Proklima

Final report

Consumption & emission inventory of fluorinated greenhouse gases (CFC, HCFC and HFC) in Mexico

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Registered offices
Bonn and Eschborn, Germany

Programme Proklima
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
Telephone +49 61 96 79-10 22
Fax +49 61 96 79-80 10 22

proklima@giz.de
www.giz.de/proklima

Programme manager
Bernhard Siegele, bernhard.siegele@giz.de

Responsible
Alvaro Zurita, alvaro.zurita@giz.de

Authors
Bhaskar Jyotinath & Ashutosh Pandey, Emergent Ventures International Pte. Ltd., Singapore

Review
Dr Jonathan Heubes, HEAT GmbH

On behalf of
German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
Division KI II 7, International Climate Finance,
International Climate Initiative

Köthener Straße 2-3
10963 Berlin, Germany

Phone: +49 (0)30 18 305-0
Fax: +49 (0)30 18 305-4375

EIII7@bmu.bund.de
www.bmu.de

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PROKLIMA

Proklima is a programme of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Since 2008 Proklima has been working successfully on behalf of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) under its International Climate Initiative (ICI) to promote ozone-and climate friendly technologies.

Proklima provides technical assistance for developing countries since 1996, commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) to implement the provisions of the Montreal Protocol on substances that deplete the Ozone Layer.

This publication has been compiled in the project “Development of NAMAs in the refrigeration, air conditioning and foam manufacturing sectors” funded by the BMU International Climate Initiative.

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THE INTERNATIONAL CLIMATE INITIATIVE

Since 2008, the International Climate Initiative (ICI) of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) has been financing climate and biodiversity projects in developing and newly industrialising economies, as well as in countries in transition. Based on a decision taken by the German Parliament (Bundestag), a sum of EUR 120 million is available for use by the initiative annually. The ICI is a key element of Germany’s implementation of fast start financing. The Energy and Climate Fund launched by the German Government in 2011 is a further source of funding for international climate protection projects, and for activities to conserve biodiversity. Part of that funding is deployed through the ICI. That fund is replenished from the auctioning of emission permits. This innovative source makes Germany well-prepared to deliver long-term financing for climate and biodiversity projects worldwide.

The ICI is active in four areas: Mitigating greenhouse gas emissions, adapting to the impacts of climate change, conserving natural carbon sinks with a focus on reducing emissions from deforestation and forest degradation (REDD+), as well as conserving biological diversity.

www.international-climate-initiative.com

EXECUTIVE SUMMARY

HCFCs and HFCs are mostly used in refrigeration, air conditioning and foam sector. Since HCFCs have ODP, transitioning to non-ozone depleting alternatives in these sectors will make a significant contribution to the recovery of the ozone layer. A range of HCFC alternatives have been developed for the refrigeration, air conditioning and foam sector. These alternatives include Hydro Fluorocarbons (HFCs), natural refrigerants (e.g., carbon dioxide, ammonia and hydrocarbons) While neither HFCs nor natural refrigerants contribute to ozone depletion, HFCs do have significant global warming potential (GWP) and they are included in the United Nations Framework Convention on Climate Change (UNFCCC) basket of controlled greenhouse gases.

The 1997 Kyoto Protocol to UNFCCC was the first ever international agreement devised binding developed nations (Annex 1) to act in accordance with target assigned to them for Green House Gas (GHG) emission reduction. Later, 2007 Bali Climate Change Conference adopted 'Bali Action Plan' which guides developing countries to contribute in global emission reduction and sustainable development. Under this action plan, different (developing) countries may take different "Nationally Appropriate Mitigation Action (NAMA)" in accordance with common but differentiated responsibilities and respective capabilities based on relevant factors like social and economic conditions of a country.

As a commitment made for the 'Bali Action Plan', Mexico has committed to reduce its GHG emission by 30% from Business As Usual (BAU) projection by 2020 and a 50% reduction by 2050, from 2002 levels. This ambitious goal needs further mitigation actions than currently implemented.

