National Survey on HFC Use in Sri Lanka

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NATIONAL SURVEY ON HFC USE IN SRI LANKA

Table of Content

1. INTRODUCTION

This section provides an overview of Sri Lanka, ODS phase-out activities undertaken so far, and HFC survey and data collection process.

1.1 Background

Sri Lanka is an island country in the Indian Ocean to the south of India, with a land area of approximately 65,000 sq. km. It has an approximate population of 21.3 million with an estimated GDP per capita (PPP) of USD 3,280 (2013 estimate). On the sectoral basis, the agricultural sector accounts for approximately 13.4% of GDP, the industry for nearly 29.4% and the services sector 57.3%. The population density is approximately 309 persons per sq. km and the urban population represents approximately 15% of the total population.

Historically, thanks to its religious and cultural heritage, Sri Lanka is well known for its action for protecting and living in harmony with nature. At present, human-induced climate change has emerged as an environment issue regarded globally as an overarching development challenge that can seriously affect economic growth, food security, water security, public health, and social stability to which developing countries are especially vulnerable. Addressing the adverse effects of climate change is highlighted in the Government's "Green Lanka Programme 2009 and Caring for the Environment: Path to Sustainable Development Action Plan 2008-2012" (Presidential Secretariat, 2009; MoENR, 2008).

Being among the first 50 countries to join the United Nations Framework on Climate Change (UNFCCC), Sri Lanka is party to UNFCCC and the Kyoto Protocol (KP). HFC is included in the basket of gases to be stabilized in the atmosphere according to the KP. When HFC was introduced as a replacement to CFCs and HCFCs in the early 1990s, during the Montreal Protocol discussions, Sri Lanka highlighted the challenge with HFC as being a Greenhouse Gas (GHG) with high Global Warming Potential (GWP).

Towards becoming an internationally competitive middle-income country, the Sri Lankan economy has seen a strong growth in the first decade of 21st Century, despite suffering from internal conflicts from 1983 to 2009 and some major natural disasters. The gross domestic product of the country grew at an average of 5% during this period. One of the major factors behind development and economic growth is government spending. Agricultural production, textile and apparel, tourism and tea export are the biggest economic drivers. A substantial portion of foreign exchange also comes through overseas employment especially in the Middle East, Republic of Korea, Japan, USA, UK and Australia.

Under the newly elected government as of January 2015, Sri Lanka is preparing a systematic approach and action plan for implementing sustainable development goals which includes a clear framework for collaboration with UN agencies and the global community. President Maithripala Sirisena retains the subject of environment under his purview and is keen on sustainable development giving due emphasis on environment protection and climate change. Sri Lanka hopes to become a leader in the merging 21st century global eco-civilization, by harmonizing the social, economic and environmental elements of the sustainable development framework.

The newly elected Government's policies focus on poverty alleviation and steering investment to disadvantaged areas, developing the small and medium enterprise (SME) sector, promotion of agriculture, and expanding private-public partnerships.

Literacy rate in Sri Lanka is 91% in local languages. English language proficiency is relatively high, but has declined significantly since the 1970s.

1.2 Overview of Implementation of the Montreal Protocol in Sri Lanka

Sri Lanka ratified the Vienna Convention, the Montreal Protocol and its amendments early as given in Table 1.

Table 1: Sri Lanka - Ratification of the Montreal Protocol and its Amendments

Agreement/Amendment	Ratification
Vienna Convention	December 1989
Montreal Protocol	December 1989
London Amendment	June 1993
Copenhagen Amendment	July 1997
Montreal Amendment	August 1999
Beijing Amendment	November 2002

Source: National Ozone Unit

To fulfil the country's obligation to the Montreal Protocol, a Country Programme was framed in 1993, proposing measures and actions by the Government and industry, such as institutional and regulatory measures, awareness and information dissemination, technical assistance, training and investments for technology conversions, for facilitating the phase-out of Ozone Depleting Substances (ODS) in the various ODS consuming industry sectors and to assist them in complying with the country's commitments and priorities. The Refrigeration and Air Conditioning Sectors were the main ODS consuming sectors in Sri Lanka.

The National Ozone Unit (NOU) was set up at the Ministry of Environment in 1994. It functions under the Ministry of Mahaweli Development and Environment. Sri Lanka introduced regulations on phasing out the production/consumption of (ODSs) since 1996. With the support from the Multilateral Fund (MLF) of the Montreal Protocol, Sri Lanka made

significant progress in ODS phase-out, specifically Chloroflorcarbons (CFCs) by 2008, two years before the deadline. The other ODSs, mentioned below, were phased out by 2010.

- Methyl Chloroform (MC)
- Halon
- Carbon tetrachloride (CCl_4)
- Methyl bromide (MeBr) with exemption for Quarantine & Pre-Shipment purposes (QPS).

Hydrochloroflurocarbons (HCFCs) were recommended as transitional refrigerants because of their low Ozone Depleting Potential (ODP) value. Their use continued until 2013 without any restrictions. However, at present, HCFCs are being gradually phased out and will be completely phased out by 2030.

CFCs and HCFCs, were widely used in the following applications over many decades after the invention of CFCs and HCFCs in late 1930 as best refrigerants.

- Refrigeration and Air Conditioning installations and servicing
- Foam manufacturing
- Solvents
- Aerosol/perfume manufacturing
- Fire-protection products/equipment

The commonly used HFCs such as **HFC-134a, R 404A, R-407C, R-410A, R-507A, HFC-152a** in Sri Lanka have hundreds to thousands times higher Global Warming Potential (GWP) over a 100-year time.

2.

Substance	GWP	Use/Application
HFC-134a	1,430	Domestic, commercial and industrial refrigeration, Mobile Air Conditioning, Central AC, Transport refrigeration
R-404A	3,922	Commercial and industrial refrigeration
R-407C	1,774	Commercial and industrial refrigeration
R-410A	2,088	Unitary Air Conditioning
R-507A	2,465	Industrial refrigeration and Transport refrigeration
HFC-152a	124	Fire suppression

NATIONAL SURVEY ON HFC USE IN SRI LANKA

2.1 Introduction

HFCs were introduced into commercial use largely because they have proven to be effective substitutes for ODSs. They do not deplete the ozone layer and are suitable for use in applications in place of CFCs and HCFCs.

The use of HFCs increases rapidly as a result of global economic development and population growth. HFCs are the fastest growing greenhouse gases in the world. Atmospheric observations show that the abundance of HFCs in the atmosphere is increasing rapidly. Global average temperatures have already increased to considerable levels over the past years, which scientists agree is also due to human activity that has occurred in relation to halogenated hydrocarbons.

2.2 Objectives

The objectives of the survey are as follows:

- Conduct an initial survey of HFC consumption in Sri Lanka to establish the current HFCs consumption
- Provide future projections of growth patterns by substance
- Establish use and growth patterns for various HFCs in the country.
- Identify opportunities and challenges for transition to low-GWP alternatives for various applications.

At this stage, the survey would provide data to facilitate selection of appropriate safe and efficient low-GWP alternatives, wherever currently available for various applications, thus contributing to direct and indirect emission reductions, when such alternatives are adopted.

