Ozone Depleting Substances Alternative Survey Report

LIBERIA

February 2017

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ACKNOWLEDGEMENTS

The Environmental Protection Agency (EPA) of Liberia, would like to acknowledge with deepest gratitude the immense cooperation and support received from all stakeholders in the various sectors and sub-sectors where ozone depleting substances (ODS) alternatives are currently being used; particularly the refrigeration and air-conditioning, as well manufacturing sectors and others. Also the administrators of the data questionnaire for providing the needed data on imports, uses and storage.

Particular mention is also made of the Liberia Customs and Excise Commission, especially the Automated System for Customs Data section (ASYCUDA), at the Ministry of Finance and Development Planning, for providing valuable import data.

The EPA is also grateful to the Liberian Refrigeration, Air-conditioning, Engineer and Technicians Union (LIBRAETU) for its support and unwavering courage exhibited during the data collection process

EXECUTIVE SUMMARY

The ODS alternatives survey was conducted in response to decision XXXVI/9 which provided for Article 5 countries to receive financial support from the MLF to carry out the survey. The objectives of the survey was to assist Article 5 countries to better understand their consumption trends for non-ODS alternatives, and their distribution by sector and sub-sector; To establish a bank of inventories on ODS alternatives which will provide the country with an overview of its national market where ODS alternatives have been and will be phased in, while taking into consideration existing technologies; and To estimate the amounts of each ODS alternative currently used in the country, identify alternatives that could be potentially used in the future to replace HCFCs and HFCs; and forecast the amounts of each ODS alternative currently used and potentially to be used in the country for the period 2015-2030.

Liberia became a signatory Party to the Vienna convention and the Montreal Protocol on substances that deplete the ozone layer on January 1, 1996. Liberia has ratified all of the amendments of the Convention as follow: the London and Copenhagen Amendments, 1st January 1996, the Beijing and Montreal Amendments; 30th August 2004.

The National Ozone Unit (NOU), created in 2004, is located within the Environmental Protection Agency and is responsible for the coordination, implementation and enforcement of laws and policies related to the protection of the ozone layer in Liberia. The National Ozone Unit receives financial support from the Multilateral Fund through UNEP and GIZ for the implementation of all ozone related activities.

The Ozone Depleting Substances (ODS) Regulations was promulgated in 2004 to control the imports of ODS and ODS-related equipment. In 2010, the Regulations was revised, banning the import and use of CFCs and other potent ozone depleting substances and to consider the control of HCFCs and related equipment.

The Ozone Unit implements an Import Quota System and maintains records of the imports of ODS and ODS-related equipment. It also captures import data on chemicals of interest from ASYCUDA maintained at Customs entry points. To enhance their capacity, customs officers at various border crossing points have been trained by the Ozone Unit for the control and monitoring of trade in ODS.

Beside the physical training, the NOU has distributed eleven identifiers to the various entry points through the Bureau of Customs and Excise. The training of customs officers and provision of ODS-detecting equipment have led to seizure of illegal imports and contaminated refrigerants.

During the ODS alternatives survey, the following were determined as key outcomes:

1. HFCs, HFC blends, and Hydrocarbons are the major ODS alternatives in use in the

2. refrigeration and air-conditioning sector.
3. For HFCs and HFC blends, R-134a, R-404a, R-407c, R-410a are ODS alternatives that have penetrated the Liberian Market.
4. Though to a lesser extent, the HC refrigerants: R-600a, and R-290 have appeared on the market and is steadily increasing, especially in domestic and commercial refrigeration. This means that the market penetration is expected to grow. Safety concern on the part of stakeholders continues to be paramount which is slowing down the uptake of the technology.
5. HFC blends such as R-407c, R-404a, and R-410a are widely used in commercial refrigeration and air-conditioning appliances.
6. R-134a and R-404a are most used in commercial refrigeration.
7. R-22 is being replaced by R-407c and R-410a in air-conditioning appliances. However, R-22 continues to hold the largest market share especially in older air-conditioning systems and most technicians prefer working with it.
8. Water and carbon dioxide are the predominant fire suppressants, replacing halon 1301.
9. R-134a is the widely used refrigerant in the MAC sector. Its use will continue to increase until a Suitable alternative can be adopted.
10. There are many challenges and barriers to the introduction and use of ODS alternatives. Among them are: safety concerns related to the application of HC refrigerants; high cost of obtaining ODS alternatives; non-availability on the market, lack of training on new technology, lack of proper tools and equipment, reluctance by owner to adopt to new technology.
11. Training and certification schemes, stricter control measures for the use of R-22 and new regulations controlling ODS and GHG-based appliances are required.

GLOSSARY OF TERMS

Term/ Acronym	Definition*
ASYCUDA	Automated System for Customs Data: A system for capturing import and export data
EPA	Environmental Protection Agency: Agency responsible for regulating the environment
CFC	Chlorofluorocarbon: a family of chemicals containing chlorine, fluorine and carbon
Chiller	A refrigerant system designed to chill a liquid
CO_2	Carbon dioxide
Condensing unit	A combination of a condenser and compressor. Used in split systems connected to an evaporator in a separate location
DME	Dimethyl ether: an HFC alternative used in aerosols and foams
GOL	Government of Liberia
GWP	Global Warming Potential. The GWP compares the global warming impact of a gas to CO_2 which is defined as having a GWP of 1.
HC	Hydrocarbon: a family of chemicals containing hydrogen and carbon
HCFC	Hydrochlorofluorocarbon: a family of chemicals containing hydrogen, chlorine, fluorine, and carbon
HFC	Hydrofluorocarbon: a family of chemicals containing hydrogen, fluorine and carbon
HFE	Hydrofluoroether
HFO	Hydrofluroolefin: a family of chemicals containing hydrogen, fluorine and carbon, with a double bond in the molecule
LEC	Liberia Electricity Corporation: The authority for the supply of electricity in the country
LIBRAETU	Liberia, Refrigeration, Air-conditioning, Engineers and Technicians Union
LISGIS	Liberia Institute of Statistics and Geo-Information Services: The agency responsible for the collection, compilation, interpretation, storage and dissemination of national statistical data.

MAC	Mobile air-conditioning. This refers to an air-conditioning system used in a vehicle including MACs in cars, busses and trains.
MDI	Metered dose inhaler. A specialised aerosol used to deliver respiratory drugs. MDIs use HFC aerosol propellants
ODP	Ozone Depleting Potential compares the impact on the ozone layer of a gas compared to CFC-11 which is defined as having an ODP of 1
ODS	Ozone Depleting Substance. A gas that can cause damage to the stratospheric ozone layer
PF foam	Phenolic insulation foam
PU foam	Polyurethane insulation foam
Split system	A type of refrigeration or air-conditioning system with a cooling evaporator in one location and a compressor/condenser in a different location. Usually used with reference to small air-conditioning systems that use an indoor unit and an outdoor unit
Stand-alone	Small factory built refrigeration units that need to be connected to an electricity supply. A domestic refrigerator is a stand-alone system. Various types of stand-alone unit are used in food retail and food service
TEAP	Technology and Economic Assessment Panel
VRF	Variable refrigerant flow. A type of split system air-conditioning system used in medium and large sized air-to-air applications. One or more condensing units are connected to a number of indoor units (up to 64). Each indoor unit can be selected for either cooling or heating. Variable speed compressors provide control flexibility
XPS foam	Extruded polystyrene insulation foam

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SECTION-I:

GENERAL INFORMATION

1.1 COUNTRY BACKGROUND

The absolute location of Liberia is latitude 4°20′ to 8°30′ North and Longitudes 7°8′ to 11°20′ West. Liberia covers an area of 111,370 km^2 of which 15,050 km^2 is water and the remaining 96,320 km^2 is land. Liberia is bordered to the south by the Atlantic Ocean, to the east by the Ivory Coast, to the west by Sierra Leone and to the north by Guinea. The Capital of Liberia, Monrovia, is the country's largest city. Other important cities are Buchanan, Robertsport, Harper, Greenville, Gbarnga, Kakata, Ganta, Zwedru, Voinjamin, etc. Liberia is divided into 15 political sub-divisions or counties.

