fans may pose challenges. Proper placement is crucial to ensure effective air circulation without obstructing the storage capacity of the unit.

1.2.2. Heat Exchanger Design:

Heat exchanger (HX) design is widely used for improving efficiency in commercial refrigeration by enhancing heat transfer. The design encompasses thermal and mechanical design, and manufacturing considerations with the principle of transferring heat from hot fluid or surface to a cooler counterpart. While they offer substantial benefits, widespread adoption may be hindered by many factors. HX design requires a rather high initial investment associated with procurement, installation, and integration into existing refrigeration setups. Furthermore, the process of integrating new technology into older refrigeration systems may necessitate modifications and adjustments, incurring additional costs and potentially disrupting regular operations. While the operation and maintenance of the system often call for specialized technical expertise which can be difficult to manage. Consequently, businesses may find themselves increasingly reliant on external experts, leading to elevated operational costs.

1.2.3. Ejectors

Ejectors can enhance the EE of refrigeration systems by utilizing high-pressure energy from one part of the system to improve the performance of another. However, despite their potential benefits, ejectors are not widely used in the commercial refrigeration sector. This is primarily because they are more commonly applied in larger-scale industrial systems, where the efficiency gains are more significant. In smaller systems, like those in commercial refrigeration, the efficiency improvements are less substantial, and space constraints make ejector implementation challenging. Additionally, the design, installation, and maintenance of ejector systems are complex, requiring specialized engineering knowledge and expertise, which leads to higher initial costs. Maintenance can also be more complicated, and finding qualified technicians with expertise in ejector technology can be difficult.

1.2.4. Electronic Expansion Valves

Electronic expansion valves, commonly used in commercial refrigeration, contribute to precise control and improved efficiency. The electronic expansion valve has the function of adjusting the flow of refrigerant injected into the evaporator to suit the cooling load and ensure no overheating. In addition, the electronic expansion valve also helps adjust the condensation temperature to the lowest possible level depending on the cooling environment temperature. This has great significance in saving energy when operating with reduced load, ensuring the machine works with high cooling capacity and low compression work. However, like any technology, electronic expansion valves come with certain disadvantages. One significant drawback is the higher initial cost associated with electronic expansion valves compared to traditional thermostatic expansion valves. Complex electronic and control systems may lead to challenges in installation, setup, and troubleshooting, requiring specialized knowledge and expertise. Manufacturers need to consider these factors while promoting the advantages of enhanced system performance.

1.2.5. Leak Minimization

Leak minimization measures have become a basis in refrigeration systems, representing an industry standard aimed at ensuring both environmental preservation and safety compliance. While the benefits of these strategies are clear, the associated challenges revolve around the implementation of leak detection and prevention measures, often entailing additional costs. To maintain optimal performance and environmental leak detection, devices should be installed with leak checks performed periodically. Establishing response protocols and proactive measures for leak detection and implementing a refrigerant tracking system further enhances the overall effectiveness of the refrigeration system. Manufacturers are obliged to seek solutions that can balance between efficiency and cost-efficiency to minimize refrigerant leakage.

1.2.6. Air curtains, strip curtains, night blinds

Air curtains, strip curtains and night blinds are simple and low-cost solutions for maintaining consistent temperatures by preventing warm air infiltration, thus reducing the load on the refrigeration system and improving overall EE. However, their widespread adoption varies due to factors such as space constraints, aesthetic considerations, and specific operational requirements.

1.2.7. LED lighting

LED lighting is steadily replacing traditional lighting systems in commercial refrigeration, primarily due to its EE and extended lifespan. This shift aligns with the sector's dedication to sustainable practices, making LED lighting a standard feature in modern refrigeration equipment. It serves as a viable energy-saving option that can be easily applied into existing equipment. The efficiency of LEDs, coupled with their lower heat emission, enhances the performance of refrigerated equipment, aiding temperature maintenance and reducing the overall refrigeration load.

1.2.8. Glass Doors, Multi-Layer Glazing, Gaskets:

Incorporating glass doors, multi-layer glazing, and efficient gaskets in commercial refrigeration equipment is a proven strategy for enhancing EE by minimizing heat exchange with the surroundings. Additionally, coating the glass doors or lids with a thin metal layer can effectively reflect infrared radiation. This not only reduces the cooling load but also cuts energy consumption for defrosting. This solution has been applied by many commercial establishment, however broader implementation of this application in the commercial refrigeration sector depends on factors such as cost-effectiveness, compatibility, and industry awareness of the climate benefits.

2. Placement of green cooling technology

2.1. Refrigerants

Alternative refrigerants depend largely on manufactures and the climate awareness of the commercial establishments and their demand on sustainable cooling equipment and systems. Alternatives for smaller commercial equipment, specifically stand-alone/ plug-in units with natural hydrocarbons such as HC-600a and HC-290 have already been applied in the recent years. This category's application is the most common in the commercial refrigeration sector from small retailers to chain stores and big supermarkets. As for larger systems, particularly remote systems are widely applied in supermarkets and cash & carry businesses.

These types of equipment, while some have already shifted to HC-600a and HC-290, a large part still uses traditional refrigerants such as HFCs and HCFCs. Converting to R-744 systems is also a preferred option. A lot of work still has to be done to accelerate the transition in this area.

Lastly, centralized systems, are rarely seen in Viet Nam and only found in large supermarkets and cash & carry businesses. Centralized systems are gradually converting to more ecofriendly refrigerants such as HC-290 and is the ideal system to convert to R-744 due to its size and space coverage.

However, Viet Nam tends to favor old and second-hand equipment and systems, which have high GWP refrigerants and high leakage rate. Hence the conversion to new refrigerants is rather complicated and will take a long time to complete. The following Tabel presents the alternative refrigerant options for equipment types and applications.