The fast growing refrigeration, air conditioning and foam blowing sectors have a huge and growing potential for greenhouse gas emission reduction. A significant portion of Mexico's emission reduction target could be met by reduction in consumption of high GWP F-gases. The Mexican 'Hydro Chlorofluorocarbon Phase-out Management Plan (HPMP)' reveals that by phasing out HCFC from Mexico, reductions equal to 4.47 GT CO_2eq can be achieved. Currently HCFCs are replaced by high GWP HFCs, contributing to global warming. This can be avoided by using natural refrigerants instead of HFCs. To prepare a 'NAMA Project' in the refrigeration and air conditioning sector (RAC), it is required to study detailed emissions from fluorinated gases. The emission inventory can then form the basis for establishing the baseline and a trajectory of relevant sector emission against which the emission reduction options will be measured. The report provides the consumption and emission inventory of

CFC, HCFC and HFC (sometimes together all these gases are referred to as “refrigerants” in the report) in refrigeration, air conditioning and foam sector of Mexico.

The inventory is prepared as a basis for the project “NAMAs in the refrigeration, air conditioning and insulation foam Sector” under the International Climate Initiative by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

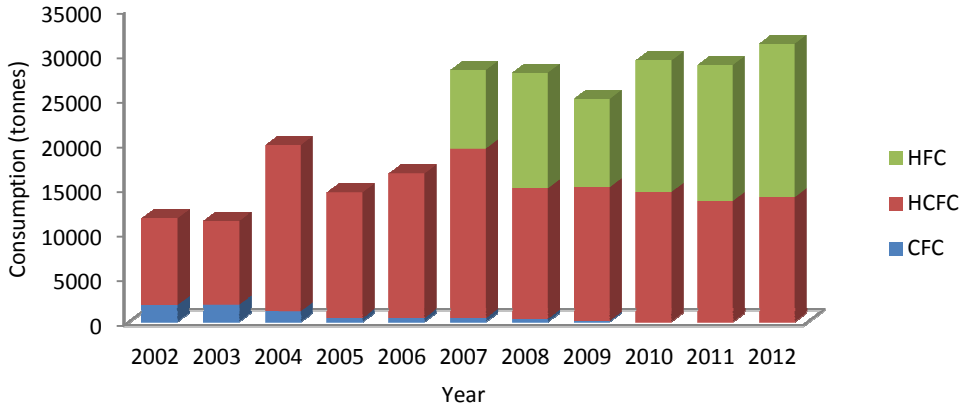
The information presented in this report provides historical consumption of CFCs, HCFCs and HFCs by sector in Mexico. The report also provides historical and projected estimates of HFC emission from different subsectors of RAC sector. Emission estimates are prepared in a consistent manner using Tier 1 (a & b) and Tier 2 approach of revised 1996 IPCC Guidelines for National Greenhouse gas Inventories (IPCC-1997). In the first part of the report, potential emissions (as per tier 1 approach) of CFC, HCFC and HFC from different sectors from year 2002 to 2012 are reported. In the second part of the report, the current actual emissions (Tier 1b) are calculated along with HFC demand & bank. Furthermore, future estimate until 2030 are provided under BAU scenario

The inventory is prepared primarily based on information received from various stakeholders such as importers, exporters, original equipment manufacturers and after-sales service providers, ministries and associations, as well as the custom department. The gas specific production data for CFCs and HCFCs is based upon the information recorded by SEMARNAT. Company specific import and export data of HCFCs are based upon Mexico’s HPMP, Import and export data of HFCs are gathered from Mexico’s custom department and company. The total consumption of gases is calculated based on production, import and export data. Data on ‘Sectoral Distribution’ of gases is obtained from interactions with various stakeholders, Mexico’s HPMP and survey. The actual emission calculation, as per IPCC Tier 2 approach, requires production, sales & stock data of various gas based equipments under the RAC sector. The report provides trend of equipment production, sales and stock data for various subsectors under RAC sector. The other input parameters used in the emission calculation are based on either survey or sources available in public domain.

The demand for RAC equipment increased over the past decade. This has a direct impact on the demand and emissions of fluorinated greenhouse gases in the country. The figure-1 shows the potential emission (consumption) trend of CFC, HCFC and HCFC over the period of 2002 till 2012. Due to constraint of data availability, HFC consumption data have been presented from 2007 to 2012.