Map 1: Map of Liberia

Liberia's economy is dependent mainly on the extractive industries, which include mainly timbers, gold, diamond, rubber and other agricultural crops. The primary sector of the economy includes agriculture, forestry, and mining. Rubber is the main export crop. Fishery is an important agricultural sector also. The secondary sector comprises mainly manufacturing, dominated by key activities such as food processing, wood-based products and cement and chemicals, building materials and brewing of beverages. The tertiary sector comprises of

electricity, water, utility, transportation, communication and services. The current population of Liberia is 4.5 million people, with a current GDP of $2.053 billion (2015; World Bank)

The equatorial position and distribution of low and high pressure along the African continent and Atlantic Ocean determine the climate of Liberia. Because of the position and the moderating influence of nearby Atlantic Ocean, there is a fairly warm temperature throughout the year with a very high humidity. Liberia's coastline runs approximately from southeast to southwest and to right angles to the prevailing southwesterly rain-bearing winds. The country has two seasons, namely the Rainy and dry Seasons. The Rainy Season runs from May to October, and the Dry Season begins in November and ends in April. The average annual fall along the coastal belt is over 4000mm and declines to 1300mm at the forest-savannah boundary in the north. The location of the country about 10 degrees above the equator and southwest of the monsoon, brings massive rainfalls during the rainy season.

On the whole, the temperature over the country ranges from 27°-32°C during the day and from 21°-24°C at night. The highest temperature occurs between January and Marc and the lowest is between August and September.

Liberia is a low volume consumer of ODS alternatives in all sectors. The latest technology, particularly in the refrigeration and air-conditioning (RAC) sector, is gradually appearing on the Liberian Market.

They include the hydrocarbon group. With the increasing supply of electricity in the country, the use of refrigeration and air-conditioning equipment will expand as people attempt to improve their socio-economic standing.

Most households in the urban areas have refrigeration appliances, while those in medium to low density suburbs have installed air-conditioning appliances which operate on HFCs and HFC blends, especially R-600a and R-290. Liberia does not manufacture nor export refrigeration and air-conditioning equipment and related chemicals.

1.2 KEY STAKEHOLDERS AND INSTITUTIONAL ARRANGEMENTS

Table 1: Key Stakeholders and their roles

Key Stakeholder	Role
National Ozone Unit (NOU)	Coordination and implementation of ODS alternative initiation workshop, designing data collection questionnaire, training of data collectors, monitoring and supervision of data collection process, approving and submission of report.
Bureau of Customs and Excise	Provision of data imports
Ministry of Commerce & Industry	Provision of import certificate/Import Permit Declaration (IPD)
Importers, wholesalers, Distributors	Provision of data on imports, sales, distribution, etc.
Refrigeration Technicians	Information on uses of ODS alternatives

The major stakeholders in the ODS alternatives survey are the Bureau of Customs and excise, importers, wholesalers, distributors, owners of appliances as well as technicians (Users). These provided the information on quantities imported, sold, or used.

The Bureau of Customs and Excise of the Ministry of Finance and Development Planning (MFDP) and the Ministry of Commerce and industry provided valuable import information.

Located within the Environmental Protection Agency, the National Ozone Unit is the central national unit which functions as an integral part of the EPA of Liberia. It serves as the central coordinating office for the implementation and monitoring of the Liberia Country Programme of the Montreal Protocol.

The NOU reports to the Deputy Executive Director of the EPA through the Coordinator of the Division of “Multilateral Environmental Agreements (MEA’s).

The structural representation of the Ozone Unit is schematically illustrated below:

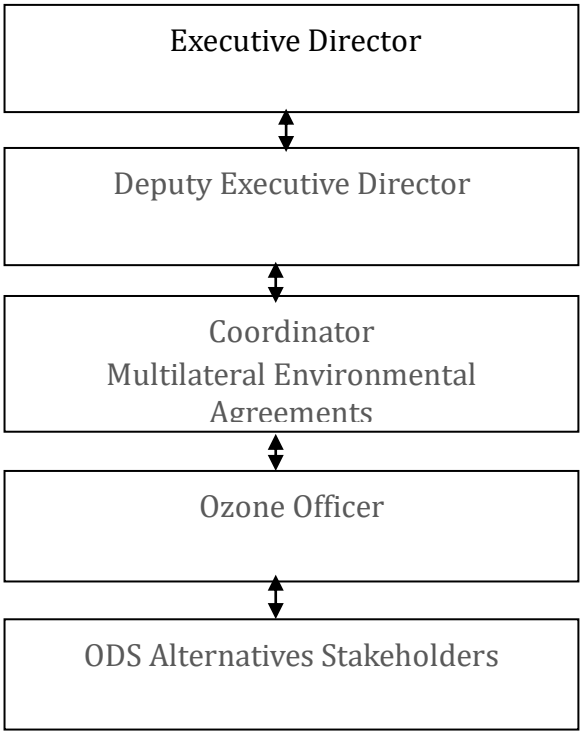

Figure 1: Schematic representation of the Institutional arrangements

The Ozone Unit is headed by the Ozone Officer who is supported by an Assistant Ozone Officer. Staffs of the Ozone Unit are paid from the Institutional Strengthening (IS) Project fund provided by the Multilateral Fund (MLF) through the United Nations Environment Programme (UNEP).

1.3 EXISTING POLICY FRAMEWORK AND CONTROLS

Liberia, as a signatory party to the Vienna convention and its off-spring, the Montreal Protocol, developed regulatory and institutional framework to manage and control the importation and consumption of ozone depleting chemicals. These instruments ensure that Liberia remains in compliance with ODS phase out activities. These include:

Table 2: Policy Framework and Legislation

Type of Action/Legislation	Status	Since when	Comments
Environment Management and Protection Law	Existing	2003	
ODS Regulations	Existing	2004	Revised in 2010
Import Licensing	Existing	2007	

The Environment Protection and Management Law of 2003, Part VII Section 89(1b), undertakes to control practices and activities likely to result to degradation of the ozone layer and the elimination of substances that deplete the ozone layer. This responsibility has since been delegated to the National Ozone Unit.

The Ozone Depleting Substances Regulations promulgated in 2004, was revised and approved by the Policy Council in 2010. The Regulations established the ODS Import Licensing System and mechanism to monitor the import of all controlled substances. These Regulations make It mandatory for all importers of ODS, HFCs and ODS or HFC related equipment to register with the EPA prior to the import of the controlled substances and equipment. The Regulations prohibit untrained and uncertified personnel from carrying out servicing, repairing, installations, commissioning and decommissioning of RAC appliances. It require all importers to first obtain import permit from the EPA, through the Ozone Unit, for import of ODS and ODS-based equipment. There have been numerous challenges in the enforcement of this provision of the regulations. Even with the training of most technicians in Good Refrigeration Practices and Safe use of HCs, none has been certified under an approved standard or accredited certifying body. Arrangements for the development of national standard and guidelines on certification of RAC practitioners are currently ongoing.

The current regulations do not include control measures for the imports of ODS alternatives (HFCs, Ammonia, Carbon dioxide, hydrocarbons) among others, importers are however required to declared their importation to the National Ozone Unit. Importers are provided permit for the importation of these chemicals, which basically assist in tracking their quantities being imported.

1.3.1 Controls on Imports of ODS Alternatives

Other regulatory instruments include functioning ODS Import Licensing System to regulate, control and monitor importation of ODS and related equipment. This system is coordinated by the Ministry of Commerce and Industry and the EPA, through its Ozone Unit.

Additionally, there is memorandum of understanding between the Ministry of Commerce and Industry and the EPA for the licensing of ODS and related equipment and products. There is also a memorandum of understanding between the Ministry of Finance and Development Planning (MFDP) and the EPA for the enforcement of the Licensing System.