Table 11: Alternative refrigerant options for equipment types and applications

Type	Sub-type	Application	Domestic	Commercial				
		Sub-application	Domestic	Kiosk	Convenience	Grocery	Suprmrkt	Cash&crry
Stand-alone/ plug-in	Non-fixed	fridge/ freezer	HC-600a	HC600a, 290	HC-600a,290	HC-600a,290	HC-600a,290	HC-600a,290
		vertical cooler	HC-600a,290	HC-600a,290	HC-600a,290	HC-600a,290	HC-600a,290	HC-600a,290
	Fixed	chest freezer		HC-290	HC-290	HC-290	HC-290	HC-290
		display cabinet		HC-290	HC-290	HC-290	HC-290	HC-290
		cold room monoblock					HC-290,744	HC-290,744
		preparation						
Remote	Cond units	display cabinet					HC-290,744	HC-290,744
		cold room					HC-290,744	HC-290,744
Central-ised	Compressor pack	display cabinets					R-744	R-744
		cold room					R-744	R-744
	Chiller/ secondary	display cabinets					HC-290	HC-290
		cold room					HC-290,744	HC-290,744

2.1.1 HC-600a

HC-600a (Isobutane) is a hydrocarbon refrigerant known for its use in domestic refrigeration systems due to its EE and low environmental impact.

2.1.1.1 Operating System of HC-600a

Refrigeration Systems

The refrigeration cycle begins in the **compressor**, where HC-600a (isobutane) in its gaseous state is compressed. This compression increases the refrigerant's pressure and temperature. HC-600a operates at a lower pressure in suction line than many other refrigerants, reducing the load on the compressor and contributing to energy savings.

After compression, HC-600a enters the **condenser**, where it is cooled by ambient air or water. As the refrigerant cools, it transitions from a gaseous state to a liquid state, while its temperature and pressure decrease. Next, the HC-600a passes through the **expansion valve**, where it undergoes a rapid pressure and temperature drop. This process produces a mixture of liquid and gas, preparing the refrigerant for the next phase of the refrigeration cycle. The mixture then enters the **evaporator**, where HC-600a absorbs heat from the refrigerated space (e.g., a refrigerator or freezer). As it absorbs heat, HC-600a transitions from a liquid to a gaseous state, lowering the temperature within the refrigerated environment. Finally, the HC-600a, now in a gaseous state, returns to the compressor, repeating the cycle continuously to maintain the cooling effect.

Remote Systems

In remote refrigeration systems, the condensing units are typically located separately from the refrigeration equipment (e.g., outdoors) and connected via piping. This design optimizes space and aesthetics in the display area. In the remote condensing unit, HC-600a is compressed in the compressor and cooled in the condenser, transitioning into a liquid state. The liquid HC-600a is then piped to the refrigeration equipment, where it passes through the expansion valve, evaporates, and absorbs heat from the internal environment to produce cooling.

2.1.1.2 Advantages of HC-600a

High Energy Efficiency

HC-600a systems offer a higher Coefficient of Performance (COP) compared to other refrigerants, such as HFC-134a, commonly used in domestic refrigerators. This indicates superior EE and cooling performance with lower energy input.

Studies and field tests have demonstrated that HC-600a systems consume 10-20% less electricity compared to HFC-134a systems, especially in commercial refrigeration applications where energy costs represent a significant portion of operating expenses.

Low Operating Pressure

HC-600a operates at lower pressures than many other refrigerants. This reduces the mechanical load on the compressor, extends the lifespan of system components, and minimizes the risk of refrigerant leaks, enhancing system reliability and safety.

Environmentally Friendly

With a GWP of 3, HC-600a has a negligible impact on global warming, making it an environmentally friendly choice compared to traditional refrigerants like HFC-134a (GWP of 1430). It complies with stringent environmental regulations.

2.1.1.3 Disadvantages of HC-600a

HC-600a presents several challenges due to its highly flammable nature, which presents significant safety risks if leaks occur. This flammability necessitates stringent safety measures, such as proper ventilation and leak detection systems, to minimize the risk of fire or explosion. Additionally, regulatory constraints in some regions limit the use of HC-600a, requiring adherence to specific safety and compliance regulations. The refrigerant is primarily suitable for small to medium-sized systems, with its use in larger systems being constrained by its flammability and lower charge limits.

Moreover, HC-600a may face compatibility issues with certain materials used in refrigeration systems, requiring the use of specialized components to prevent leakage or degradation. The implementation of HC-600a systems often involves higher initial costs due to the need for additional safety features and specialized equipment. Maintenance and servicing are also more complex, requiring skilled technicians and adherence to safety protocols. Effective leak management is essential to ensure safe operation and prevent environmental damage, adding to the overall complexity and cost of maintaining systems using this refrigerant.

2.1.1.4 Applications of HC-600a

HC-600a-based refrigeration systems have become a popular choice in supermarkets and convenience stores, particularly for high-volume commercial applications, due to their EE and significant cost savings. In household appliances, HC-600a is widely used in refrigerators and freezers, offering not only superior EE but also environmental advantages. Its efficient cooling capabilities make HC-600a an ideal refrigerant for compact units such as mini refrigerators, where space is limited. Furthermore, HC-600a is extensively applied in commercial refrigeration systems, including remote setups in supermarkets and food stores, delivering benefits in terms of reduced energy consumption and enhanced environmental sustainability.

2.1.2 HC-290

HC-290 (Propane) is a hydrocarbon refrigerant used in various refrigeration applications for its high efficiency and minimal environmental footprint.

2.1.2.1 Operating System of HC-290

Explosion-Proof Design

Given the highly flammable nature of HC-290 (propane), refrigeration systems utilizing this refrigerant must be engineered to minimize the risk of fire or explosion. This requires the use of components and electrical equipment specifically rated for hazardous environments. Critical components include explosion-proof relays, switches, and fans, which are designed to operate safely in areas where flammable gases may be present.

Ventilation System

HC-290 systems require a robust ventilation mechanism to ensure that any propane gas leaks are rapidly dispersed into the atmosphere. Proper ventilation mitigates the risk of gas accumulation, preventing potential ignition sources from causing an explosion.