2.3 Scope of Works

The scope of work revealed that the survey had to cover all the sectors and subsectors that used HFCs. An exercise was carried out, based on the review of potential information available at the NOU, to identify all the sectors and subsectors.

Preliminary discussion was held with the Director, the NOU and its Technical Officials to formulate a methodology and update information on global HFC issues. The following decisions were taken as a result:

- To conduct this survey at 3 levels in collaboration with the NOU.
- To jointly prepare questionnaires to suit different sectors.
- To appoint survey teams with technical background for all districts of the country
- To hold consultation meetings with the survey teams when required.

2.4 Data Collection

a. Institutional Level Data collection

Data was collected from Sri Lanka Customs, Department of Motor Traffic, Board of Investment and Ministry of Industries. These are the key Government Institutions involved in import of HFCs or equipment containing HFCs. The data available with these institutions

are in various forms but are useful as an overall picture of the total amount of HFCs entering the country. Since Sri Lanka is not producing HFCs, the requirement is met with imports.

b. Middle Level Data Collection

Data was collected from Importers, Distributors, and Retailers in order to obtain the total quantity of HFCs and mixed blends imported for the year 2012, 2013 and 2014. The country's requirement is met with imports.

c. National Level Data Collection

HFCs are used in a range of applications in different parts of Sri Lanka. In order to collect maximum and accurate data from each sector where HFCs are used, it was decided to form 12 teams to do the survey at the national level. One team consisted of one instructor from a technical college as the leader of the team and 4 students from the technical colleges. According to the geographical demarcation and Technical Institution where Team Leader worked, 12 teams were formed to cover the following Administrative Districts. District of Colombo was divided into 2 groups because of a large number of HFC users. Some teams were allocated 2-3 districts due to less concentration of HFC use or less number of workshops.

Team	Administrative District
1	Colombo I
2	Colombo II
3	Gampaha
4	Kurunegala + Matale + Puttalam
5	Kandy + Kegalle + Nuwara-Eliya
6	Galle + Matara+ Hambantota
7	Kaluthara + Rathnapura
8	Anuradapura + Polonnaruwa
9	Badulla + Monaragala
10	Trincomalee + Batticaloa
11	Kilinochchi + Mannar + Vavuniya
12	Jaffna + Mullative

The National Survey Team had to recognize places of HFC use in particular districts according to the General Questionnaire, with an authorization from the Team Leader. Apart from that the Team Leader had to summarize the data according to the type of users and submit to the NOU for record, and to the Consultant for analysis. An Excel sheet was prepared to efficiently record the collected data.

2.5 Questionnaires

HFC consumption data were collected through Questionnaire Survey and cross checked with

the import data. A set of Questionnaire for each sector was developed to cover various sectors that used HFCs. Questions pertaining to availability and use of alternatives formed part of the relevant questionnaire. The questionnaires developed are as follows:

1. Questionnaire for Customs
2. Questionnaire for Refrigerant Importers/Dealers
3. Questionnaire for RAC Equipment Importers
4. Questionnaire for RAC Equipment Manufacturers/Assemblers
5. Questionnaire for RAC Service Workshops
6. Questionnaire for Military Establishment

It must be noted that the estimates presented in this report are based on inputs made available during the survey, and technical inputs based on prevailing HFC consuming industry situation in Sri Lanka.

3. HFC SUPPLY AND DEMAND AND CONSUMPTION TRENDS

This section presents HFC demand and supply situation and HFC consumption trends in Sri Lanka.

3.1 HFC supply situation

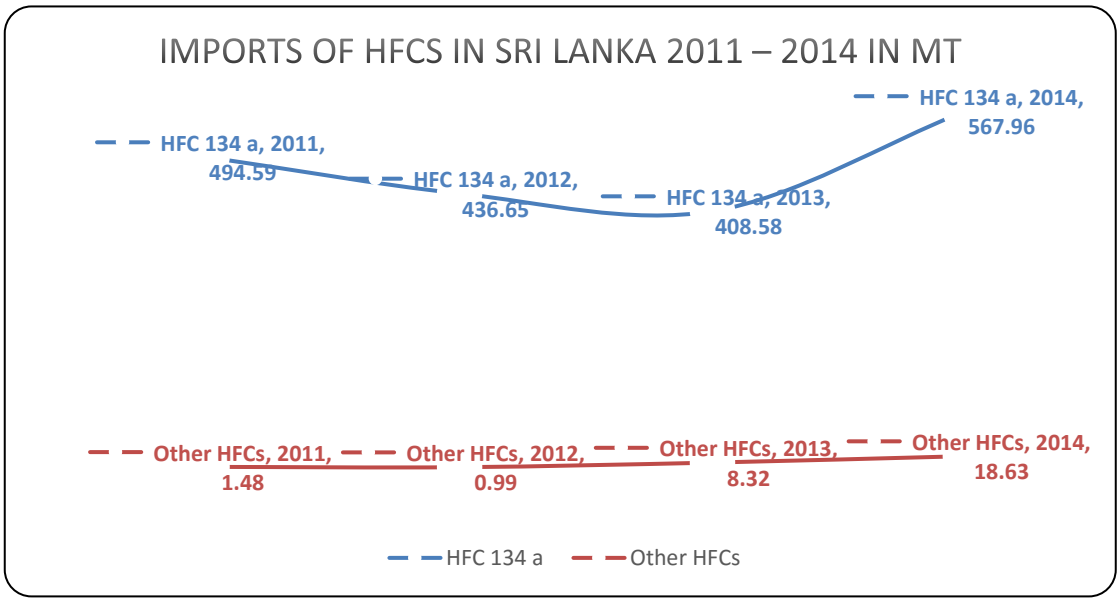
Sri Lanka does not produce any HFCs but imports HFCs for its requirements. The following table summarises the imports of main HFCs i.e. HFC-134 and other HFCs (R-407C, R-410A, R-404A, R-507A) into the country.

Table 2: Imports of HFCs in Sri Lanka 2011 – 2015 (in metric tonnes)

Chemicals	2011	2012	2013	2014	May 2015
HFC-134a	494.59	436.65	408.58	567.96	67.29
Other HFCs	1.48	0.99	8.32	18.63	6.24
Total	**496.07**	**437.64**	**416.90**	**586.59**	**73.53**

Source: Sri Lanka Customs

Figure 1: Import of HFCs in Sri Lanka 2011-2014



Since separate H.S. Codes have not been introduced for different types of HFCs blends, other than HFC-134a, a common H.S. Code has been applied for all blends such as R 407C, R-410A, R-404A, R-507A. The data analysis revealed that since the import license was not required for HFCs import, most of the importers used H.S. Code allocated for HFC-134a to import other HFCs also.

These data are not included in the Article 7 data reports as HFCs are not Ozone Depleting Substances. As mentioned earlier, import licenses for HFCs are not required.

Table 3: HFC Supply Sector

No.	Sector	Approximate Population
1	HFC Manufacturing	0
2	HFC Importers	15-20
3	HFC Dealers	80- 90

Source: HFC Survey 2015

Some of the key aspects related to supply of HFCs that can be seen from Table 3 are:

- HFCs are imported by 15-20 importers. The details of imports by the individual importers are given in Table 4. This information is given by importers to the best of their knowledge and on available records.