Table 3: International Agreements and Conventions

Conventions/Treaty	Ratification/Accession
Vienna Convention	1st January 1996
Montreal Protocol	1st January 1996
London Amendment	1st January 1996
Copenhagen Amendment	1st January 1996
Beijing Amendment	31st August 2004
Montreal Amendment	31st August 2004
Kigali Amendment	Arrangements in Process

Liberia became a Party to the Vienna Convention and its off-spring, the Montreal Protocol on 1st January 1996 and has acceded to all the amendments of the convention. With the inclusion of HFCs and their blend on the list of controlled substances, frantic efforts are being exerted for the amendment of the current ODS Regulations to include control measures for the these substances in line with the Kigali Amendment.

1.3.2 Planned Legislation, Policies and Regulations

Liberia, through the EPA, and in collaboration with GIZ, has drafted a Code of Practice (CoP), to include current ODS related issues and to guide refrigeration technicians in performing their servicing duties. The draft has been presented to GIZ for consideration.

Modalities for the drafting of national standard for technicians are currently being worked out. Consultations are taking place with the relevant authorities in this regard.

With funding from GIZ, a refrigeration technician's certification curriculum for use by the only refrigeration technicians' training school has been drafted and submitted to GIZ. Certification of technicians will reduce incidences of hazards and fire during servicing work.

SECTION-II: METHODOLOGY FOR DATA COLLECTION

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2.1 Project Overview

The ODS alternatives Survey Project was conducted in response to decision XXXVI/9 which provided for Article 5 countries to receive funding from the MLF to carry out surveys on ODS Alternatives to better understand their historical consumption and predict future consumption trends of ODS Alternatives in different sectors and sub-sectors. The outcome would assist in assessing the penetration of alternative technology in developing countries. The survey was conducted in accordance with the MLF guidelines developed and agreed during the 75th Meeting of the Executive Committee held in Montreal, Canada in November 2015.

2.2 Methodology

The Ozone Unit of Liberia Made use of the data collection tools and guidelines provided by the Multilateral Fund (MLF): UNEP/OzL.Pro/ExCom/75/77/Rev1 & MLF/IAM.2016/1/22)

Table 4: Data collection methods

Data Collection Method	Desk Study and Questionnaire
Geographical Scope	The 15 Political sub-divisions
Survey Duration	July to October 2016
Data Sources	Customs, Commerce Ministry, Importers, Service companies and users

2.2.1 Desk Study

Valuable data on imports was obtained through the Automated System of Customs Data (ASYCUDA), which is at the Ministry of Finance and Development Planning (MFDP). Besides, the National Ozone Unit keeps comprehensive data on imports of ODS and related equipment from ODS import permits issued to importers. The NOU also gathered Information from import permit declaration from the Ministry of Commerce and Industry.

2.2.2 Data Collection

Prior to the data collection, an initiation workshop involving forty major stakeholders was held on June 1, 2016. The workshop provided information on the purpose of the ODS alternatives survey and to more fully involved stakeholders in the process. Participants provided suggestions on how the data collection questionnaire should be structured and administered.

Twenty-one data collectors were recruited from the membership of the Liberian Refrigeration Union, and were rehearsed on the use of the various data collection forms and the different methods to apply in the data collection process. The data collectors, in addition to carrying union identity card, were also issued introductory letter providing reasons why respondents should provide the requested information. This helped to ally the fear of abuse or misuse of collected information and provided for confidentiality. National awareness followed the recruitment process. Both the electronic and print media were used in the awareness. The entire data collection process was under the supervision of the National Ozone Unit.

Questionnaire was developed in line with the MLF guidelines and covered importers, wholesalers and distributors, servicing companies and owners of ODS alternatives. The questionnaire was modified at the initiation workshop, which was held prior to the commencement of the data collection process. The participants at the workshop were informed of the purpose of the survey, data collection techniques to be used, how the data was to be analysed and their role and the expected outcome. Participants were also trained on how to complete the questionnaire with the required information.

Data collection was conducted throughout the fifteen political sub-divisions of the country and the data collectors visited all known importers, wholesalers, servicing shops, users as well as distributors of the substances. Also visited were manufacturing companies, banks, hospitals, concession companies, hotels, government ministries and agencies, embassies, among others. The data information collected was brought to the National Ozone Unit for compilation, analysis and production of the National ODS Alternatives Survey Report using the template and data tables developed by MLF. The national Ozone Unit was robust in making follow-ups visits to places where there was doubt to ascertain that the data collection was being done properly.

Data collected and presented to the NOU was categorized in various forms such as by weight or quantity of refrigerant used, number of units installed, serviced, and repaired. Data from the importers and distributors was authenticated by comparing with data gathered from desk study.

Data from the Bureau of Customs and Excise Automated System for Customs Data (ASYCUDA) were very useful in validating the results of the survey.

With respect to non numeric data, deductive and inductive reasoning were used to establish scenarios and trends. Besides, the questionnaires provided for a section where respondents were asked to list the challenges, opportunities and barriers to the introduction and use of ODS Alternatives. The qualitative responses also gave an insight on the projected demand of ODS Alternatives.

SECTION-III: SECTORS USING ODS AND ODS ALTERNATIVES, AND ANALYSIS OF DATA COLLECTED

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Table 5: Sectors and subsectors using ODS Alternatives

SECTOR/SUB-SECTOR	ENTITIES INVOLVED	METHOD OF DATA COLLECTION
RAC Servicing	Servicing companies and technicians	Questionnaire and interviews
Imports	Importers, wholesalers and distributors	Questionnaire and interviews

3.1 REFRIGERATION

The refrigeration sector in Liberia comprises servicing and repairs as well as installation and decommissioning of appliances ranging from domestic fridges and cold rooms. Refrigeration companies in Liberia buy panels from manufacturing companies from abroad for construction of cold rooms.

3.1.1 Domestic Refrigeration

The refrigeration sub-sector in Liberia is dominated by R-134a refrigerant which is widely used in servicing most standalone units such as freezers and fridges. The usage of R-134a from 2012 to 2014 showed a steady growth while in 2015 the sector experienced a reduction in the use R-134a from 20.02 Mt in 2014 to 13.82 Mt in 2015. The reduction was due to outbreak of an epidemic of Ebola Virus disease in Liberia from 2014 to 2015; a period that experienced a reduction in business transactions in the country. The use of R-134a is expected to increase due to its availability and low cost and the availability of low cost 134a-based appliances in the country. With the ongoing electrification project currently being carried out in the country by the Government, a considerable number of households is expected to be connected to the electricity grid thereby increasing the use of domestic units operating on R-134a.

The use of R-600a in domestic refrigeration is gradually gaining ground in the servicing of domestic refrigeration appliances. Import documents show that most imported domestic

fridges are charged with R-600a. There is an ongoing campaign in the country aimed at promoting the use of hydrocarbon refrigerants.

To ensure that the campaign is successful, most technicians have been trained on how to convert from high GWP refrigerants such as R-134a to low GWP refrigerants such as R-600a. The increasing import of R-600a units in the country coupled with the availability of R-600a at minimal cost, have resulted in wide adoption of R-600a in domestic refrigeration.

The use of R-600a, however, poses several challenges which include its flammability. To avert the hazard that may result from the unprofessional use of R-600a, many technicians have been trained in the handling and application of the chemical. The use of R-600a has advantages as well; reduced charge, which makes it very economical to use and is also energy efficient.

3.1.2 COMMERCIAL REFRIGERATION

The commercial refrigeration sector in Liberia uses various ODS alternative refrigerants, which include R-134a, R-404a, and to a minimal extent, R-290. R- 134a is used in the servicing of most small to medium sized commercial refrigeration appliances while the use of R-290 in commercial refrigeration appliances has just begun. R-404a is used in servicing of commercial refrigeration appliances such as cold rooms, chillers, and freezers. The use of R-404a is expected to rise until a more suitable replacement for R-22 is determined. R-404a is the predominant ODS alternative refrigerant in commercial refrigeration, especially in medium to large size appliances and is most used as replacement for R-22 in mid and low temperature applications. It is also used in small, medium and large commercial freezers, cold rooms, bottle coolers, etc.