Standard Refrigeration Cycle

HC-290 operates under a standard refrigeration cycle that includes the key processes of compression, condensation, expansion, and evaporation. During this cycle, HC-290 absorbs heat from the space being cooled as it evaporates, and releases heat to the surrounding environment as it condenses.

Operating Pressure

One of the advantages of HC-290 is its operation at relatively low pressures compared to other refrigerants. This reduces the strain on system components, including the compressor, leading to increased longevity and reduced maintenance.

2.1.2.2 Advantages of HC-290

High Energy Efficiency

HC-290 has superior thermodynamic properties, particularly in heat transfer. This allows refrigeration systems to achieve effective cooling with lower energy consumption compared to other refrigerants.

HC-290 typically exhibits a higher COP than refrigerants like R-404A, with studies indicating up to 10-15% greater efficiency under similar conditions. This results in improved cooling capacity relative to energy input.

Reduced Compressor Load

Due to its low operating pressure, HC-290 places less strain on the compressor, allowing for smoother operation, energy savings, and extended equipment life.

With efficient heat transfer properties, HC-290 can reach target temperatures more quickly, reducing the compressor's operational time and further conserving energy.

Stability at High Temperature Conditions

HC-290 maintains its efficiency even in high ambient temperatures where other refrigerants may experience performance decline. This makes HC-290 especially suitable for commercial refrigeration applications, such as in supermarkets or freezers where temperatures tend to be elevated.

Reduced Operating Costs

Due to its high EE, HC-290 systems can substantially lower electricity bills, which is particularly beneficial for businesses operating refrigeration equipment continuously.

Environmentally Friendly

While flammable, HC-290 has a negligible impact on the ozone layer and an extremely low GWP. Its use helps companies reduce costs related to carbon taxes and comply with environmental regulations.

2.1.2.3 Disadvantages of HC-290

HC-290's primary drawback is its high flammability, necessitating stringent safety measures both in design and operation. This requires explosion-proof equipment, adequate ventilation, and rigorous safety protocols. In some regions, HC-290's flammability results in regulatory limitations or additional safety requirements, restricting its widespread use.

Hence, HC-290 systems must be equipped with leak detection sensors, along with automatic shutdown or emergency notification systems to mitigate the risks posed by leaks. The maintenance and servicing of these systems require highly trained technicians familiar with handling flammable refrigerants.

2.1.2.4 Application of HC-290

HC-290 is commonly used in household refrigeration appliances such as domestic refrigerators and freezers due to its high efficiency and environmental benefits.

HC-290 is also utilized in some AC systems, particularly in small and medium-sized installations, where its efficiency and low environmental impact are desirable.

Many commercial refrigeration systems in convenience stores, supermarkets, and restaurants employ HC-290, benefiting from its energy savings, operational efficiency, and reduced environmental footprint.

2.1.3 R-744

R-744 (Carbon Dioxide) is a natural refrigerant with unique thermodynamic properties, commonly utilized in commercial and industrial refrigeration systems.

2.1.3.1 Operating System of R-744

Subcritical Systems

In subcritical systems, R-744 operates below its critical point (i.e. 31.5°C at atmospheric pressure). These systems are often used in cascade configurations, where R-744 acts as the low-temperature refrigerant, while other refrigerants (such as NH_3 or HFC) are used for higher temperature stages. R-744 typically operates in a very low-temperature range, making it ideal for deep-freeze applications like cold storage or industrial processes.

Trans-critical Systems

For trans-critical systems, when R-744 operates above its critical point, it cannot fully condense into a liquid during the cooling process and undergoes a gas cooling process instead. Trans-critical systems utilize a pressure-regulating valve to optimize this gas cooling process and maintain ideal operating pressures. Commonly used in commercial refrigeration, trans-critical systems are particularly effective in supermarkets or other large public refrigeration setups where ambient temperatures may exceed CO_2's critical point.

Remote systems, with condensing units located away from the cooling spaces allow multiple evaporators to connect to a single system. R-744 is compressed and cooled in the condensing unit before being piped to evaporators in the remote cooling locations. These systems typically operate in trans-critical mode due to the high pressure of R-744. In this mode, R-744 does not fully condense in the condenser but passes through a gas cooler. After passing through the expansion valve, R-744 transitions into a gas-liquid mixture, enters the evaporator, and absorbs heat from the refrigerated space before returning to the compressor to repeat the cycle.

2.1.3.2 Advantages of R-744

High Energy Efficiency

R-744 offers excellent heat transfer properties and performs efficiently at very low temperatures, reducing energy consumption, especially in large refrigeration systems with multiple evaporators. Subcritical systems utilizing R-744 achieve higher COPs in cold storage and deep-freeze applications, resulting in reduced energy consumption.

R-744 operates more efficiently than traditional refrigerants (e.g., R-404A, HFC-134a) in deep-freeze applications (below -20°C) due to its superior heat absorption capacity.

Environmental Benefits

With a GWP of only 1, R-744 significantly reduces environmental impact compared to traditional refrigerants.

Optimal Design

CO_2 systems offer significant design advantages through their heat recovery capabilities. By capturing and repurposing heat from the gas cooler, R-744 systems can provide space heating or hot water, thereby reducing reliance on additional energy sources and enhancing overall EE. The high operating pressure of R-744 permits the use of smaller diameter pipes, which not only minimizes heat loss but also improves overall system efficiency. Additionally, the modular nature of remote systems allows for easy expansion, making R-744 systems particularly well-suited for facilities with extensive and varied cooling requirements, such as supermarkets and distribution centers. This flexibility in design and operation ensures that R-744 systems can efficiently meet the cooling and heating needs of large-scale commercial and industrial applications.

2.1.3.3 Disadvantages of R-744

R-744 operates at much higher pressures than other refrigerants, requiring specialized components designed to withstand these pressures. Although this may increase initial costs, long-term energy savings and improved efficiency can offset the investment. Additionally, Installation and maintenance of R-744 systems require skilled technicians with expertise in high-pressure systems and specialized refrigeration equipment.