- HFCs are mainly imported from Singapore, China, India, the UAE and a small quantity is imported from European countries.

3.2 Import of HFCs

During the survey, a consultation was carried out with the National Ozone Unit on the list of HFC importers in Sri Lanka. Data on imports from the importers were collected through a specific questionnaire and presented in the following Table 4.

Table 4: All HFC imports during 2012 – 2014 (in metric tonnes)

Importer name	2012		2013		2014	
	HFC-134a	Other	HFC-134a	Other	HFC-134a	Other
Acref Spares (Pvt) Ltd	21.76	4.34	25.56	4.92	19.38	7.80
Ajanee Trading	16.32	1.04	21.76	3.53	31.00	2.20
Araliya Enterprises	-	-	-	-	31.50	4.10
ATCO Refrigeration (Pvt) Ltd	59.84	9.09	76.84	11.95	92.48	13.57
Bio- Tech Engineering	6.80	1.36	13.6	6.12	2.72	6.80
Coolking	2.72	1.78	6.80	4.44	6.80	4.40
C.W. Mackie & Co	2.62	4.53	3.17	-	2.43	1.69
Everest Industries Lanka Ltd.			22.93		8.90	
JSS Enterprises	4.76	2.31	-	1.36	-	5.98
Lalith Enterprises	-	-	1.36	-	1.36	-
Modern Air Con Pte Ltd.	14.28	-	12.24	0.56	19.04	1.41
Modern Group	26.86	-	32.64	-	38.08	28.56
New City Enterprises	-	-	-	12.20	-	-
RAU Trading	6.80	1.13	6.80	1.16	6.80	
Rohan Rodrigo & Co	8.16	12.20	8.16	11.30	10.88	10.07
Thilhara Ref & Electrical	-	-	2.04	1.13	-	-
Vivasa	3.40	3.78	1.36	1.13		
Frostaire Pte Ltd	4.08	1.38	6.12	1.65	5.44	3.20
P & G Holdings	12.24	1.09	32.64	3.27	51.00	1.63
Total	**190.64**	**44.75**	**274.02**	**67.96**	**327.81**	**94.78**
Total HFC imported	**235.39**		**341.98**		**422.59**	
Percentage (%) of total import	**81**	**19**	**80**	**20**	**77**	**23**

Source: HFC Survey Data 2015 (verified through Importers records)

Table 5: Import of other HFCs in 2014 (in metric tonnes)

Year	R-407C	R-410A	R-404A	R-507A	Total
2012	2.55	12.22	27.27	2.69	**44.74**
2013	10.78	21.74	30.78	4.65	**67.96**
2014	15.37	28.76	47.79	3.85	**94.78**
Total	**28.70**	**62.72**	**105.84**	**11.19**	**208.45**

Source: HFC Survey Data 2015 (verified through Importers records)

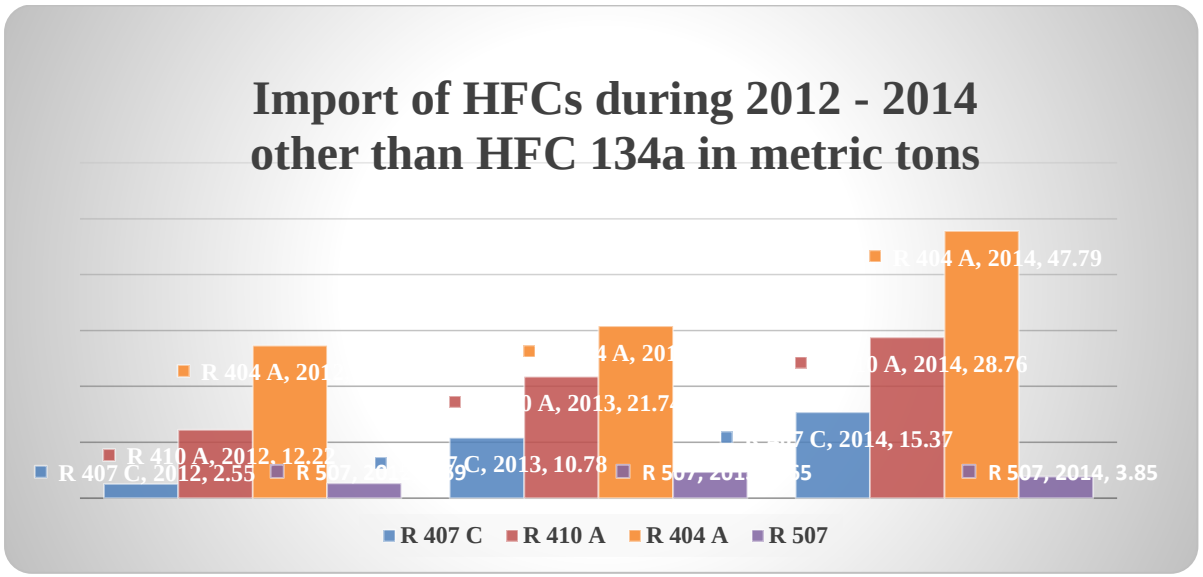


Figure 2: Imports of HFCs other than HFC-134a

HFC-134a and other HFCs are mainly used in RAC applications in servicing and installation, manufacturing domestic refrigerators and bottle coolers.

Over the last few years, HFCs consumption have been increasing because of the growing demand in servicing sector and economic growth. It must be noted that HFC consumption is expected to grow further in the next few years primarily driven by consumption growth of RAC applications and a rapid increase in the number of vehicles. HFC blends are used mainly in unitary air conditioning, commercial air conditioning, refrigeration applications and refrigerated transport.

Table 6: Estimated HFC Consumption by Sector

No	Sector	Approximate Population
1	RAC Equipment Importers	50-55
2	RAC Equipment Manufacturers	2-4
3	RAC Equipment Assemblers	4-6
4	RAC Equipment Installers	80- 100
5	RAC Service Sector workshops	3,000 – 3,300
6	End Users	Refer to Table 7

An estimate in various applications was made from the data on the experiences obtained through the HCFC survey conducted in 2009/10. The companies that underwent the HCFC Survey were consulted during the HFC survey.