The use of R-290 in servicing of commercial refrigeration appliances is slowly picking up owing to the adoption of HC refrigerants as safe replacements for HCFC-22 in low temperature refrigeration appliances. R-290 is now being used in commercial display freezers as a replacement for HCFC-22 because of its zero ozone depletion potential and low global warming potential. However, its widespread application has been limited due to safety concerns. Under the country's HPMP, technicians have been trained to convert R-22 based commercial appliances to R-290 only when some safety and technical conditions are fulfilled. Its low back pressures in areas characterized by high ambient temperatures, provides improved performance in terms of discharge temperatures.

Or practical conversion purposes, the NOU in 2013, GIZ-Proklima provided 66kgs of R-290 for training of technicians on "Safe Handling and Application "of HC Refrigerants. The training led to the successful conversion of AC units at the EPA main office.

3.1.2 TRANSPORT REFRIGERATION

R-134a and R-404a are the main refrigerants used in transport refrigeration in the country, with R-404a being used in newer refrigerating trucks. R-404a is used for servicing purpose only.

3.2 AIR-CONDITIONING

The air conditioning sector in Liberia covers the installation, servicing and repairs as well as decommissioning. Liberia does not manufacture air conditioning appliances. All A/C appliances in the country are imported.

3.2.1 STATTIONARY AIR-CONDITIONING

R-410A Air-conditioning appliances have begun to appear on the market as R-22 is being phased out. The use of R-410A in domestic, commercial and industrial AC is expected to increase until suitable alternatives are introduced. The use of R-290 as a replacement in this sub-sector has not been widely adopted because of its non-availability, high cost and safety aspects. R-410 is used in air conditioning as a replacement for R-22. It is used mostly in split units. The refrigerant is not readily available on the local market and this has limited its widespread use.

R-410A is being used as replacement for R-22 in both domestic and commercial air conditioning systems. Most air-conditioners imported come pre-charged with R-410a refrigerant.

3.2.2 MOBILE AIR-CONDITIONIN (MAC)

In MAC units, the refrigerant that is most used in servicing is R-134a for smaller to medium sized vehicles. All used motor vehicles imported into the country that are fitted with A/C units come charged with R-134a refrigerant. The use of alternative refrigerant to R-134a in MAC has not picked up except in newer vehicles.

3.3 FIRE SUPPRESSION

Water and carbon dioxide based fire suppression systems are the major ODS alternatives used as fire suppressants in the country.

3.4 ESTIMATED USE OF ODS ALTERNATIVES[1]

Table 6: Estimated use of ODS Alternatives from 2012 to 2015 (MT)

Estimated use by ODS Alternative (MT)ALTERNATIVE	ESTIMATED USE (MT)			
	2012	*2013*	*2014*	*2015*
*HFC**				
HFC-134A	2.10	15.6	20.02	13.82
R-404A	4.91	0.00	3.38	0.58
R-407C	0.00	0.00	1.43	0.00
R-410A	4.87	0.64	5.9	2.31
HC-290	0.00	0.00	0.002	1.36
HC-600A	0.26	6.18	1.34	4.37

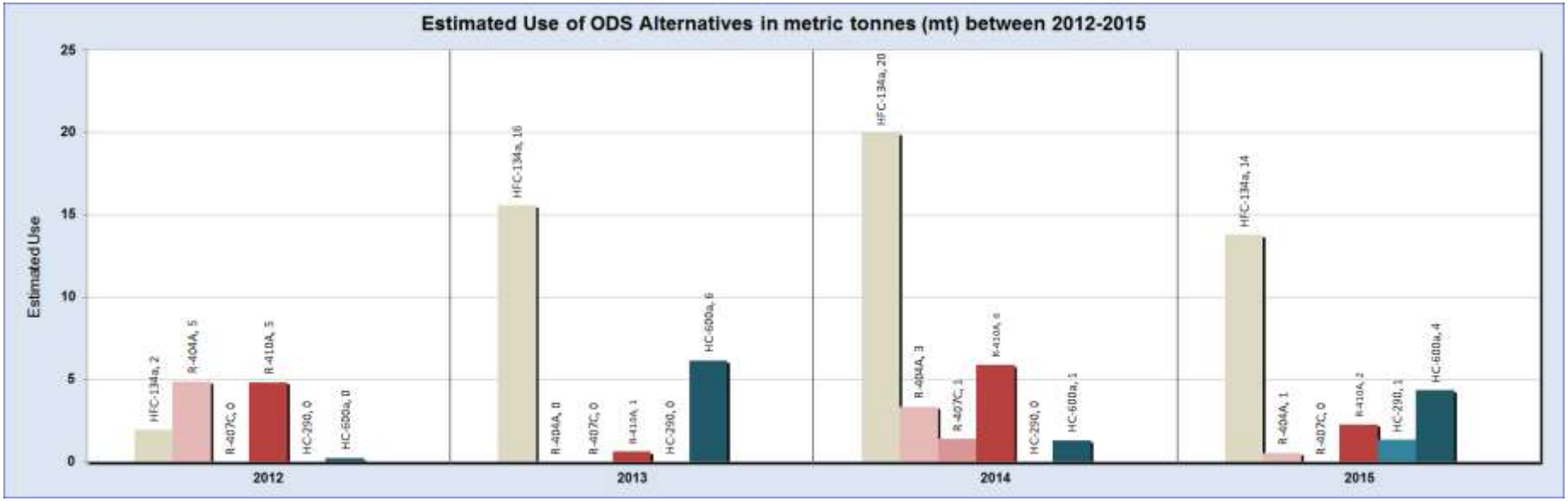

Figure 2: Estimated use of ODS Alternatives between 2012 -2015 (MT)

3.6 SUMMARY OF USE IN ALL SECTORS BETWEEN 2012 TO 2015 (MT)

Table 7: Summary of use in all sectors for 2012 (MT)

Alternative	Refrigeration and air-conditioning		PU foam	XPS foam	Aerosol	Fire fighting	Solvent	*Other*
	Manufacturing	Servicing						
HFC								
HFC-134a		20.10						
HFC blends								
R-404A		4.91						
R-407C								
R-410A		4.87						
HC-290								
HC-600a		0.26						