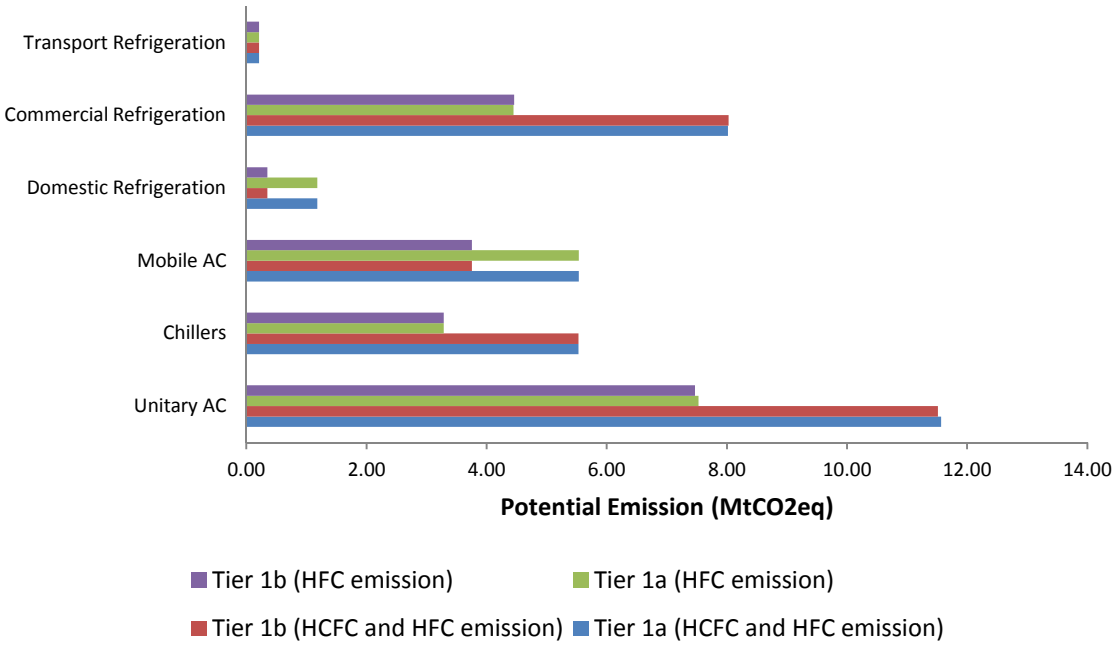
Due to activities of CFC phase out in Mexico, the dependence on HCFCs increased in the first decade of this century. Toward the end on this decade, HCFCs were confined majorly in just servicing sector and in some of the OEM applications such as air conditioning (majorly using HCFC-22) and foam manufacturing (HFCF-141b and HCFC-142b).

Figure-1: Potential emission (consumption) trend of CFC, HCFC and HFC in tonnes (from 2002 to 2012)



The Potential emissions of these gases have also been calculated for both RAC and foam sector separately. Further, potential emissions from different subsectors of RAC sector have been estimated. The figure-2 shows the sectoral contribution of potential emissions as per tier 1a and tier 1b approach in $MtCO_2eq$ for the year 2012.

Figure-2: Potential emission (HCFC and HFC) of RAC subsectors in $MtCO_2eq$ in year 2012



The RAC sector is largest contributor to total potential emissions of Fluorinated greenhouse gases in Mexico, accounting for 78% of emissions in year 2012. The second largest contributor is foam sector, accounting for 20% of emissions in year 2012.

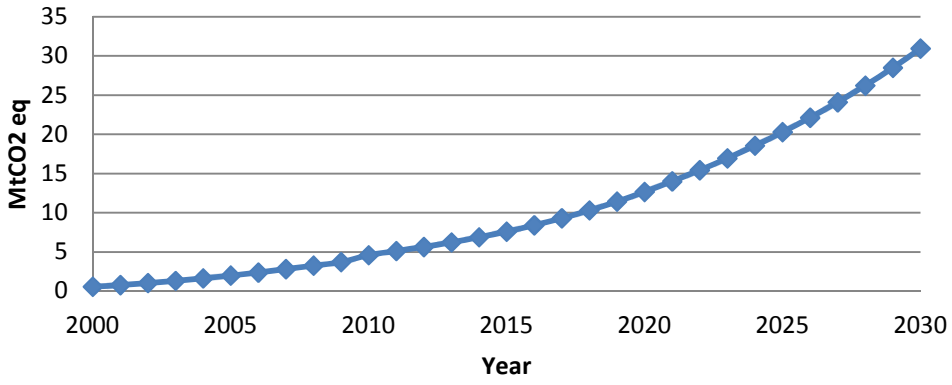
Among the various subsectors of RAC sector, the unitary AC sector accounts for largest share of potential emission (as per tier 1a) of HCFC and HFC (11.57 $MtCO_2eq$) in year 2012, followed by commercial refrigeration sector (8.02 $MtCO_2eq$), mobile AC (5.534$MtCO_2eq$), chillers (5.53 $MtCO_2eq$), and domestic refrigeration (1.18 $MtCO_2eq$). The potential emission of HCFC and HFC as per tier 1b approach differs from the tier 1a approach for the unitary AC, mobile AC and domestic refrigeration sector. Similar variation is observed for potential emission of HFC alone.