Table 7: Estimated End-users by Sub-sectors

No	Sector	Sub Sector	Approximate Population of Equipment
1	Central Air Conditioning Chillers (Screw, Reciprocating, Centrifugal) HFC-134a, R-407C (30-35% of HCFC-22 Chillers are in service)	Hospitals	70-80
		Hotels (4 or 5 star)	150-175
		Office Buildings	80- 90
		Bank Buildings	40-50
		Apartments/ Condominium	100-110
		Textile/ Garments Factories	150-165
		Food processing Factories	8-10
		Tobacco processing Factories	2
		Convention Halls	20-22
		Airports (2 Airports)	10-12
		Harbours (3 Harbours)	6-8
		Parliament	04
		Shopping Malls	30-35
		Cinema and recreation centres	4-5
2	Commercial Air Conditioning (Package water/ Air Cooled) HFC-134a , R-407C (Mostly HCFC-22)	Operating Theatres	200-220
		Hotels (2 or 3 star)	1,300-1,500
		Bank Buildings	800-850
		Commercial Buildings	2,000-2,500
		Telecommunication Tower Control Rooms	700-750
		Other applications	2,000-2,500
3	Unitary Air Conditioners R-410A, R-407C (95% working with HCFC-22)	Hospitals	ACs working on HFC represent 5% of total AC installed, i.e 16,000 – 20,000 (Assuming 1 AC per 50-60 persons population, total number of ACs 330,000 – 400,000)
		Hotels	
		Office Buildings	
		Bank Buildings	
		Houses	
		Shopping Malls	
		Cinema and recreation centres	
		Universities	
		Schools, Colleges	
		Military (Armed Forces & Police)	300-400
4	Refrigeration HFC-134a, R-404A, R-507A	Large Cold storages (warehouses)	20-25
		Hotels (cold storages)	350-400
		Supermarkets	1,200-1,300
		Shipping	Not found

		Ice plants mostly R-717, use in ice storages	6-7
		Blast Freezers	Not found. Mostly HCFC-22 and R-717
		Ice Cream manufacturing	6-8
		Milk Chilling plants	500-600
		Yoghurt and other milk products	15 -20
5	Automobile Air Conditioning HFC-134a	Cars	350,000-400,000
		Mini Buses, Vans	120,000-150,000
		Mini Refer trucks	1,500 -1750
		Buses	800-900
		Trains compartment	75-100
	Automobile Air Conditioning, R-404A R-507A	Reefer Trucks	2,200-2,400
6	Foam Manufacturing		Not found
7	Solvent Manufacturing		Not found
8	Firefighting Manufacturing		Not found
9	Glass manufacturing		1-3

Source: HFC Survey 2015 and Industry inputs

The price of HFCs is given in Table 8. It must be noted that the prices, given based on average dealer information, fluctuated due to a variety of market factors.

Table 8: Price of HFC in Sri Lanka from 2014 – 2015

(Price in US$/kg)

Substance	2014	2015
HFC-134 a	5.50	5.23
R-410A	6.75	6.25
R-404A	6.70	6.70
R-407C	7.12	6.63
R-507A	8.50	8.48

Source: HFC Survey 2015

3.3 HFC consumption in different sectors

3.3.1. Manufacturing/Assembling

a. Domestic Refrigerators

Currently HFC-134a is not used in domestic refrigerators. In August 2014, REGNIS Lanka Ltd., the sole manufacturer of refrigerators in Sri Lanka, converted its plant to manufacture refrigerators using HC-600a hydrocarbon. Approximately, REGNIS used 30-35 metric tonnes of HFC-134a annually until termination in 2014. DAMRO Sri Lanka, a home appliances and furniture manufacturing company, started manufacturing HC-600a refrigerators from 2014 under the name INNOVEX. At present, the production capacity is 30,000 refrigerators per year, and DAMRO is planning to double the production by next year aiming to export to other regional countries. Domestic refrigerators are imported mainly from Korea (LG, Samsung) Malaysia (Panasonic), India (Godrej), and China (Haier, Sanyo).

b. Commercial Refrigerators

Commercial refrigeration equipments using HFCs are primarily used in display units for fruits, vegetables, meat/fish and dairy products. These are used in large supermarkets and medium-size stores selling house-hold products. It must also be noted that in supermarkets and medium-size stores, HFC-134a and R-404A are used. The use of HC-based equipment is very limited.

Furthermore, large supermarkets and medium sized stores have cold storage using HFC-134a for storing food. These stores have small capacity (about 3 Tons of Refrigeration -TR) cooling units. It must be noted that for frozen products applications, R-404A based and R-507A based units are used.

Currently, in Sri Lanka, commercial equipment are manufactured or assembled by 4-6 companies – namely Asparai Asian Chill Equipment (Pvt) Limited, ICEMAN Pte Ltd, GTA Refrigeration (Pvt) Limited and, Everest Industrial (Pvt) Limited. It is possible that there are another 2-3 small scale enterprises in this business, but the survey teams were unable to locate them. Everest Industrial (Pvt) Limited produces bottle coolers and chilled water dispensers. All these companies use HFC-134a and R-404A as refrigerant. Leading Supermarket chains such as Cargills, Keels, Arpico and Laugfs maintain HFC-based refrigeration equipment installed at supermarkets and shopping malls by themselves or through service contracts with service companies. In addition to the above, there are a very few unorganized players who intermittently assemble commercial equipment.

The equipment work with HFC imported from China, Japan, Germany, Australia, Malaysia, Thailand, Korea and small quantities from the USA. The following table presents the quantity of HFC used in commercial equipment made or assembled in Sri Lanka in 2014.

Table 9: HFCs use in Refrigeration Manufacturing/Assembling sector in 2014 (in metric tonnes)

Description	HFC-134a	R-404A	R-507A	Total
Domestic Refrigerator/Bottle cooler Manufacturing (REGNIS and Everest Industries Lanka Ltd.)	24.9	0	0	**24.9**
Commercial refrigeration (Assembling)	8.9	3.0	0	**11.9**
Industrial refrigeration (Assembling)	4.5	4.1	0	**8.6**
Transport refrigeration (Assembling) [ICEMAN Company assembles transport refrigeration units with imported components from Australia]	1.2	1.6	0.3	**3.1**
Total	**39.5**	**8.7**	**0.3**	**48.5**

Source: HFC Survey 2015

Given the economic growth rates expected in the near future, the demand for this equipment is expected to increase in terms of domestic distribution outlets. It must be noted that the growth will include both HFC-based and non HFC based equipment (CO_2, R-717, etc.). However, at present, a lot of HCFC-22 equipment are in commercial and industrial refrigeration applications such as cold rooms and chill water systems. With the present HCFCs phase-out schedule, it is anticipated that there would be a significant growth for HCFC-free equipment.

c. Domestic Air-conditioners

Currently, domestic Air-conditioners are not manufactured in Sri Lanka. In the past, there were three manufacturers: Haikawa International, Frostaire, and Abans that started manufacturing unitary Air-Conditioning equipment 10 - 15 years ago due to price competition from international brands/products coming from China, India and Korea. Haikawa International closed down. The other two companies also reported that they assembled small quantities of HCFC-22 air conditioners during 2008-2010, with a quantity between 5,000 – 6,000 annually. At present, no assembling of air conditioners is taking place.

Table 10. HFCs use in Air Conditioning Manufacturing/Assembling Sector in 2014 (in metric tonnes)

Description	HFC-134a	R-410A	R-407C	Total
Residential Air Conditioning Manufacturing	Not found			
Residential Air Conditioning (Assembling)	-	3.0	-	**3.0**
Commercial/Industrial Chiller manufacturing	Not found			
Commercial Air Conditioning (Assembling)	Not found			
Mobile Air Conditioning (Assembling)	3.5	-	-	**3.5**
Total	**3.5**	**3.0**	**0**	**6.5**

Source: HFC Survey 2015

d. Industrial Refrigeration and Air-Conditioning equipment

HFC-134a based industrial Air-Conditioning equipment (chillers) are widely used for comfort cooling in large buildings, hospitals, hotels, garment factories and other various types of factories. R-404A, R-407C, HFC-134a are used in processing/cooling/chilling and freezing applications for the food, chemical and pharmaceutical industries.