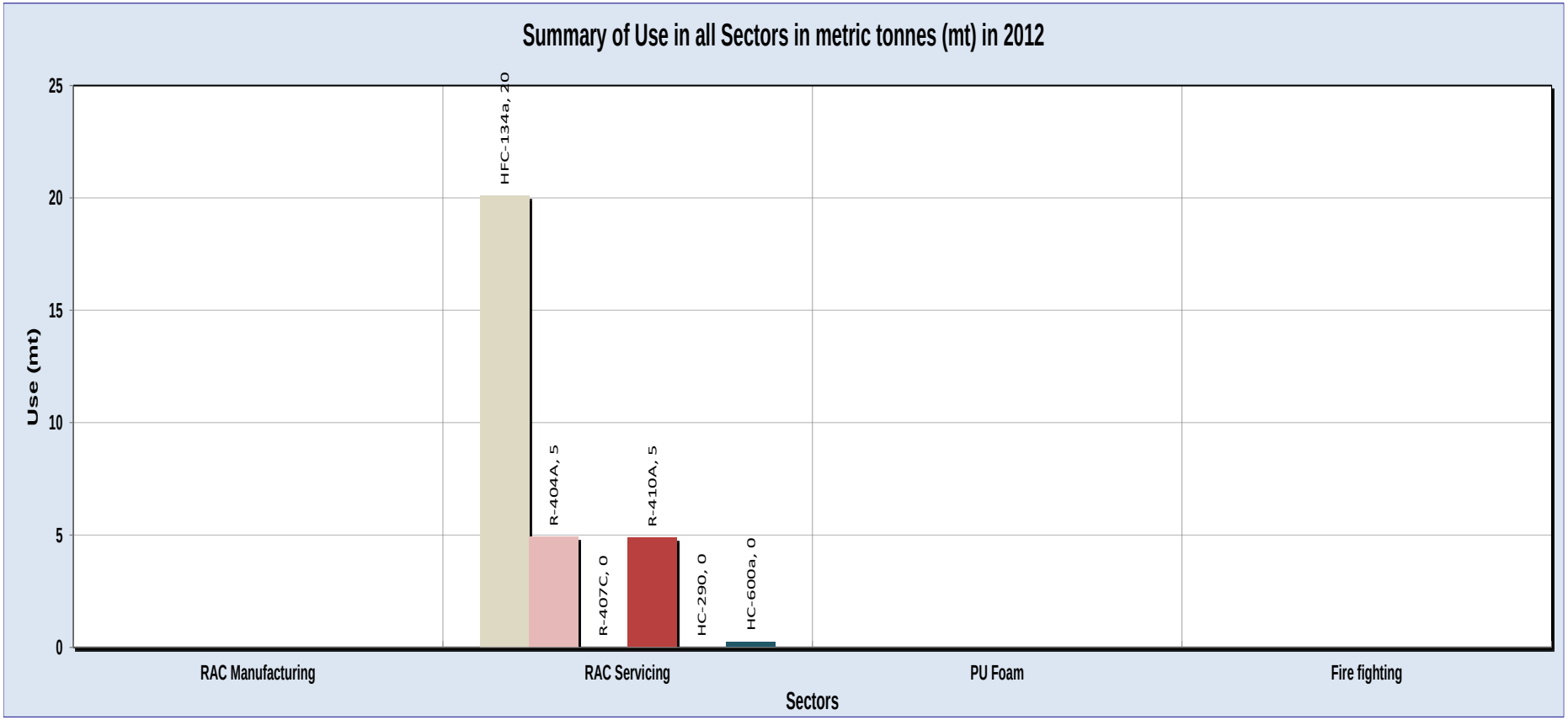

Figure 3: Summary of use in all sectors in 2012 (MT)

Table 8: Summary of use in all sectors for 2013 (MT)

ALTERNATIVE	REFRIGERATION AND AIR-CONDITIONING		PU FOAM	XPS FOAM	AEROSOL	FIRE FIGHTING	SOLVENT	*OTHER*
	MANUFACTURING	SERVICING						
HFC								
HFC-134A		15.6						
HFC BLENDS								
R-404A								
R-407C								
R-410A		0.64						
HC-290								
HC-600A		6.18						

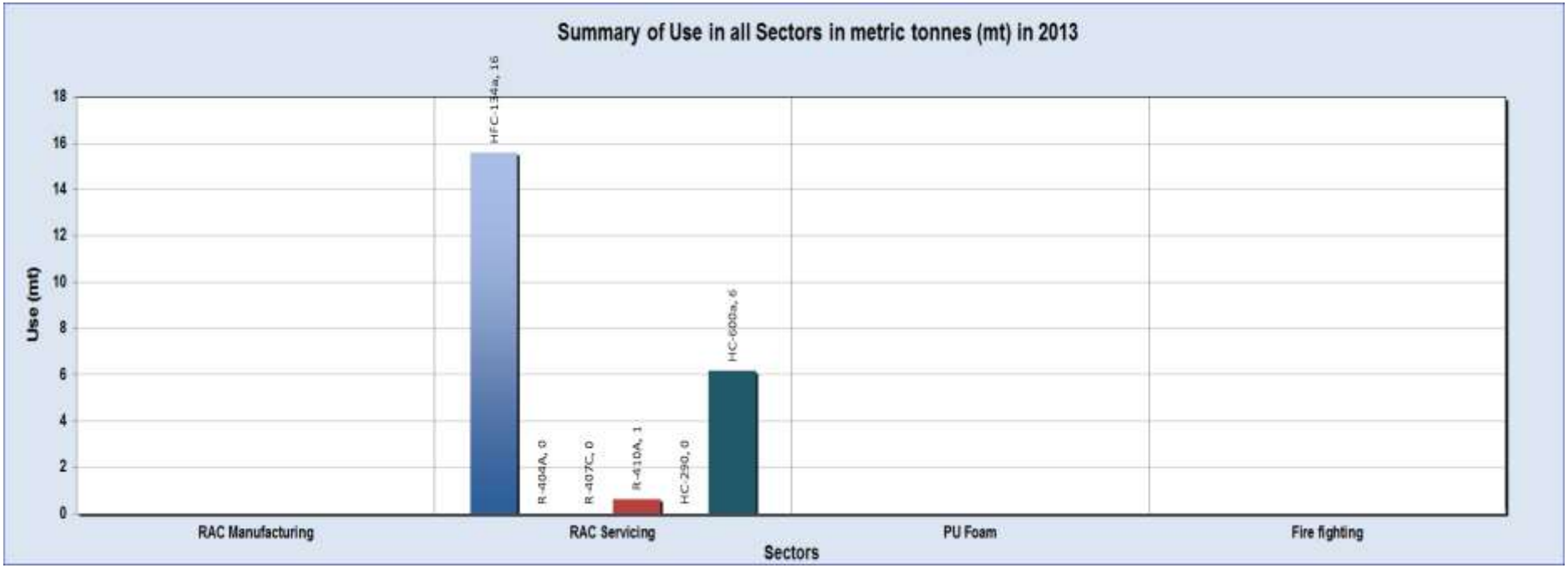

Figure 4: Summary of use in all sectors in 2013 (MT) Table 9: Summary of use in all sectors for 2014 (MT)

Alternative	Refrigeration and air-conditioning		PU foam	XPS foam	Aerosol	Fire fighting	Solvent	*Other*
	Manufacturing	Servicing						
HFC								
HFC-134a		20.02						
HFC blends								
R-404A		3.38						
R-407C		1.43						
R-410A		5.9						
R-507A								
Other alternative								
HC-290		.002						
HC-600a		1.34						

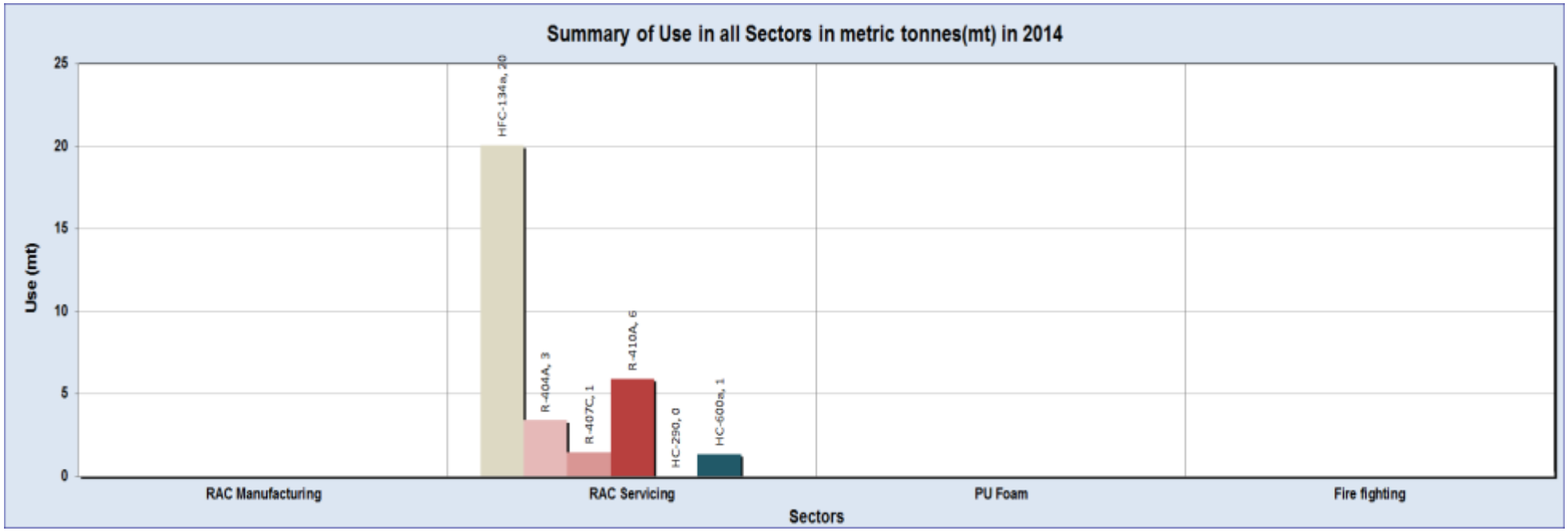

Figure 5: Summary of use in all sectors in 2014 (MT)

Table 10: Summary of use in all sectors for 2015 (MT)