Actual HFC emission from the RAC sectors have been estimated for the year 2000 to 2030 and the emission trend is shown in table-1 and figure-3.

Table-1: HFC Emissions from RAC sector ($MtCO_2eq$) from 2000 to 2030

2000	2005	2010	2015	2020	2025	2030
0.568	1.977	4.580	7.587	12.653	20.267	30.924

Figure-3: Trend of HFC Emissions from RAC sector (MtCO2eq) from 2000 to 2030



The result shows that, between year 2000 and 2010, the HFC emission from RAC sector grew from 0.57 $MtCO_2eq$ to 4.58 $MtCO_2eq$ and it is expected to grow approximately 7 times from 2010 level to 30.924 $MtCO_2eq$ by 2030. The figure-5 displays growth of HFC emission for the year 2010 and 2030 for various appliance systems under RAC sector.

Among the various appliances systems under RAC sector, the car air conditioning sector is the largest contributor to total HFC emissions from RAC sector till year 2010. The emission from this sector was only 0.38$MtCO_2eq$ in year 2000 and it reached 2.33 $MtCO_2eq$ in year 2010.

Figure-4: Share of HFC Emissions from RAC sector (MtCO2eq) in year 2010

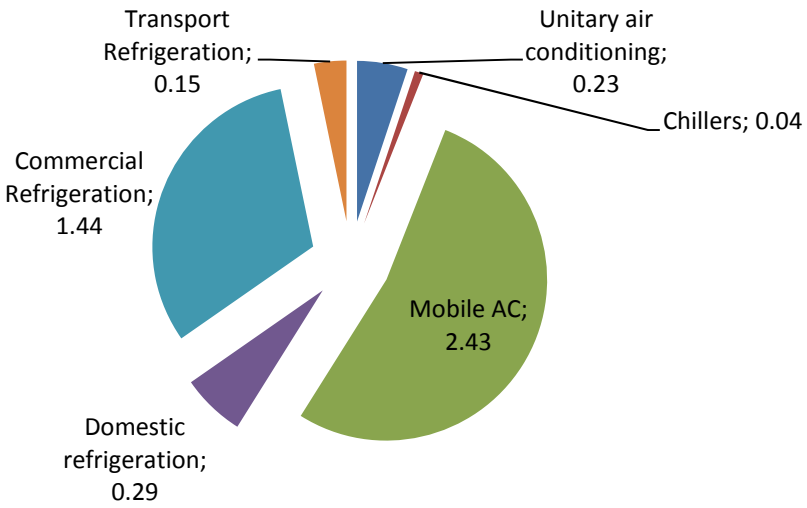
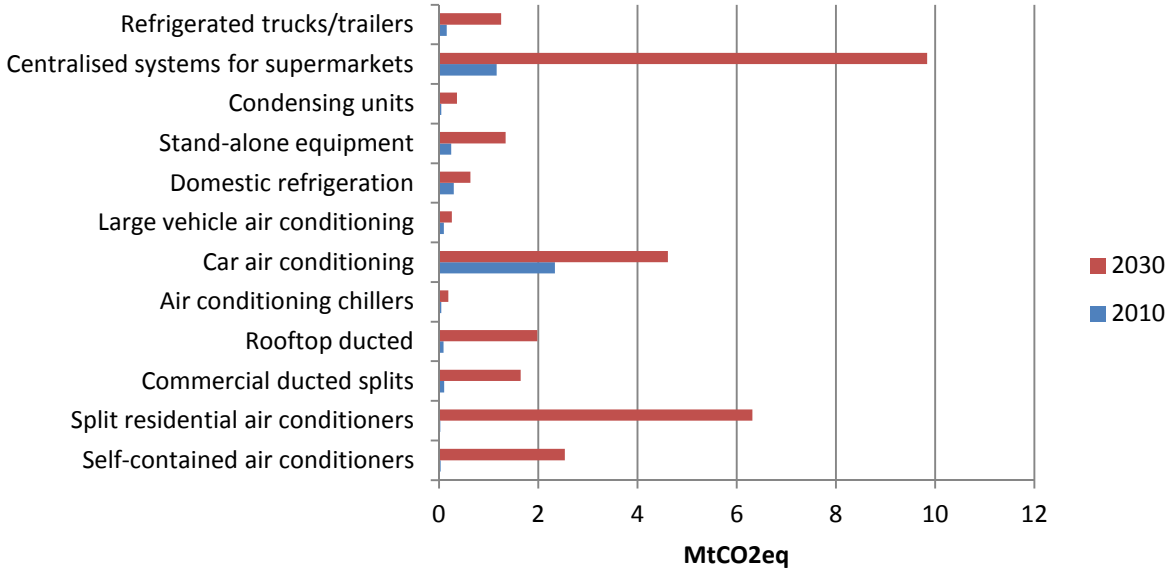