The equipment are installed by local companies which undertake contracts for installation and commissioning chillers. The list of the leading companies is presented in Table 11. Most of them are importers as well as installers. It is likely that a few additional small companies in the informal sector operate intermittently. This number, however, could be negligible.

Table 11: List of organizations installing central Air-Conditioning systems and refrigeration systems

Company Name	Equipment Category with Refrigerant Type
Abans Central Air-Conditioning Division	Chiller/Packaged/Split
Koolair	Chiller/Packaged/Split
Civimech (Pvt) Ltd.	Chiller/Packaged/Split
Builtmech (Pvt) Ltd.	Chiller/Packaged/Split
Metropolyton Air-Conditioning and Refrigeration (Pvt) Ltd.	Chiller/Packaged/Split
ERA Engineering Services	Chiller/Packaged/Split
Alfabeta Engineers (Pvt) Ltd.	Chiller/Packaged/Split
Harrier Engineers	Chiller/Packaged/Refrigeration
United Electrical Engineering (Pvt) Ltd.	Chiller/Packaged/Split refrigeration
Coolwing Engineering (Pvt) Ltd.	Chiller/Packaged
Inaire (Pvt) Ltd.	Chiller/Packaged/Split/Cool room
Arctic (Pvt) Ltd.	Chiller/Packaged/Split
Rohan Rodrigo Refrigeration & Air-Conditioning Company (Pvt) Ltd.	Chiller/Packaged/refrigeration
Hayles Industrial	Chiller/Packaged
VIVASA	Chiller/Packaged
Fuji Air-Conditioning (Pvt) Ltd.	Chiller/Packaged
SUNCO Engineering (Pvt) Ltd.	Chiller/Packaged
Craft Lanka Engineering (Pvt) Ltd.	Chiller/Packaged/Split
Usama Engineering (Pvt) Ltd.	Chiller/Packaged/Split
Frigi Engineering Services (Pvt) Ltd.	Chiller/Packaged
Idac (Pvt) Ltd.	Chiller/Packaged/Split
KASE Engineering	Chiller/Package/Refrigeration
Edana Engineering	Chiller/Packaged/Split
Modern Air Con (Pvt) Ltd.	Chiller/Package
Coolking Refrigeration	Split/Refrigeration
Thudawe Engineers	Chiller/Packaged
GTA Refrigeration (Pvt) Ltd.	Chiller/Package/Refrigeration
JEFCO Air Conditioning	Chiller/Packaged/Split
Refrians (Pvt) Ltd.	Chiller/Packaged/Split
Scan Engineering (Pvt) Ltd.	Chiller/Packaged/Split
Multi Air Technologies	Chiller/Packaged/Split
Sunco Engineering (Pvt) Ltd.	Chiller/Packaged/Split
Unitech Engineering Company	Chiller/Packaged/Split
Ice Man technologies (Pvt) Ltd.	Package/Refrigeration

Source: HFC Survey 2015 and industry sources

Typically, servicing is done by installing companies or through annual maintenance contracts by service agencies. The estimated service quantity for servicing equipment varies and depends on the equipment characteristics. Refrigerants for service are purchased from dealers.

3.3.2 HFC Use in Service Sector

The service sector deals with repair and maintenance of domestic refrigeration, unitary Air-Conditioning system and Mobile Air Conditioning. However, they used to carry out installation of new air conditioners and also repair and maintenance of the commercial RAC system. According to the survey questionnaires, it was revealed that 98% of domestic refrigerators were HFC-134a systems. Since HC-600a systems were recently introduced and are serviced by service agents of the Manufacturers or Importers, service workshops do not receive/handle refrigerators with HC-600a. The service workshops usually handle HCFC-22 system in unitary Air-Conditioning system. With the R-410A air conditioning systems being new, they hardly come for repair. However, R-410A is purchased for charging new air conditioners at the time of installation. The table below presents an estimated number of service establishments servicing RAC equipment in Sri Lanka.

Table 12: Estimated Number of RAC servicing establishments in Sri Lanka

Province	Capital	Total no. of Establish-ments	Estimated size by number of Technicians		
			Small size (<2)	Medium size (3-5)	Large size (> 5)
Central	Kandy	340	258	64	18
Eastern	Trincomalee	65	26	39	0
North Central	Anuradhapura	145	85	54	6
Northern	Jaffna	22	18	4	0
North Western	Kurunegala	180	68	96	16
Sabaragamuwa	Ratnapura	111	48	58	5
Southern	Galle	460	120	296	44
Uva	Badulla	80	56	22	2
Western	Colombo	1,640	164	984	492
Total		**3,043**	**843**	**1617**	**583**

Source: HFC Survey 2015 data and industry sources

Some of the main characteristics of the service sector are:

- The equipment is serviced both on-site and at servicing workshops. On site servicing is common for split units, and servicing at workshops is common for domestic refrigerators.
- On-site repair work is undertaken for industrial refrigeration and Air-Conditioning equipment and chillers. As mentioned earlier, the service technicians for the equipment are either available in-house or outsourced from local RAC equipment service agencies.
- Typically, in case of large RAC installing companies and service establishments, the technicians are formally trained in servicing refrigeration and Air-Conditioning equipment.

- There are approximately 7,500 trained technicians who obtained formal training working in servicing sector of RAC equipment in the country. There are about 4,000 - 4,500 technicians who have not received formal training but have "learned through hands-on experience" in the service sector. The National Ozone Unit has trained over 4,500 technicians under several training programmes implemented during the past 21 years. Additionally, both government and private technical colleges and vocational training institutes, totaling 26-28 institutions, train about 800 - 900 technicians annually.

The following table provides HFCs consumption in the service sector at the provincial level in 2014 in metric tonnes. The consumption shown is a bottom-up calculation based on estimation. In Sri Lanka, installations of a considerable amount of brand new ACs are carried out by the service workshops as a part of their profession. Therefore, the service sector purchases R-410A for new installations.

Table 13: HFC Consumption in Service Sector at Provincial Level

Province	**HFC-134a**	**R-407C**	**R-410A**	**R-404A**	**R-507A**
Western Province	55.14	1.15	4.18	6.54	0.45
Southern	12.55	-	1.27	0.05	0.25
Eastern	3.00		0.85	0.10	
Northern	0.90	-	0.047	-	-
North-West	14.48	0.065	0.84	1.14	-
North- Central	12.50	-	0.90	0.60	0.25
Central	16.01	0.023	1.32	1.49	0.30
Sabaragamuwa	7.21	0.163	0.06	0.06	-
Uva	3.22	-	0.85	-	-
Total	**125.01**	**1.40**	**10.31**	**9.98**	**1.25**
For accuracy of covering all the service sector 10% may add	**12.35**	**0.14**	**1.03**	**1.00**	**0.12**
Grand Total	**137.36**	**1.54**	**11.34**	**10.98**	**1.37**

Source: HFC Survey 2015

It was evident that HFC-134a is the dominant chemical used in this service sector for repair of Mobile Air-Conditioners, followed by domestic refrigerators. There was also a considerable use of R-410A for initial charging of residential air conditioners and service of variable refrigerant flow controls (VRV) systems. A summary of HFC consumption in 2014 in different sectors by substances is given in the Table 14.