Alternative	Refrigeration and air-conditioning		PU foam	XPS foam	Aerosol	Fire fighting	Solvent	*Other*
	Manufacturing	Servicing						
HFC								
HFC-134a		13.82						
HFC blends								
R-404A		0.58						
R-407C								
R-410A		2.31						
Other alternative								
HC-290		1.36						
HC-600a		4.37						

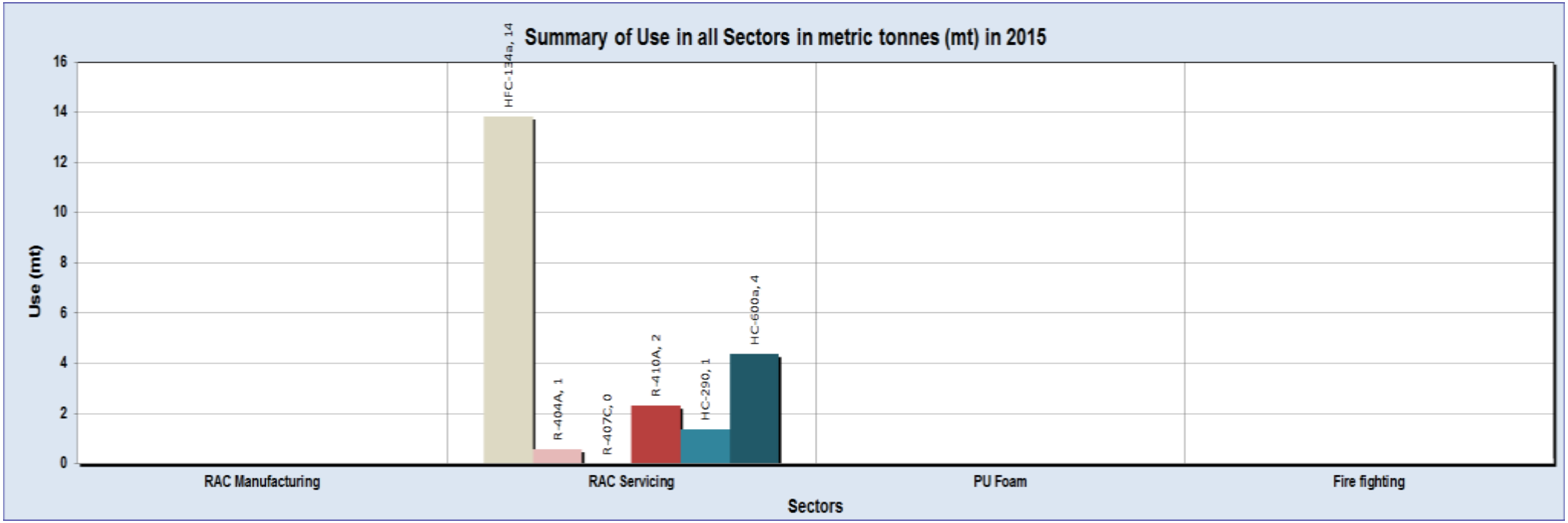

Figure 6: Summary of use in all sectors in 2015 (MT)

3.7 IMPORT AMOUNTS OF ODS ALTERNATIVES

The below table shows imports of commonly used ODS alternatives from 2012 to 2015 in Liberia.

Table 11: Imports amounts in all sectors from 2012 to 2015 (MT)

ALTERNATIVE	IMPORTS (MT)			
	2012	2013	2014	2015
HFC				
HFC-134A	**2.10**	**15.6**	**20.02**	**13.82**
HFC BLENDS				
R-404A	**4.91**	**0.00**	**3.38**	**0.58**
R-407C	**0.00**	**0.00**	**1.43**	**0.00**
R-410A	**4.87**	**0.64**	**5.9**	**2.31**
HC-290	**0.00**	**0.00**	**0.002**	**1.36**
HC-600A	**0.26**	**6.18**	**1.34**	**4.37**

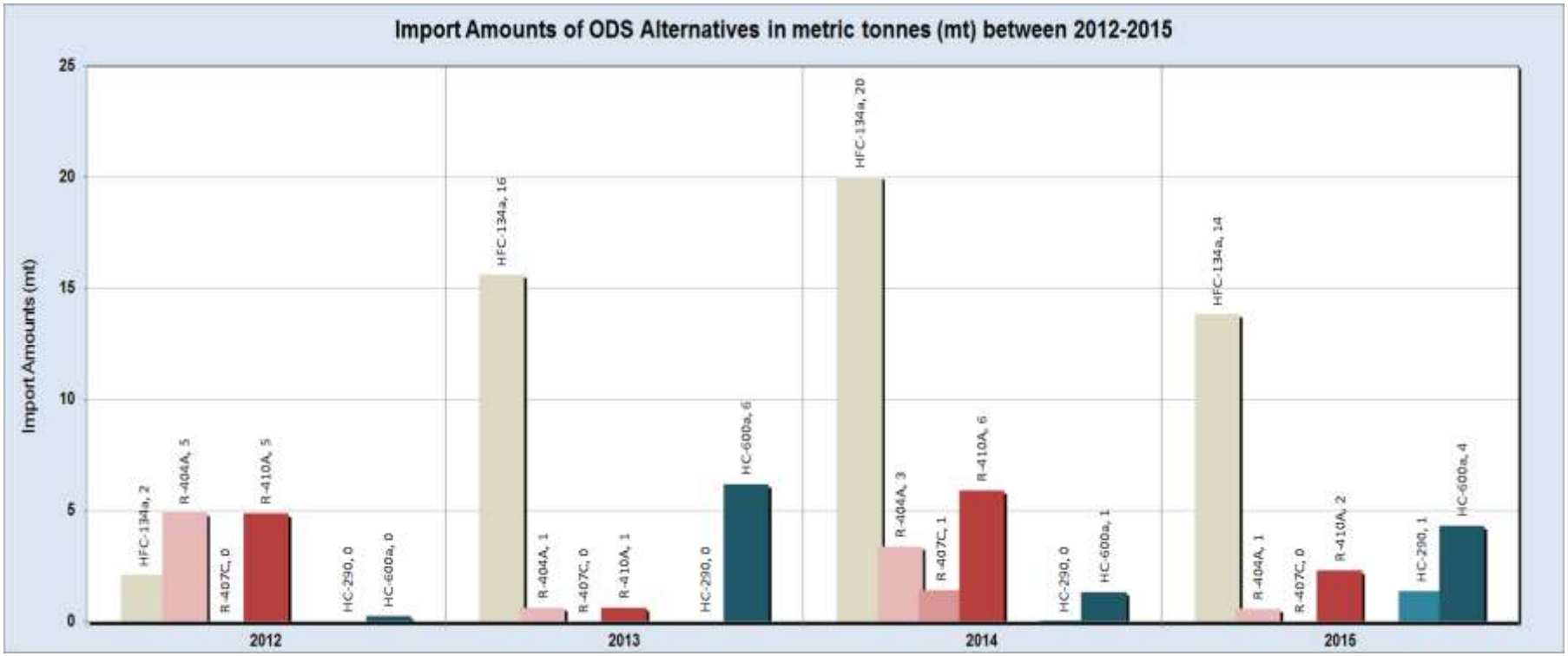

Figure 7: Imports amounts of ODS Alternatives between 2012 -2015 (MT)

3.8 TREND ANALYSIS AND PROJECTED DEMAND OF ODS ALTERNATIVES

Data collected on use of ODS alternatives from 2012 to 2015 showed linear pattern. Therefore, linear extrapolation is used to predict the 2020, 2025, and 2030 consumption demands figures for ODS alternatives. Linear extrapolation estimates the value f(x) that lies outside the range of the known independent variables. Consequently, the years 2020, 2025, and 2030 lie outside the range of the period covered by the survey (2012 – 2015).

Thus, the extrapolation formula, $f(x) = y1 + ((x-x1)/(x2-x1))*(y2-y1)$ is used

where:

X is the year whose value f(x) is to be extrapolated;

(x1, y1) and (x2, y2) are known values on the data set derived from the survey;

From the historical data obtained from the survey, the predicted data was calculated. The delimitation with this method is that

- it has inherent errors
- the predicted data might differ from actual figures as there are lots of factors that could contribute to the deviations.