R-744 operates most efficiently in cooler climates. In hot environments, its performance may decrease, necessitating optimization strategies such as enhanced gas coolers or hybrid systems using additional refrigerants.

2.1.3.4 Applications of R-744

R-744 systems are increasingly adopted in various settings for their efficiency and environmental benefits. Supermarkets and convenience stores utilize remote R-744 systems for their high EE and lower environmental impact. In large distribution centers and cold storage facilities, R-744 is ideal for maintaining low temperatures across extensive areas. Central refrigeration systems in supermarkets commonly use R-744 due to its high efficiency and ability to meet diverse cooling needs, while food processing plants and cold storage facilities benefit from its rapid cooling capabilities at very low temperatures.

2.1.4 R-717

R-717 (Ammonia) is a versatile and efficient refrigerant widely employed in industrial refrigeration systems for its high cooling capacity and low operational costs.

2.1.4.1 Operating System of R-717

R-717, commonly known as ammonia, operates on a standard vapor-compression refrigeration cycle consisting of four primary stages: compression, condensation, expansion, and evaporation. This cycle is continuously repeated to maintain a cooling effect.

Compression

In the refrigeration system, gaseous R-717 is drawn into the compressor. Here, it is compressed, increasing both its pressure and temperature. This process consumes electrical energy, but R-717's high efficiency optimizes this process. As the refrigerant is compressed, its pressure rises significantly, accompanied by an increase in temperature. The high-pressure, high-temperature ammonia vapor is then directed to the condenser.

Condensation

The high-pressure, high-temperature ammonia vapor enters the condenser. Here, it comes and contacts with cool air or water (depending on whether the system uses air or water cooling), causing the ammonia to change from a vapor to a liquid state. As the ammonia condenses, it releases a significant amount of heat to the surrounding environment. This heat is removed from the system through heat exchangers, typically fans or cooling towers.

Expansion

After condensation, the high-pressure liquid ammonia passes through an expansion valve. This valve reduces the pressure of the ammonia, causing its temperature to drop significantly. As a result, the ammonia becomes a low-temperature liquid-vapor mixture. This sudden change in pressure and temperature prepares the ammonia to absorb heat in the next stage.

Evaporation

The low-temperature liquid-vapor mixture enters the evaporator. Here, it absorbs heat from the refrigerated space or substance (e.g., air in a cold storage room, water in an air conditioning system, or food in a freezer). As the ammonia absorbs heat, it vaporizes, completely changing into a gaseous state. The heat is removed from the environment or product being cooled, resulting in a cooling effect. The gaseous ammonia is then drawn back into the compressor, and the refrigeration cycle begins anew.

2.1.4.2 Advantages of R-717

High Energy Efficiency

R-717 offers high EE with a high Coefficient of Performance (COP), allowing it to convert energy into cooling more effectively and reducing overall operating costs. Its excellent heat transfer properties enhance the efficiency of heat exchange in both the condenser and evaporator, leading to improved cooling capacity and performance.

Environmentally Friendly

R-717 has a zero Ozone Depleting Potential (ODP) and zero GWP, making it an environmentally friendly choice in refrigeration systems, aligns with global efforts to reduce greenhouse gas emissions and mitigate climate change.

Low Refrigerant Cost

Ammonia is one of the most cost-effective refrigerants available, combining its low initial cost with high efficiency to further reduce operating expenses. Remote systems using R-717 typically have a longer operational lifespan and lower maintenance requirements compared to systems utilizing synthetic refrigerants, contributing to long-term cost savings.

Recyclability

Ammonia can be recovered, recycled, and reused within a refrigeration system, reducing the need for new refrigerant and supporting sustainability efforts.

2.1.4.3 Disadvantages of R-717

The primary concern is its toxicity; exposure to ammonia can lead to health issues such as respiratory and skin irritation, necessitating stringent safety measures. These include proper ventilation, leak detection systems, and emergency response plans to mitigate health risks. While R-717 is not highly flammable, it can ignite at high concentrations, requiring careful system design to avoid dangerous levels and ensure adequate safety protocols.

In addition to safety concerns, ammonia is corrosive to certain materials necessitating the use of corrosion-resistant components. This can increase the initial installation and maintenance costs. R-717 also operates at higher pressures than many other refrigerants, placing additional demands on system components and infrastructure, which can lead to higher upfront costs. The complexity of installation, maintenance, and servicing further requires specialized knowledge and skilled technicians, contributing to increased service costs.

While R-717 has an ultra-low GWP, its release into the environment can still have negative impacts, particularly if it is not handled properly. Ensuring that systems are well-maintained and that any leaks are promptly addressed is crucial. Hence, R-717 is not commonly used in domestic refrigeration applications. Its use is more prevalent in large-scale commercial and industrial systems where the benefits outweigh the risks.

2.1.4.4 Applications of R-717

R-717 is extensively utilized across various industries due to its high cooling capacity and cost-efficiency. In the food industry, it is integral to large-scale refrigeration systems in food processing plants, cold storage facilities, and dairies, where its robust performance supports high cooling demands and operational cost savings. In supermarkets and grocery stores, R-717 is used in expansive cold storage and freezer systems, often integrated into remote systems to enhance operational efficiency and reduce noise, thereby improving the customer experience.

2.2. Energy-reducing technologies

The choice and application of technology in the commercial refrigeration are closely linked to the preferences of the head of the commercial establishment, their environmental consciousness and as well as the balance between profitability and equipment performance. Certain technologies, such as the deployment of leak detection devices, LED lighting, air curtains, strip curtains, night blinds, and the incorporation of glass doors with multi-layer glazing and gaskets, can be applied across all types of equipment and systems. These technologies not only contribute to EE but also align with sustainability goals.

While other technologies innovations such as variable speed compressors, HX design, ejectors, and electronic expansion valves offer significant advantages in terms of EE and performance optimization, they require a higher initial investment and demand a highly specialized team for operation. As a result, these technologies find their optimal application in large systems, specifically in remote and centralized setups commonly associated with large supermarkets and cash & carry chains.