Table 14: Consumption of HFCs in Service Sector (by sub-Sectors)

Sector	HFC-134a	R-407C	R-410A	R-404A	R-507A
Domestic Refrigeration (25%)	34.34	-	-	-	-
Unitary Air Conditioners (75%)	-	-	8.51	-	-
Mobile Air Conditioners (45%)	61.81	-	-	-	
Commercial Refrigeration	13.73	0.50	-	2.20	0.40
Commercial Air Conditioning	-	0.34	1.13	-	-
Industrial Refrigeration	20.64	0.50		5.49	
Industrial Air Conditioning	Service by Chiller Suppliers				
Refrigerated Trucks	1.00	-	-	1.00	0.75
Other	5.84	0.20	1.70	2.29	0.10
Total (MT)	**137.36**	**1.54**	**11.34**	**10.98**	**1.25**
As percentage (%)	**84**	**1**	**7**	**7**	**1**

Source: HFC Survey 2015

Total consumption of HFCs in all sectors for the year 2014 is given below.

Table 15: HFC Consumption in All Sectors in 2014

Sector	HFC-134a	R-407C	R-410A	R-404A	R-507A
Domestic Refrigeration Manufacturing	24.90	-	-	-	-
Commercial Refrigeration Assembling	8.90	-	-	3.00	-
Industrial Refrigeration Assembling	4.50	-	-	4.10	-
Transport Refrigeration Assembling	1.20	-	-	1.60	0.30
Residential Air Conditioning Manufacturing	Not Found				
Residential Air Conditioning (Assembling/Installing)	-	-	3.0	-	-
Commercial/Industrial Chiller Manufacturing	Not Found				
Commercial Air Conditioning Systems (Assembling)	Not Found				
Mobile Air Conditioning (Assembling)	3.50	-	-	-	-
Domestic Refrigeration Servicing (25%)	34.34	-	-	-	-
Air Conditioners Servicing (75%)	-	-	8.51	-	-
Mobile Air Conditioners Servicing (45%)	61.81	-	-	-	-
Commercial Refrigeration Servicing	13.73	0.50	-	2.20	0.40
Commercial Air Conditioning Servicing	-	0.34	1.13	-	-
Industrial Refrigeration Servicing	20.64	0.50		5.49	
Industrial Air Conditioning (Chillers)	Service by Chiller Suppliers				
Refrigerated Trucks Servicing	1.00			1.00	0.75
Other	5.84	0.20	1.70	2.29	0.10
Total (MT)	**180.36**	**1.54**	**14.34**	**19.68**	**1.55**
As percentage (%)	**83**	**1**	**6**	**9**	**1**

3.4. HFC-based Equipment in Sectors

a. Food Processing Industry

In Sri Lanka, HCFC-22 and R-717 are predominantly used in freezing and storage applications. HFC-134a and R-404A are used in cooling and chilling applications in food processing.

b. Fishing Industry

HCFC-22 based refrigeration equipment are still used in large fishing boats – fishing trawlers with capacity of 25 tons and above. Apart from fishing, Sri Lanka is one of the leading countries in Asia for seafood processing and exporting. There are 4 large seafood exporting companies which have blast freezing, plate freezing and storage facilities. Some companies use R-404A equipment for cold storage.

Given the increase in commercial activities in northern Sri Lanka, fish caught in the northern part of the region are transported through refrigerated trucks with HCFC-22, R-404A or HFC-134a refrigeration units. It is estimated that over 300 refrigerated trucks operate in various kinds of chilled or frozen food transport.

c. Poultry Farms

There are a total of about 40 poultry farms using refrigeration systems. Of this, 5 are large-size, 10 are medium-size and 25 small-size. For their blast-freezing applications, R-717, HCFC-22 and R-404A based refrigeration systems are used.

A total of about 150 refrigerated trucks are estimated to be in operation for in-country transportation of poultry products. The majority of these trucks are operating with R-507A and HFC-134a, due to low temperature requirements for these products.

d. Milk Processing Industry

There are 7 main milk processing plants in Sri Lanka: MILCO, Pelawatta Nestlé Lanka, Anchor, Kothmale, Lucky Lanka, and Ambewela. They have a network of milk chilling centres to chill collected milk and transportation to main factories for processing.

Most of these centres use HFC-134a based chilling tanks, many of which were retrofitted from CFC-12 by the National Ozone Unit through the Multilateral Fund assistance in collaboration with UNDP during 2009-2010.

e. Meat Processing and Storage

There are mainly six meat processing plants in Sri Lanka: namely CIC, Keells Food Processing, Cargills Food Products, Gills, Pussella, Ceylon Cold Stores and Crisbro. These plants use HCFC-22 and R-717 for blast freezing. HCFC-22, HFC-134a and R-404A are used for storage and transport. A total of about 20-25 refrigerated trucks operate with R-404A and R-410A.

f. Ice-cream Manufacturing

There are four large ice cream manufacturing plants – namely Elephant House, Cargills, Highland and Kotmale. Elephant House uses R-404A based refrigeration equipment for ice cream hardening machines. It is estimated that a total of 30 - 40 trucks fitted with HFC refrigeration units are used in ice cream transportation.

g. Other Industrial Applications

Industrial refrigeration equipment and chillers are used to produce flake ice and chilled water for plastic-molding, rubber, textile, printing industries, for example. The installations use HFC-134a as refrigerants. Small cold rooms working with HFC-134a are in operation for storing pharmaceutical and agricultural products.

h. Hotels, Hospitals, Resorts, and Commercial & Housing Complexes

Chillers and central Air-Conditioning equipment are widely used in these applications. It is estimated that refrigeration equipment with about 125,000 – 150,000 TR refrigeration capacity is installed in the country. Of this, 60 % constitutes HFC based refrigeration and Air-Conditioning equipment. During the survey, many of the respondents indicated that they would be transitioning from HCFC-22 to alternative based equipment that are more energy efficient compared to HCFC and HFC-134a based equipment.

i. Firefighting systems

Firefighting systems installed are mainly CO_2 and water. Sri Lanka does not produce fire extinguishers, but imports them from India and China. The FM 200 (HFC-227ea) systems are costly and not used much in Sri Lanka. They are therefore not imported due to the lack of refilling facility as generally the empty cylinders are sent to Singapore for refilling.

4. Future Demand on HFC and Challenges

4.1 HFC Demand

The HFCs used in the RAC Sector are firstly in the servicing sector and secondly in the manufacturing/assembling sector. The other potential uses are minimum and found in small quantity in glass manufacturing and fire suppression systems.

From the consumption analysis, the major consumption of HFC-134a is still in the domestic refrigeration (manufacturing and servicing) and mobile Air-Conditioning sector (servicing). It appears that the trend would continue to grow despite a growing market share of HC-600a in refrigerators, because repair and servicing of mobile Air-Conditioning system has an upward trend. Furthermore, considerable amounts of HFC-134a chillers are in central air conditioning systems, since HFC-134a is a proven technology for this sector. Old HCFC-22 chillers are being replaced with either HFC-134a or R-410A mainly because these new refrigerant-based chillers are easily available and energy efficient. This means an increasing trend of getting more and more HFC-based AC system for servicing in future.