Assumptions:

- The prediction herein is based on the assumption that all things remain constant or that there will be no significant changes in policies regulating the existing ODS alternatives which may lead to deviations from projected figure. The policies may include promoting low GWP and high energy efficient ODS alternatives such as HC-600a and HC-290, which have negligible impacts on the environment;
- That the prediction is based on the development of ODS alternatives under the existing policy or Regulations without taken into consideration the recent Kigali Amendment of the Montreal Protocol on Sbstances that Deplate the Ozone Layer;
- That growth in the number of imports of both new and second hand refrigeration and air-conditioning equipment is based on the average annual growth rate of import of equipment from 2012 to 2015.

Table 12: Historical and predicted data up to 2030

ODS Alternative	Historical Data				Predicted Data		
	2012	2013	2014	2015	2020	2025	2030
HFC-134a	2.10	15.60	20.02	13.82	38.61	58.40	78.19
R-404A	4.91		3.38	0.58	4.03	8.83	13.64
R-407C			1.43		1.29	2.00	2.72
R-410A	4.87	0.64	5.90	2.31	1.86	0.65	0.56
HC-290			0.00	1.36	2.99	5.03	7.08
HC-600a	0.26	6.18	1.34	4.37	7.91	11.65	15.40

3.9 PRICES OF ODS ALTERNATIVES

Table 13: Current prices of ODS Alternatives (US$/kg)

ODS ALTERNATIVE	PRICE/KG (US$)
R-134a	7.35
R-404a	9.20
R-407c	11.08
R410a	9.20
R-290	15.12
R-600a	6.55

Table 13 shows current prices of ODS alternatives in the country. R-290 is the most expensive refrigerant since its just penetrating the market.

3.10 CHALLENGES AND OPPORTUNITIES IN ADOPTING ODS ALTERNATIVES

In Liberia, lack of technology, lack of capacity, coupled with unavailability, affordability, safety and health issues, as well as lack of policy and regulatory measures to promote ODS alternatives, are few of the challenges currently confronting the adoption of ODS alternatives in different sectors. Majority of refrigeration technicians lack the skill and knowledge required for them to be able to correctly use HFC blends, especially when charging a system is required. This lack of skill and knowledge is factor for the failure of technicians to adopt ODS alternatives, which is contributing to the slow pace at which some ODS alternatives is penetrating the market. To avert this situation, there is need for a more robust training on the use of HCs and their blends.

Another challenge is that the prices for ODS Alternatives are very high as compared to ODS such as HCFC-22 forcing technicians to resort to the available ODS. Refrigerants like R-407C are not readily available on the local market. There have been cases of seizures of contaminated R-134a refrigerants that were on the market and causing damages to compressors.

Technicians must be adequately trained on safe use and handling of flammable Hydrocarbon refrigerants such as HC-290 and HC -600a. In addition new tools are needed. Such training will increase the uptake of ozone and climate friendly refrigerants. In addition, when working with HC refrigerants, the workshop environments need to be upgraded to allow for free circulation of air.

R-290 based air conditioning units and compressors for use with HC refrigerants are in scarce supplies on the local market. This is also contributing to the slow penetration of R-290 into the country.

The opportunities for adopting ODS Alternatives exist though they are few as compared to the challenges. When new policies and regulations promoting the use of zero ODP and zero or low GWP alternatives, as being envisaged, Liberia is likely to witness a high demand for ODS Alternatives in the very near future.

The reduced charge of HC refrigerants compared to CFCs, HCFCs and HFCs makes them very economical to use. In addition HCs have high energy efficiency which makes them favorable as they consume less energy. With the problem of electricity in the sub-region, the use of HCs will go a long way in alleviating the energy problems.

ENERGY EFFICIENCY POLICY AND RELATED PROJECTS

In consideration of providing energy access to the population, the Government of Liberia (GOL) published, in 2007, a renewable energy and energy efficiency policy and action plan. This document outlines Government's policy to build and increase the application of renewable energy and energy efficiency technologies in Liberia by promoting investment, technology transfer, market development and local capacity building.

Liberia's first comprehensive National Energy Policy (NEP) was adopted in 2009, and contains the national vision for the energy sector, from the emergency phase, which was completed in 2010, through capacity building and development phases, including the government management contract signed in early 2010 for the Liberia Electricity Corporation (LEC). The principal objective of the NEP is to ensure universal access to modern energy services.

The government of Liberia has also created a Renewable Energy and Energy Efficiency Policy and Action Plan of Liberia, implemented by the Centre for Sustainable Energy Technology. The main objectives of the policy and action plan are to:

- increase access to energy services, with particular references to poverty reduction,
- increase energy sector competition by facilitating government support through tax subsidies for renewable and energy efficiency scale-up,
- facilitate private sector investment/lending in the clean energy sector,
- increase investment in off-grid rural electrification through the deployment of renewable energy technologies,
- facilitate indigenous energy technologies that demonstrate clear cost advantage without jeopardizing quality, and
- organize training to build local capacity for renewable issues.

Prior to the escalation of civil conflict in 1987, the Liberia Electricity Corp. (LEC's) total nameplate installed capacity was around 190 MW, which supported a peak demand of 63 MW. Electricity was mainly provided in the capital of Monrovia, where the Corporation served around 35,000 customers by 1989. Generation was a mix of hydropower, heavy fuel oil (HFO), and diesel.

The small isolated rural systems were powered by diesel plants ranging from 300 kilowatts (kW) to 1,300 kW. The total installed electricity generation capacity, including the private sector, was about 412 MW. The private sector generation, largely mining companies, also consisted of hydropower, heavy fuel oil, and diesel. During the war, the Monrovia Grid and all rural systems outside of Monrovia were largely destroyed.

When H.E. President Ellen Johnson Sirleaf's Administration came into power in January 2006, LEC, which is the national electricity company of Liberia, wholly owned by the Government of Liberia (GOL), was virtually non-existent as was its power grid and generation facilities.

In response, from June 2006 to November 2009, an international donor consortium consisting of USAID, the European Commission, the World Bank, the Republic of Ghana, and the Government of Norway, formulated and implemented a multi-phase Emergency Power Program (EPP), aimed at reviving the Liberia Electricity Corporation for the resumption of commercial operation.

In order to improve and expand the transmission and distribution networks, the Government of Liberia, with financing from donor partners, has undertaken the following projects:

- **Monrovia Accelerated T & D Expansion Project:** to rehabilitate and expand the capacity of four (4) substations and the construction of 22KV distribution lines with distribution transformers installation and connection of customers in the Monrovia area. The project was commissioned in October 2014 and increased the substations transformer capacity from 40 MVA to 146 MVA.

- ***World Bank Project:*** The 66 kV Corridor Paynesville to Kakata (56 km) is an on-going project financed under the World Bank Liberia Accelerated Electricity Expansion Project (LACEEP).

Additional funding of the World Bank LACEEP Project are under discussion for developing the followings:

- the New 66/22kV Virginia substation and new 66/35kV Clay substation as well as 66kV connection to Robertsport, Grand Cape Mount County
- the New 66/22kV Stockton Creek substation, and
- the New 66/22kV Gardnersville substation.

- ***Bomi County Corridor Project:*** The LEC intends to extend the transmission network in the Western Region of Liberia with substations in Kle, Tubmanburg, Robertsport and Bo Waterside. Under this arrangement the project stands to connect a total of 12,475 customers along the Bomi County Corridor.

- ***AFDB/EU Project:*** The African Development Bank and European Union project entails the construction of the 66 kV transmission line from Paynesville to Roberts International Airport (RIA) as well as the extension of the Paynesville Substation to enable the construction of a 66/22 kV Substation in Schefflin and a 66/33 kV Substation in RIA. It also includes the extension of the 33 kV transmission line from Pleebo to Fish Town. Under this project a total of 9,000 customers will be connected.

Currently, the Mt. Coffee Hydropower Plant in Harrisburg, Montserrado County, has an installed capacity of 66 Megawatts and the overall installed capacity of the LEC stands at 104 Megawatts.