Figure-5: Growth of HFC emission for the year 2010 and 2030 for various appliance systems under RAC sector



It is projected that by year 2030, the share of emissions by centralized system for supermarket will be the highest (9.83 $MtCO_2eq$) amongst all followed by spilt residential air conditioning units (6.31 $MtCO_2eq$) and car air conditioning units (4.60 $MtCO_2eq$).

An exhaustive QA & QC process has been applied on the activity data to maintain the quality of the data and to reduce uncertainty in the emission estimates. For production, import and

export figures of refrigerants and appliances, cross verification has been done with various national statistics available for the sectors which is also verified by experts from the domain. For emission calculation, supporting data such as refrigerant distribution, consumption trends, market growth data etc have been cross verified from various publications as well as high quality data centres such of UNEP report etc.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AC	Air conditioner
BAU	Business as Usual
CFC	Chlorofluorocarbon
GHG	Green House Gas
GDP	Gross Domestic Product
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
HCFC	Hydrochlorofluorocarbon
HPMP	Hydrochlorofluorocarbon Phase Out Management Plan
MLF	Multilateral Fund
MOP	Meeting of Parties
NAMA	Nationally Appropriate Mitigation Actions
ODP	Ozone Depleting Potential
ODS	Ozone Depleting Substances
PFC	Perfluorocarbon
RAC	Refrigeration & Air-Conditioning
MAC	Mobile Air Conditioning
UNIDO	United Nations Industrial Development Organization
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention On Climate Change
UAC	Unitary Air Conditioning

1 GENERAL INFORMATION

1.1 COUNTRY BACKGROUND:

Geography:

Mexico is a vast country located in the south of United States of America (USA) with an area of 1,964,375 km^2 making it the 14th largest country in the world by area. Mexico is surrounded by Guatemala and Belize in the south-east, Gulf of Mexico and Caribbean Sea from the eastern side and Pacific Ocean from the western side.

Democracy:

A Democratic Republic Nation with 31 free and sovereign states and a Federal District which is the capital city of the country. Mexico's estimated population as of 2012 was 114,975,406, making it the 11th largest country in the world by population. With about 77%, i.e. approximately 86 million out of 122 million urban inhabitants[1].

Economy:

Mexico is a free market economy and is the 14th largest economy in the world based on GDP (nominal), which is about US$1,177,116 million according to 2012 estimate[2]. It stands on 65th rank worldwide based on its GDP (nominal) per capita which is about US$ 10247[3].

Energy:

National total energy consumption in 2008 was 8,555 PJ. The transport sector represented 47.6% of the final energy consumption and the industrial sector, 26.3%. The residential, commercial and public subsectors represented 17.7%, and the agricultural sector, 2.8%. Particularly noticeable was the growth in the consumption of the transport sector, mainly due to the consumption of gasoline and diesel[4].

Climate:

Mexico's climate varies from tropical to desert, with overall average temperature between 10° C- 26.5° C (average annual mean), as most parts of Mexico lies in the sub-tropical region. About 20% of its population, which is approximately 22,206,449, resides in areas with hot temperatures (~ average annual mean of 18° C- 26℃).