The general perception was that, due to steady economic growth in the last decade, the purchasing power of refrigeration units and/or air conditioners of middle income and lower middle income groups had substantially increased. AC apartments, hospitals, shopping malls, and leisure industry are growing exponentially.

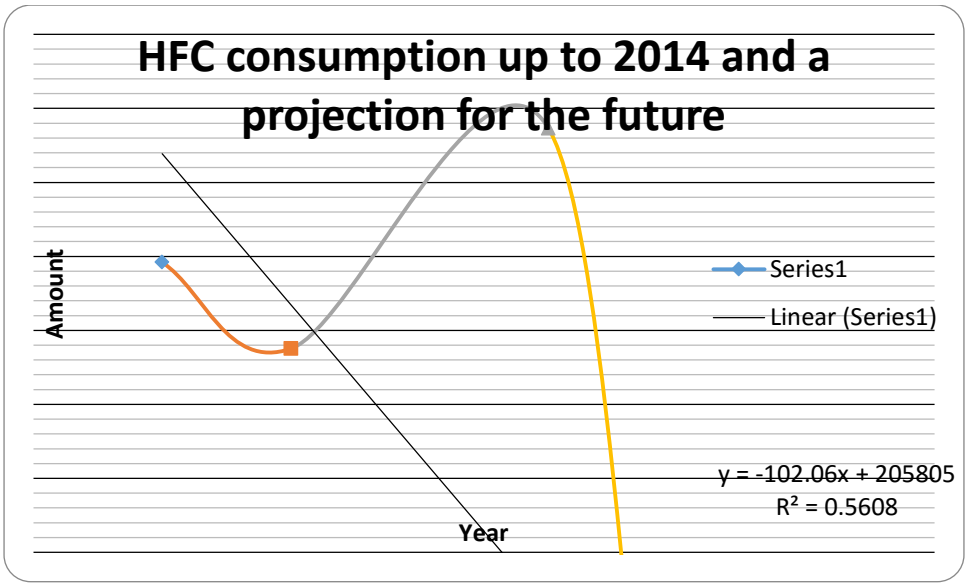


Figure 3: HFC consumption up to 2014 and a projection for the future

Although records from the Department of Customs indicate imported refrigerant amounts; the figures do not tally with listed importers records. The main reason is that HFCs are not licensed substances. Importers may give false information for economic benefits. Importers are not keeping proper records and are sometimes reluctant to reveal the figures due to various reasons such as tax concerns. In order to obtain reliable data, it will be necessary to bring HFCs under licensed items in the future.

The growth of RAC equipment is on a steady increase and as a result, the repair and maintenance is also on the rise. It is evident that the consumption in the servicing sector is anticipated to maintain a steady growth and will have a cumulative effect on the rise of HFC import and consumption. Considering all the above with a minimum growth rate, HFC consumption is projected to increase by 40 - 50 metric tonnes per year and it may increase to 80 – 100 MT with a higher potential growth of the industry and economic development. Consumption of HFC-134a for MAC services will grow exponentially since annual imports of motor vehicles to Sri Lanka have increased 200-300% in the first six months of 2015 compared to previous years. With the introduction of Government's new economic policies, more foreign investments may come in, especially from Japan and the EU. Therefore, the demand of HFCs in all sectors is expected to increase.

4.2 Present scenario of HFC Use

After replacing CFC with HFC for most of the RAC applications, there has been a significant increase in HFC demand due to growth in emerging domestic markets. HFC demand and consumption cannot be accurately calculated, because HFCs, unlike HCFCs, are not a controlled substance and could be imported without an import license. But HFC demand is growing annually at an expected rate of 10-12% because industry has started replacing HCFC-22 based chillers and the NOU promotes low-GWP HFC such as HFC-32 for new procurement. Residential ACs working on HFC-32 has been introduced to the market and it is catching up slowly but steadily.

Most unitary AC systems still use HCFC-22 since the stakeholders are very familiar with it and it is a reliable and user-friendly refrigerant. Although HCFCs will be phased out by 2030, the process will take long and industry is not in a hurry to switch over to alternatives now. Currently, unitary ACs working with HCFC-22 respresent approximately 95% while HFC-410A and HFC-407C account for most of the remainder; propane (HC-290) for less than 0.1% from Midea, China. Godrej, India will promote HC-290 based ACs soon. HFC-32 based ACs is also expected to be on the rise due to the increase of HFC-based ACs in Southeast Asian countries. MAC use HFC-134a almost 100%, and domestic refrigerators at present are about 92% HFC-134a and 8% HC-600a. HC-600a is becoming popular and the market trend is upward because customers benefit from its energy efficiency and environmental friendliness. Industrial chillers are mainly working on HFC-134a.

4.3 Challenges

Although HFCs are ozone friendly and will not deplete the ozone layer like CFCs and HCFCs; they are very powerful greenhouse gases. If left uncontrolled, HFCs will counteract other global actions for climate change mitigation. The consequences of the rapid growth in HFC emissions are many-fold. HFC-134a, the most commonly-used HFC has a GWP of 1,430 over 100 years, and 3,830 over 20 years. It shows that early action on HFCs will have an immediate, strong and positive impact on climate change.

A recent peer-reviewed report[1] shows that if we only focus on reducing CO_2 and do nothing about HFCs, they will be responsible for between 28% and 45% of carbon-equivalent emissions by 2050. Even if we do not act on CO_2, HFCs would still be responsible for between 10% and 20% of carbon-equivalent emissions by 2050.

- Replacing high GWP HFCs to low GWP HFCs or recommended alternatives for HFC is a challenge for a country like Sri Lanka. Local industries as end-users have identified the following constraints: A proven technology on safety, performance and energy efficiency is yet to be demonstrated.
- Insufficient financial resource to meet the cost of technology transfer.
- Lack of technical skills on new technology which are not easily and widely available
- Difficulty in choosing the best technology for the technology transfer due to different thermodynamic and safety properties of the alternatives. No simple solution that can be used in all sectors.
- Unclear policies/regulations introduced by authorities on refrigerant issues and the overall industry.

4.4 Recommendation

- Create more awareness on new alternative safe and energy efficient technologies.
- Provide import tax concession on import of equipment working on safe and energy efficient alternative technologies.
- Provide incentives, through the MLF, to the public sector to replace existing equipment with high GWP HFCs since the public sector represents a significant share of the total use of HFCs
- Provide more trainings on correct use of alternatives for technicians in the formal and informal sectors. Include educational materials in the curricula of technical students at the Technical and Vocational Training Institutes.
- Enhance capacity of professional and industrial associations through information-sharing on environment issues
- Establish mechanisms to advice and support people on selection of best alternatives for their requirements
- Actions such as regulations, adoption of standards or codes should be taken at the national level to encourage safe and energy efficient alternatives to HFCs.
- Public procurement policies should be formulated to favour substances with low GWP using equipment acquired by the public sector.
- Establish a mechanism for SMEs to easily access suitable technology from local and international sources.