The decision-making process involves a careful consideration of the unique needs and priorities of the commercial establishment. The balance between upfront costs, long-term benefits, and the availability of expertise plays a pivotal role in determining the suitability of advanced technologies for specific applications. *Again, considering that* ***Viet Nam establishments prefer old and second-hand equipment and systems,*** *the difficulty and complex of enhancing the efficiency of the cooling equipment and systems is consequently elevated****.*** The initial efficiency is already decreased with more maintenance and reparation involved with outdated technologies. Overall, there are many challenges the commercial refrigeration sector is witnessing a dynamic transition powered by environmental consciousness, economic viability, and technological advancements, shaping the landscape of sustainable and efficient cooling solutions.

3. Cost implications

3.1. Producers

Regarding the producers of stand-alone/plug-in refrigeration systems, this type of equipment benefits from streamlined production processes, which translate to lower manufacturing costs while the straightforward design and reliance on established technologies contribute to cost-effectiveness. However, challenges may arise in maintaining a competitive edge through innovation, as these systems might have fewer opportunities for differentiation. In contrast, producers of remote refrigeration systems face higher upfront costs due to the incorporation of advanced technologies, including remote monitoring and control features. Centralized refrigeration systems, while more complex to manufacture, may offer scalability benefits. However, the challenge lies in optimizing production efficiency to mitigate the inherent complexities and associated costs.

The transformation cost for producers (manufacturers of refrigeration equipment) transitioning to green cooling technologies, such as natural refrigerants, represents a significant investment across multiple areas: research and development (R&D), production line upgrades, and compliance with new standards. These costs arise primarily from the need to adapt equipment designs and manufacturing processes to safely and efficiently accommodate refrigerants like ammonia, CO_2, and hydrocarbons.

- **Research & Development(R&D) and Equipment Redesign** costs are substantial as manufacturers need to develop new models or modify existing designs to be compatible with natural refrigerants. Natural refrigerants often require handling higher pressures (such asCO_2 systems) or flammability concerns (like hydrocarbons), necessitating a complete redesign of components such as compressors, heat exchangers, and safety systems. The cost of R&D can range from 5-10% of the manufacturer's total annual turnover[11], particularly for small-scale manufacturers. This redesign process also requires adherence to stricter environmental and safety regulations, adding further financial pressure.
- **Production Line Upgrades** are another key cost factor. Manufacturers need to invest in specialized machinery and equipment to handle the properties of natural refrigerants, particularly the high pressures of CO_2 or the flammability risks associated with hydrocarbons. Upgrading production lines could cost between 10-20% of the current setup cost, depending on the complexity of the refrigerants being handled[12]. Furthermore, modifications may involve the installation of more advanced safety systems, given the risks associated with natural refrigerants.

Certification and Testing costs also contribute to the transformation expenses. Manufacturers must ensure their products meet international standards for EE, safety, and environmental impact. Additionally, production staff require training to safely handle these refrigerants, adding further costs for both training and certification processes.

[11] Consulted from sector expert and some producers in Viet Nam.
[12] Consulted from sector expert and some producers in Viet Nam.

3.2. Service sector

The service sector's engagement with stand-alone/plug-in refrigeration systems is solely related to the installation and maintenance procedures. Technicians require less specialized training due to the simplicity of these systems, which allows for efficient troubleshooting and repairs hence reducing workforce training costs. In contrast, the service sector dealing with remote systems must invest in training programs to equip technicians with the necessary expertise in handling complicated technology. For centralized systems, the installation process demands a higher skill set from technicians, contributing to elevated service costs. Additionally, the need for ongoing specialized maintenance, often under long-term contracts, adds complexity and expense. Businesses may experience revenue loss during the transition period, but the eventual operation of improved systems and the display of environmental commitment contribute to long-term benefits.

The transformation to green cooling technologies, specifically the adoption of natural refrigerants, poses substantial costs to the service sector, which includes technicians and servicing companies. These costs are primarily tied to **training and certification, investment in new tools and equipment, and adaptation to stricter safety and environmental protocols**.

- **Training and Certification** costs are significant as technicians need specialized education/training on handling natural refrigerants like CO_2, hydrocarbons, and ammonia. The cost of training programs depends on the complexity and the level of certification needed. Additionally, ongoing certification may be necessary as the industry continues to evolve, adding a recurring expense for servicing companies.
- **Tool and Equipment Upgrades** also represent a major expense. Servicing equipment designed for traditional HFC or HCFC refrigerants may not be compatible with natural refrigerants. Technicians and servicing companies need to invest in specialized tools such as pressure gauges, leak detectors, recovery units, and personal protective equipment that are suitable for high-pressure CO_2 or flammable refrigerants like propane. These upgrades is depending on the scale of the business and the types of refrigerants being handled.
- **Safety and Compliance Costs** further increase the financial burden. Servicing companies need to adopt higher safety standards due to the hazardous nature of certain natural refrigerants. This includes setting up secure workspaces, implementing more rigorous leak detection systems, and ensuring that technicians follow strict safety guidelines. Failure to comply with environmental and safety regulations can lead to fines, which further highlights the need for substantial upfront investments.

3.3. End-user

End-users of stand-alone/plug-in refrigeration systems will face costs associated with purchasing energy-efficient commercial refrigeration system. While there are upfront costs, the energy savings over the lifespan of the new systems can result in reduced operational expenses, providing a return on investment. Remote and centralized systems which cater to larger-scale applications and enterprises, besides high initial investment, training and certification of the technicians also incur moderate costs. Maintenance costs and frequency also increases but can be balanced by potential energy savings and an extended system lifespan contributing to lower operational costs.

In summary, regardless of the technological advancements pursued, the initial investment will always be high. It's essential to note that the qualitative estimates provided are generalizations. The actual costs will vary based on specific circumstances, the technologies chosen, and regional factors. Detailed cost assessments should be conducted based on individual projects and organizational needs to ensure accurate planning and decision-making in the adoption of energy-efficient commercial refrigeration systems.