[1] The World Fact book, Central Intelligence Agency (CIA) of United States of America (USA)
[2] World Economic Outlook Database-April 2013, International Monetary Fund
[3] World Economic Outlook Database-April 2013, International Monetary Fund
[4] Mexico: Fifth National Communication to the UNFCCC

Environment:

Mexico's geographical and extreme population level makes it one of the world's most polluted countries. According to studies conducted, Mexico's contaminant emissions will increase by ten folds in the next decade from the late 1980's levels, which were ~5 million tons.

Estimated ODS consumption of Mexico for the year 2012 was ~1428.58 tonnes (Calculate in terms of ODP)[5].

1.2 HCFCs AND HFCs USED IN THE COUNTRY

Chlorofluorocarbons (CFCs) were widely used in refrigeration and air conditioning sector, also used propellants (in aerosol applications), were phased out by 2010 as per the commitment made under the Montreal Protocol. CFCs have high ODPs and GWPs, and post phasing out process they were being substituted by various HCFCs and HFCs in Mexico.

HCFs are the most common amongst all, with various applications in domestic and commercial air conditioners, refrigerators and fire extinguishers. Also used as blowing agents and solvents for various processes in chemical industries. Types of HFCs used in Mexico are:

HFC-23 HFC-125 HFC-134a HFC-152a HFC-245fa
HFC-404A HFC-407C HFC-410A

HCFC, the most widely used gas in refrigeration and air conditioning sector has relatively lower ODP (~0.055) but a high GWP (~1800 CO_2e). Some of the most widely used HCFCs in Mexico are:

HCFC-22 HCFC-123 HCFC-124 HCFC-141b HCFC-142b

HCFCs are transition substances which were substituted for CFCs and other ODS, for their suitable properties and comparatively lower ODPs, however due to their higher GWPs they're being planned to phase-out.

1.3 SECTORS ENGAGED IN USING HCFC AND HFC.

In addition to various chemical and physical properties of HCFCs and HFCs, which makes them suitable refrigerants and blowing agents for foams, they have several other industrial-friendly properties like higher energy efficiency, non-flammability and superior solvent for which they're extensively used in various applications like fire-extinguishers, aerosols, heat

[5] Mexico's HPMP prepared by UNIDO, 2010

pumps etc. However, the majority of HCFCs and HFCs consumption still occurs in the RAC sector and foam (Open & Closed Cell) application.

HCFC-22 and HCFC-141b are the major HCFCs used in refrigeration and foams, accounting to about 98% of all HCFCs consumption of Mexico. HCFC-22 is the only amongst all which is being produced in Mexico itself, rest all are imported, either in bulk or pre-charged equipments. Refrigeration and air-conditioning product manufacturing sectors and product servicing sector of prior sectors majorly engage HCFC-22. HCFC-141b is majorly used in sectors such as foam application and solvent aerosol etc. HCFC-142b is also used as blowing agents in foam industry. RAC servicing sector also employs HCFC-123 & HCFC-124. For aerosols, HCFC-141b and HCFC-22 are used because of their suitable chemical properties.

HFCs have diverse applications ranging from air conditioning and refrigeration to pharmaceuticals and processing agent in chemical industry. Because of HCFC phase-out, HFCs replaced HCFC almost every sector like refrigerators, air conditioners, fire extinguishers, aerosol sprays, foam etc. HFC-134a is majorly used as refrigerant in stationary and mobile air conditioners as well as domestic refrigeration and commercial stand alone units. HFC-245fa is solely used as blowing agents in foam industries (for domestic refrigerator). HFC-410A & HFC-407C are dominantly used in air-conditioning sector. For condensing and centralized unit of commercial refrigeration, HFC-404A is used.

The table below gives a generic idea about the sectors which employ major CFCs, HCFCs and HFCs in Mexico.