An alternative is considered suitable only if it results in at least the same performance level of energy efficiency as the HFC/HCFC being replaced. The GWP values of the various HFCs or HCFCs are generally in the thousands. Conversely, GWPs of climate-friendly alternatives should be much lower. The most commonly used alternatives to HFCs presently available are listed in Table 16.

If the rapid growth in HFC consumption continues, developing countries will consume 8 times more than developed countries by 2050[2]. This threat to the climate can be avoided if developing countries leapfrog HFCs straight to the long-term solutions such as natural refrigerants or low-GWP alternatives.

From the stakeholder consultation, some alternatives were identified against the HFCs currently in use for various applications mainly in developed countries.

Table 16: Commonly used alternatives for HFCs globally

System	HFCs	Alternatives
Domestic Refrigeration	HFC-134a	HC-600a
Mobile Air Conditioning	HFC-134a, R-404A	HC Blend (retrofit option), HFO-1234yf
Unitary Air-Conditioning	R-407C, R-410A	HFC-32 (also HFC having low GWP and lower flammability), HC-290
Chillers	HFC-134a, R-410A, R-407C	R-717, C-40 (HC)*, CO_2
Commercial refrigeration	R-404A, R-410A	CO_2
Foam Insulation	-	-
Solvents	-	-
Aerosol	HFC-134a	Not in kind technologies
Fire fighting	HFC-125, HFC-227ea	Not identified

***** This is one of the series of Petroleum hydrocarbons which are a large group of varied compounds. The compounds can be classified by number of carbons molecules and arrangement. The more carbons in the compound, the less volatile, or higher the boiling point.

[1] Velders et al, "Estimated Consumption and Emissions of HFCs in Refrigeration and Air-Conditioning" (2009), http://www.pnas.org/content/suppl/2009/06/22/0902817106.DCSupplemental/0902817106SI.pdf

[2] Velders et al, "Estimated Consumption and Emissions of HFCs in Refrigeration and Air-Conditioning" (2009) http://www.pnas.org/content/suppl/2009/06/22/0902817106.DCSupplemental/0902817106SI.pdf

5. CONCLUSIONS

Presently most of the HFCs are used in Refrigeration and Air Conditioning (RAC) equipment. HCFC-22 is still the imminent refrigerant in this sector. However, HCFCs are being phased out gradually and demand for HFC refrigerants is expected to increase significantly in the short and medium term to meet expected growth particularly in, for example, hotels, condominiums, office buildings and supermarket refrigeration.

Household refrigerators are mostly working with HFC-134a although HC-600a is already introduced in Sri Lanka. Systems have improved drastically but some concerns on flammability remains. Therefore it will take some time for the domestic refrigerant market to turn to HC-600a or other alternatives. Further retrofitting option is not available for conversion from HFC to HC-600a as in the case of from CFC to HFC.

In Sri Lanka, Mobile Air-Conditioning sector accounts for the major share of refrigerant use and alternatives are not well known and are not widely or freely available. Therefore, this sector is expected to rely on HFCs for long time to come.

In Air-Conditioning applications, the future use of HFCs is expected to increase in residential, commercial and chiller units, largely driven by economic growth and their affordability. While some low GWP options would be available in the market in the near future, R-410A, HFC-32 and other HFC based systems are expected to experience high growth in the market.

The progressive economic development in Sri Lanka has resulted in increasing demands and use of household refrigerators, automobiles and their MAC. Institutional arrangements would need to be put in place to support replacement of high-GWP refrigerants. Awareness raising and information exchange among decision makers would be necessary to achieve mainstreaming of HFC-related issues into legislation. General public awareness would also need to be enhanced to keep the public abreast in case of evolving rules and regulations.

Annex 1

Table 17 HFC INVENTORIES
[Estimated based on Survey data]

Sector	**HFC-134a**	**R-407C**	**R-410A**	**R-404A**	**R-507A**	**Total (metric tonnes)**	**Total CO_2 eq. Tonnes**
Domestic Refrigeration Manufacturing	24.90	-	-	-	-	24.90	35,607
Commercial Refrigeration Assembling	8.90	-	-	3.00	-	11.90	34,487
Industrial Refrigeration Assembling	4.50			4.10		8.60	22,507
Transport Refrigeration Assembling	1.20	-	-	1.60	0.30	3.10	9,183.5
Residential Air Conditioning Manufacturing	Not Found						
Residential Air Conditioning (Assembling)	-	-	3.00	-	-	3.00	6,264
Commercial /Industrial Chiller manufacturing	Not Found						
Commercial Air Conditioning systems (Assembling)	Not Found						
Mobile Air Conditioning (Assembling)	3.50	-	-	-	-	3.50	5,005
Domestic Refrigeration servicing (25%)[1]	34.34	-	-	-	-	34.34	49,106.2
Air Conditioners servicing (75%)[1]	-	-	8.51	-	-	8.51	17,768.9
Mobile Air Conditioners servicing (45%)[1]	61.81	-	-	-	-	61.81	88,388.3
Commercial Refrigeration servicing	13.73	0.50	-	2.20	0.40	16.83	30,737
Commercial Air Conditioning servicing	-	0.34	1.13	-	-	1.47	2,961.2
Industrial Refrigeration servicing	20.64	0.50		5.49	-	26.63	51,921
Industrial Air Conditioning (Chillers)	Service by Chiller Suppliers						
Refrigerated Trucks servicing	1.00			1.00	0.75	2.75	8,338.8
Other	5.84	0.20	1.70	2.29	0.10	10.13	21,630.1
Total	**180.36**	**1.54**	**14.34**	**19.68**	**1.55**	**217.47**	**383,878**

1 - An assumption based on survey findings.

Table 18 HFC usage by sectors **Annex II**

Total No. of Equipment	No. of Equipment Annually	Amount per Charge	Frequency of Charge	Refrigerants	Total Charge
Domestic Refrigeration 1,366,000	340,000	0.1kg	Once in 4years	HFC-134a	34.34MT
Mobile Air Conditioner 34,337	15,452	0.4kg	Once in 1,1/2 years	HFC-134a	61.81MT
Unitary Air Conditioner 3,782	2,836	3kg	Once in 2 years	R-410A	8.51MT
Commercial Refrigeration 1,373	1,373	10kg	Annually	HFC-134a	13.73MT
50	50	10kg		R-407C	0.50MT
220	220	10kg		R-404A	2.2MT
40	40	10kg		R-507A	0.4MT
Commercial Air Conditioning 22	22	15kg	Annually	R-407C	0.34MT
75	75	15kg		R-410A	1.13MT
Industrial Refrigeration 1,376	1,376	15kg	Annually	HFC-134a	20.64MT
33	33	15kg		R-407C	0.5M
549	549	10kg		R-404A	5.49MT
Refrigerated Trucks 100	100	10kg	Annually	HFC-134a	1.00MT
100	100	10kg		R-404A	1.00MT
75	75	10kg		R-507A	0.75MT
Other 1,013	1,013	10kg	Annually	All refrigerants	10.13MT

Assumption: Amount per charge was considered an average mainly because charge depends on size, capacity, make, type etc.