3.4. Estimation of transformation cost for NetZero Target

Based on the data in the Section III., the consumption trend in the Refrigeration sector in the period of 2020 to 2030 is as follows:

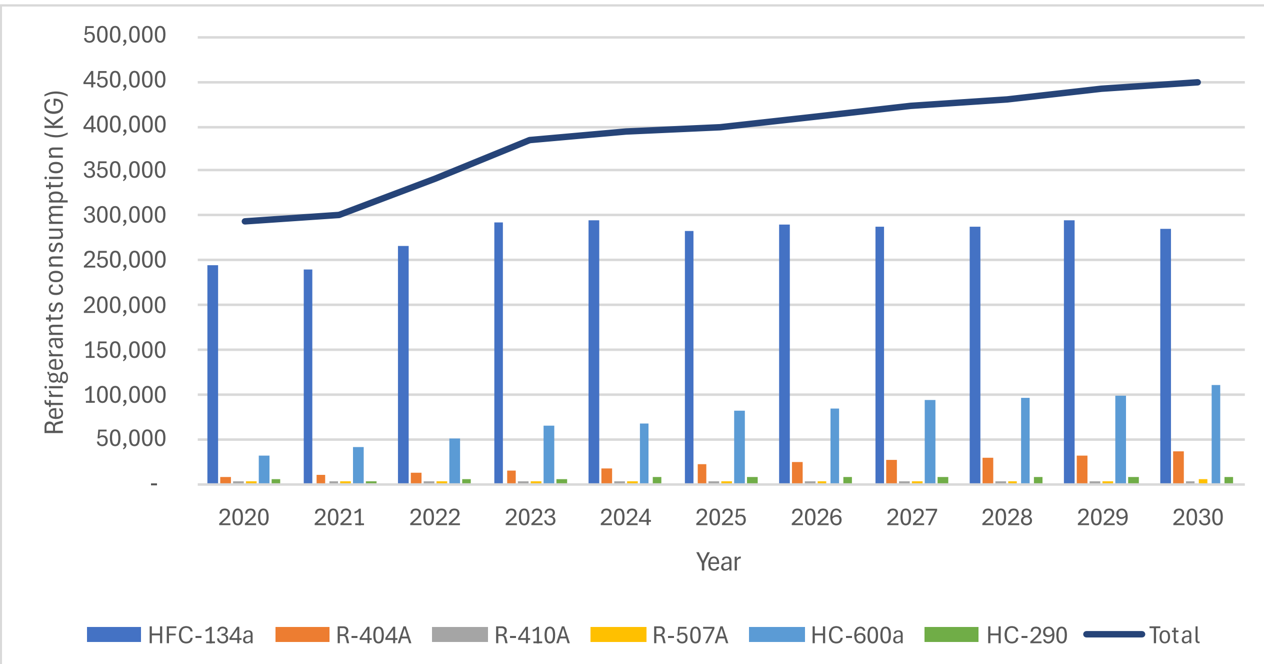

Figure 15: Refrigerants consumption in Refrigeration sector in period 2020 – 2030

To get the NetZero target, it is necessary to reduce the use of high GWP refrigerants such as HFC-134a, R-404A, R-410A, R507A and increase the proportion of HC refrigerant. With the assumption for the next period of 2025-2030, the equipment using high GWP will be reduced from 20-30% and replaced by the equipment using natural refrigerants. The projection for NetZero scenario is shown below:

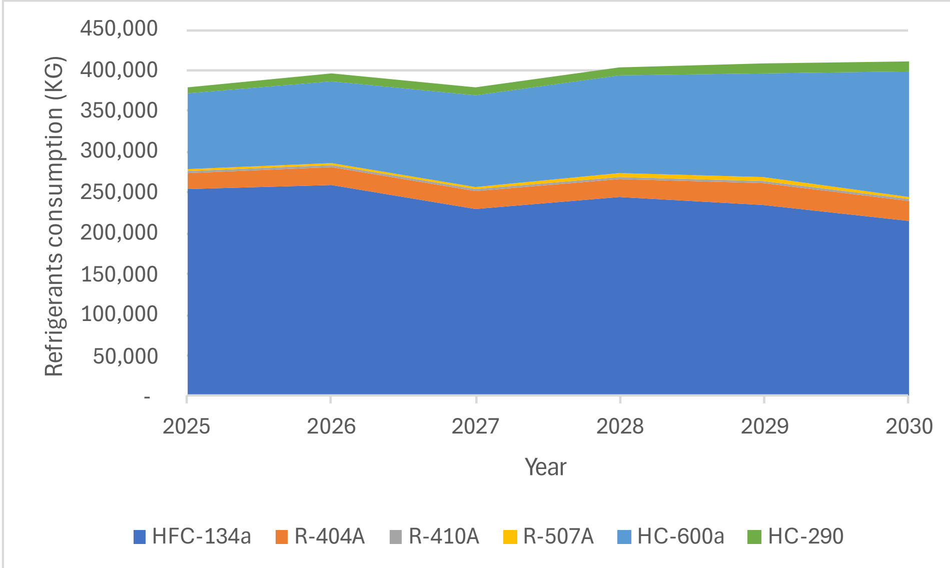

Figure 16: Refrigerants consumption in NetZero scenario from 2025-2030

Based on the refrigerants consumption in Business as usual (BAU) scenario and NetZero scenario has been shown above, the price of refrigerants (which is collected from Market survey and interviews with some refrigerants distributors) was used to estimate the transformation cost with the **Cost escalation factor is 8%**. The result is shown below:

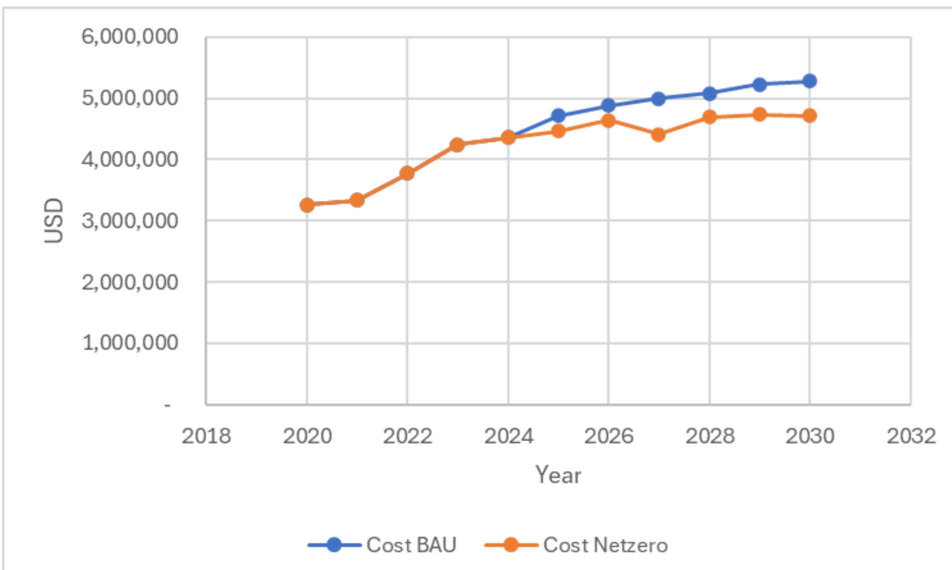

Figure 17: Cost for transformation from BAU to NetZero Target

By the calculation, the necessary capital for transformation in the period of 2025-2030 would be about 2.5 million USD.

V. Summary/Proposed National transformation plan

1. Short-term Activities (from 2024 until the end of 2026)

i. Conduct Comprehensive Sectoral Survey on Refrigeration Equipment and Practices:

- The current data on refrigeration systems in the food cold chain sector is inadequate. A sectoral survey should be initiated to gather reliable data on the types of refrigeration equipment in use, refrigerants consumption levels, and current servicing practices.
- Collaboration with relevant stakeholders, such as the Ministry of Agriculture and Rural Development (MARD), Ministry of Natural Resources and Environment (MONRE), and industry associations, will be crucial for collecting accurate data for both domestic and commercial refrigeration subsectors, especially in retail, supermarkets, and the fishery industry.

ii. Encourage transition to Natural Refrigerants:

- Promote the adoption of natural refrigerants like HC-600a (isobutane) and HC-290 (propane), focusing on developing safety standards and technical guidelines for their use, considering the flammability and toxicity risks.
- Develop national safety standards, technical guidelines, and regulations for the safe use of natural refrigerants like HC-600a and HC-290 in refrigeration equipment.
- Engage industry stakeholders, including manufacturers and service providers, in drafting safety and technical standards for green refrigerants to address flammability risks.

iii. Develop Pilot Projects for Low/Ultra-Low GWP Refrigerant Systems:

- Implement pilots or demonstration projects that focus on converting refrigeration systems to low or ultra-low GWP refrigerants. These projects should cover various applications, including domestic refrigerators in households, retail shops, and large-scale commercial refrigeration systems in supermarkets and cold storage facilities.
- Incorporating recovery, reuse, and recycling activities within these pilot projects is important to foster the transition from high GWP refrigerants to natural refrigerants.

iv. Standardize Recovery, Reuse and Recycle Processes:

- A standard for the purity of refrigerants recovered from the food cold chain sector should be developed in alignment with international standards. This standard will guide technicians and companies on proper reuse and recycle practices, ensuring recovered refrigerants meet safety and performance criteria.

v. Strengthen Collaboration Among Key Ministries:

- Establish close collaboration between MONRE, the Department of Climate Change (DCC), and the relevant departments under MARD. This is essential to create a coordinated strategy for introducing sustainable alternatives across the food cold chain sector. These efforts should aim to set a clear direction for transforming the subsector.
- Close collaboration between MONRE and the Directorate of Vocational Training and Education (MOLISA) for developing programs and implement training for technicians and workers on good practices for ensuring safety for natural refrigerants (HC-290, HC-600a…) used in equipment and products (flammability, toxicity…). Provide comprehensive training on the use of alternative refrigerants and the environmental impacts of refrigerants to technicians working in both domestic and commercial refrigeration subsectors.

2. Long-term Activities (from 2027 to the end of 2029, and from 2030 to the end of 2040)

i. Phase down and ban R-22 equipment:

- Ensure the complete elimination of HCFC-22 by 2040, in line with Decision No. 496/QD-TTg, with comprehensive policies banning its use across all sectors, including food cold chains, supermarkets, and residential systems.
- Support the development of new technologies and infrastructure that are compatible with natural refrigerants and low-GWP alternatives, ensuring they become the dominant market standard.

ii. Develop National Recovery, Recycling, and Collection Systems:

- Establish comprehensive recovery and recycling systems for refrigerants across the domestic and commercial refrigeration sectors. These systems should be accessible nationwide to facilitate the collection of refrigerants from end-of-life equipment and to ensure proper disposal or reuse of recovered refrigerants.
- Incentivize the private sector to participate in refrigerant recovery and recycling initiatives through tax reductions or financial support.

iii. Encourage Investment in Recycling Infrastructure:

- Promote investment in infrastructure to process recovered refrigerants and purify them to meet reuse standards. Financial mechanisms such as tax exemptions and support from international sources, including soft loans, will be key to developing these systems.
- The government should seek international financial support for the early stages of this transition to cover costs and facilitate industry adoption of sustainable technologies.

iv. Foster the Adoption of Low/Ultra-low GWP Refrigerants, Renewable Energy and Energy Efficiency:

- Promote the use of low and ultra-low GWP refrigerants in domestic, commercial and industrial refrigeration systems across the food cold chain sector. Demonstration projects for alternative refrigerants, such as natural refrigerants (e.g., CO_2, and hydrocarbons), should be expanded to accelerate their adoption.
- Promote the implementation of renewable energy and efficient energy use in commercial and industrial refrigeration systems in food cold chain sector. The projects using EE and renewable energy for large cold storages and walk-in cold rooms are well suited this type of market.
- Encourage the development and adoption of advanced energy-efficient refrigeration technologies, including systems with higher COP.
- Develop and update technical documents and guidelines for energy saving and efficiency, reducing carbon emissions.
- To enhance energy efficiency and reduce emissions in the commercial refrigeration subsector, it is recommended that Viet Nam expands its MEPS to cover commercial refrigeration equipment. Currently, MEPS is mandated for room Acs, domestic refrigerators/freezers and commercial refrigerated cabinets. By extending these standards to industrial refrigeration such as cold storages, the country can promote the use of more energy-efficient technologies, reduce operational costs for businesses, and align with global sustainability goals. Implementing MEPS in this sector will drive the

adoption of high-efficiency equipment, supporting Viet Nam's broader efforts to combat climate change and improve energy security.

v. **Technician Training and Certification:**

- Promotion of comprehensive training programs for technicians and workers on good practices for ensuring safety for refrigerants (HC-290, HC-600a, R717, R744, …) used in equipment and products (flammability, toxicity…).
- Collaboration between MONRE, MARD, and the Directorate of Vocational Training and Education (MOLISA) should aim to establish a certification and licensing system for technicians to ensure they are properly trained in the handling of refrigerants and servicing practices.
- Provide incentives for technicians to undergo training in the maintenance and installation of systems that use natural refrigerants, ensuring the growth of a skilled workforce in the food cold chain sector.

vi. **Raise Public Awareness and Engage Industry Stakeholders:**

- Launch awareness campaigns targeting businesses and consumers in the food cold chain sector to emphasize the environmental and economic benefits of adopting low-GWP refrigerants.
- These campaigns should highlight the importance of using certified technicians and adhering to new refrigerant standards, while educating the public about energy-efficient and climate-friendly technologies.

vii. **Implement Regulatory Compliance and Monitoring Systems:**

- Develop a monitoring, reporting and verification system to track the progress of the phase-out of HCFCs, phase-down of HFCs and the adoption of natural refrigerants and energy-efficient systems, ensuring alignment with the country's net-zero emissions target by 2050.
- Establish mechanisms for the inspection of servicing practices, licensing of technicians, and monitoring the effectiveness of recovery and recycling policies and EE framework.
- Regularly review and adjust policies as needed to stay aligned with the overall goals of the phase-out/phase-down plan.

viii. **Support Research and Development:**

- Encourage innovation in the design and operation of refrigeration systems for the food cold chain. Research and development efforts should focus on improving the efficiency of alternative refrigerants, enhancing leak detection technologies, and developing energy-efficient systems.
- International cooperation and knowledge-sharing will be crucial to adopting global best practices and keeping pace with advancements in refrigeration technologies.

By adopting these recommendations, Viet Nam can transform the domestic, commercial and industrial refrigeration subsectors within the food cold chain, ensuring a gradual transition to low-GWP refrigerants, improved energy efficiency, and enhanced technician capacity. This will contribute to achieving national and international environmental goals while supporting economic development and sustainability in the refrigeration industry.

References

1. GIZ, 2019. Greenhouse Gas Inventory of the Refrigeration and Air Conditioning Sector in Viet Nam. https://www.green-cooling-initiative.org/fileadmin/Publications/2019_C4_Inventory_Viet Nam.pdf
2. MONRE, 2023. Draft Technical Report to on the development of a national plan on management phase out of ozone depleting substances and controlled substances that cause the greenhouse effect.
3. UNEP, 2018. Report of The Refrigeration, Air conditioning and Heat pumps technical options committee, 2018 Assessment. https://ozone.unep.org/sites/default/files/2019-04/RTOC-assessment-report-2018_0.pdf
4. VASEP, 2023. Viet Nam's seafood exports in 2022. https://vasep.com.vn/san-pham-xuat-khau/infographic/infographic-xuat-khau-thuy-san-viet-nam-nam-2022-26133.html
5. VCCI, 2021. Annual Economic Report Mekong Delta 2020: Enhancing Competitiveness for Sustainable Development. https://fsppm.fulbright.edu.vn/download/BCKT-Mekong-Delta-Eng-Final.pdf
6. Viet Nam Economic News, 2022. Agricultural, forestry and fishery exports will reach over 53.22 billion USD in 2022. https://congthuong.vn/nam-2022-xuat-khau-nong-lam-thuy-san-dat-tren-5322-ty-usd-232541.html
7. Viet Nam Industry and Trade Information Centre, 2023. Cold chain logistics market in Viet Nam, the world and prospects (Focusing on cold storage and cold chain transportation services).

GREEN COOLING INITIATIVE III

The Green Cooling Initiative III (GCI III) is a global project commissioned by the German Federal Ministry of Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). GCI III supports 07 partner countries, one of which is Viet Nam, in tackling specific challenges in shifting to green cooling technologies.

In Viet Nam, GCI III aims to strengthen the capacity of public and private actors for the Green Cooling approach and thereby support the transformation towards climate-friendly technologies, contributing to achieving Viet Nam's goal of net-zero emissions by 2050. The project works with the Department of Climate Change, Ministry of Environment and Natural Resources as its political partner, and the Hanoi Industrial Vocational College as one of the implementing partners.

The work of GCI III is based on 03 pillars: Policy advise, technology transfer, and capacity building. Regarding policy advise, GCI III supports its Viet Namese partners to include green cooling measures into the 2022 updated Nationally Determined Contribution (NDC), conduct market study and develop an implementation plan for Green Cooling technologies, and facilitate access to appropriate financing channels for Green Cooling projects. The project also organises study tours to China for local manufacturers on the production of energy-efficient R290 split air conditioners and supports the development of the supply chain for R290 air conditioners and heat pumps. Lastly, the project organises on-site training for the National Ozone Unit staff, revises the vocational training curriculum of 02 vocational colleges, and deploys training of both trainers and trainees on safe use of natural refrigerants.

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