On March 1, 2017, the Board of Directors of the LEC approved a reduction in electricity tariff from US$49 cents to US$39 cents per kilowatt hour (kwh).

SECTION-IV: CONCLUSIONS AND RECOMMENDATIONS

SECTION-IV: CONCLUSIONS AND ECOMMENDATIONS

The ODS alternatives survey was conducted throughout the fifteen political sub-divisions of the country, in line with the MLF guidelines. During the survey, every effort was exerted in ensuring the collection of accurate data.

The major ODS alternatives currently in use in the country are R-134a, R-404a, R-407c, R-410a, R-290 and R-600a. They are used basically for installation and servicing of refrigeration and air-conditioning appliances.

It is observed that from 2012 to 2015, the consumption of ODS alternatives is generally on the increase. However, HCFC-22 is still the predominant refrigerant used in refrigeration and air-conditioning sector. The prices of most ODS alternatives are high on the local market, when compared with the price of R-22. This is a factor that continues to give rise to use of R-22.

Hydrocarbon refrigerants such as R-600a and R-290, etc have been introduced as alternatives in the refrigeration and air-conditioning sectors, because of their zero ODP and low GWP. There are however challenges in adopting these new alternatives: lack of capacity building of technicians on safe use and handling of HC refrigerants; lack of proper servicing tools and equipment to cater for effective and safe use of the new refrigerants are but few of the challenges.

There is also the need to make provisions for incentive that would stimulate the adoption of ODS alternatives. The cost of ODS alternatives is still high compared to the technology to be replaced. This hampering the speedy adoption of ODS alternatives in some sectors. Also, in some sub-sectors such as air-conditioning, the non-availability of HC air-conditioning appliances is slowing down the penetration of R-290 into the local market.

[1]There is variation in the Amounts Used and the Amounts Imported along the years. This variation can be attributed to the outbreak of the deadly Ebola Virus Disease which began mid 2014 and intensified in 2015. The Ebola disease caused a first-order decrease in economic activities across Liberia. Additionally, the county of Montserrado, where most of the formal private sector activities are conducted, was hit significantly harder economically than other regions. All sectors, including the refrigeration and air-conditioning sector, were affected by the outbreak. This outbreak accounts for much of the variations in the amount used and imported as shown in the tables.

[2]Careful observation of ODS alternatives data shows that Import Amounts is slightly above Amounts Used for the period under consideration. This is so because importers normally based their imports on customers order to avoid unnecessary stockpiling, which the economic environment in Liberia does not favor. However, the tables of “Import Amounts and Used Amounts” show equality of data because there was insufficient data on use from users. As a result of this, the difference between Import Amounts and Used Amounts was so insignificant that rounding off figure could not permit.

SECTION-V: ANNEX I

SECTION-V: ANNEX I

Table 1- Estimated use by ODS Alternative

Alternative		Estimated use (mt)			
		2012	2013	2014	2015
HFC*	HFC- 134a	2	16	20	14
	HFC-32				
	HFC- 152a				
	HFC- 161				
	HFC- 245fa				
	HFC- 227ea/HFC- 365mfc				
	Others (specify)				
HFC blends	R- 404A	5	0	3	1
	R- 407C	0	0	1	0
	R- 410A	5	1	6	2
	R- 507A				
	Others (specify)				
HFO	HFO- 1234yf				
	HFO- 1234ze				
	HFO- 1233zd				
	HFO- 1336mzzm				
Other alternative	Methyl formate				
	Methylal				
	Ethanol				
	DME				
	HC- 290	0	0	0	1
	HC- 600a	0	6	1	4
	Pentane(C,N,I)				
	R- 744				
	R- 717				
	Others (specify)				

Table 2 - Summary of Use in all Sectors for Each Year between 2012 to 2015* (mt)

Table 2a- Summary of use in all sectors for 2012 (mt)

Alternative		RAC Manufacturing	RAC Servicing	PU Foam	Fire fighting
HFC	HFC- 134a		20		
	HFC-32				
	HFC- 152a				
	HFC- 161				
	HFC- 245fa				
	HFC- 227ea/HFC- 365mfc				
	Others (specify)				
HFC blends	R- 404A		5		
	R- 407C		0		
	R- 410A		5		
	R- 507A				
	Others (specify)				
HFO	HFO- 1234yf				
	HFO- 1234ze				
	HFO- 1233zd				
	HFO- 1336mzzm				
Other alternative	Methyl formate				
	Methylal				
	Ethanol				
	DME				
	HC- 290		0		
	HC- 600a		0		
	Pentane(C,N,I)				
	R- 744				
	R- 717				
	Others (specify)				

Table 2b- Summary of use in all sectors for 2013 (mt)

Alternative		RAC Manufacturing	RAC Servicing	PU Foam	Fire fighting
HFC	HFC- 134a		16		
	HFC-32				
	HFC- 152a				
	HFC- 161				
	HFC- 245fa				
	HFC- 227ea/HFC- 365mfc				
	Others (specify)				
HFC blends	R- 404A		0		
	R- 407C		0		
	R- 410A		1		
	R- 507A				
	Others (specify)				
HFO	HFO- 1234yf				
	HFO- 1234ze				
	HFO- 1233zd				
	HFO- 1336mzzm				
Other alternative	Methyl formate				
	Methylal				
	Ethanol				
	DME				
	HC- 290		0		
	HC- 600a		6		
	Pentane(C,N,I)				
	R- 744				
	R- 717				
	Others (specify)				

Table 2c- Summary of use in all sectors for 2014 (mt)

Alternative		RAC Manufacturing	RAC Servicing	PU Foam	Fire fighting
HFC	HFC- 134a		20		
	HFC-32				
	HFC- 152a				
	HFC- 161				
	HFC- 245fa				
	HFC- 227ea/HFC- 365mfc				
	Others (specify)				
HFC blends	R- 404A		3		
	R- 407C		1		
	R- 410A		6		
	R- 507A				
	Others (specify)				
HFO	HFO- 1234yf				
	HFO- 1234ze				
	HFO- 1233zd				
	HFO- 1336mzzm				
Other alternative	Methyl formate				
	Methylal				
	Ethanol				
	DME				
	HC- 290		0		
	HC- 600a		1		
	Pentane(C,N,I)				
	R- 744				
	R- 717				
	Others (specify)				

Table 2d- Summary of use in all sectors for 2015 (mt)

Alternative		RAC Manufacturing	RAC Servicing	PU Foam	Fire fighting
HFC	HFC- 134a		14		
	HFC-32				
	HFC- 152a				
	HFC- 161				
	HFC- 245fa				
	HFC- 227ea/HFC- 365mfc				
	Others (specify)				
HFC blends	R- 404A		1		
	R- 407C		0		
	R- 410A		2		
	R- 507A				
	Others (specify)				
HFO	HFO- 1234yf				
	HFO- 1234ze				
	HFO- 1233zd				
	HFO- 1336mzzm				
Other alternative	Methyl formate				
	Methylal				
	Ethanol				
	DME				
	HC- 290		1		
	HC- 600a		4		
	Pentane(C,N,I)				
	R- 744				
	R- 717				
	Others (specify)				

Table 3 - Import Amounts of ODS Alternatives

Alternative		Imports (mt)			
		2012	2013	2014	2015
HFC*	HFC- 134a	2	16	20	14
	HFC-32				
	HFC- 152a				
	HFC- 161				
	HFC- 245fa				
	HFC- 227ea/HFC- 365mfc				
	Others (specify)				
HFC blends	R- 404A	5	1	3	1
	R- 407C	0	0	1	0
	R- 410A	5	1	6	2
	R- 507A				
	Others (specify)				
HFO	HFO- 1234yf				
	HFO- 1234ze				
	HFO- 1233zd				
	HFO- 1336mzzm				
Other alternative	Methyl formate				
	Methylal				
	Ethanol				
	DME				
	HC- 290	0	0	0	1
	HC- 600a	0	6	1	4
	Pentane(C,N,I)				
	R- 744				
	R- 717				
	Others (specify)				