Table 1-1: CFCs, HCFCs and HFCs in Mexico and their Sector of use

Substance		Refrigeration and Air-Conditioning Sector (RAC)	Foam	Fire-extinguishers	Aerosols
CFC	CFC-11		X		
	CFC-12	X			
HCFC	HCFC-22	X	X		X
	HCFC-141b	X	X		X
	HCFC-123	X			
	HCFC-124	X			
	HCFC-142b		X		
HFC	HFC-134a	X	X		
	HFC-245fa		X		

	HFC-152a				X
	HFC-125			X	
	HFC-23	X			
	HFC-404A	X			
	HFC-407C	X			
	HFC-410A	X			

1.4 RELEVENT INDUSTRY ASSOCIATIONS

Various Non-Government Organizations (NGOs) could play a big role in ODS phase-out activities. The source of data for analyzing the stocks, production and share of consumption of HCFCs and HFCs of various companies in different sectors is sourced from these NGOs. Following is the list of such organizations:

Associations	
ANFIR	National Association of Manufacturers of Refrigeration Industry
ANDIRA	National Association of Industrial Distributors, Refrigeration and Air Conditioning
ANFAD	National Association of Home Appliance Manufacturers
CONAII	National Academy of Industrial Engineers
ANCITRACV	National Association of Contractors, Installers and Technicians of Refrigeration, Air Conditioning, Heat and Ventilation Devices
AI	Engineering Academy
HVAC&R	Heat Ventilation, Air Conditioning & Refrigeration
MARIO MOLINA CENTRE	Academy, Research Centre established by Prof. Mario Molina

The major HCFC and HFC consuming companies in Mexico are the refrigeration and air conditioning (Equipment Manufacturing and Servicing) and foam manufacturing companies. Following table lists out such companies in Mexico engaged in various sectors:

Sector	Major Companies
Domestic Refrigerator	Mabe, Whirlpool, Electrolux, LG and Samsung
Commercial Refrigeration	Metal frio, Imbera, Nieto, Ojeda, Fersa, Hussmann, Heil Pheonix and Kyser Warner
Domestic Air Conditioning	Mostly HCFC-22 based units, which are imported
Commercial Air Conditioning	Trane, Carrier, Johnson control (York), Lennox, Rheem and Daikin
Foam	Whirlpool, Electrolux, Bayer, Pumex, Dow, Nissan and General Motors
Mobile Air Conditioning	Nissan, Chrysler, General Motors, Volkswagen, Ford, Honda
Propellant/Aerosol	Unilever

Companies like Dupont, Qumiobasicos, Ineos, Arkema etc are some of the major importers of HCFCs and HFCs in Mexico. These importers supply HCFCs and HFCs to various

equipment manufacturing companies, and also to the companies engaged in servicing of the equipments.

1.5 INSTITUTIONAL SET-UP OF SEMARNAT (NOU) AND THE CLIMATE CHANGE FOCAL POINT

The Secretariat of Environment and Natural Resources (SEMARNAT) is the federal agency of Mexico which is responsible for promoting the sustainable development in Mexico. The organization provides support in the protection, restoration and conservation of ecosystem, natural resources and environment in Mexico.

SEMARNAT is lead by three Under-Secretaries and various decentralized organizations working together to shape the Federal Environmental Sector. The sector works on four priorities:

1. *The conservation and sustainable use of ecosystems and their biodiversity.*
2. *Prevention and control of pollution.*
3. *Integrated management of water resource.*
4. *Fight against climate change.*

The Government of Mexico (GOM) with support from SEMARNAT developed various laws and regulations aimed to reduce the overall consumption of controlled substances by the set phase-out dates. Major organization established under the SEMARNAT to execute the phase-out of the said substances is National Ozone Unit (NOU), which is working in collaboration with

- Inter-alia (Ministry of Trade, Finance and Customs) which is responsible for controlling import/exports by implementing license and border controls.
- Ministry of Agriculture and Industry, which provides support in controlling the consumption of controlled substances.

Main functional areas of NOU (under SEMARNAT) are-

1. Framing national and international policies with respect to Ozone Depleting Substances (ODS),
2. Sizing the imports, production and consumption of ODS using the available database,
3. Preparing the draft laws and regulations to control or phase-out ODS, and submit them to the ministry which can be developed as government policy.
4. Liaising with private enterprises and implementing agencies in order to assist in ODS phase-out.
5. Extending the knowledge in society about the need to phase-out such controlled substances.

2 PROJECT BACKGROUND & METHODOLOGY:

2.1 PROJECT OVERVIEW:

The Ministry of Environment and Natural Resources (SEMARNAT) is the agency responsible for conducting environmental and climate change policy in Mexico. SEMARNAT leads the inter-ministerial Commission on Climate Change and the Mexican Committee on GHG emission reduction and sequestration projects. The SEMERNAT also comprises of the National Unit for Ozone layer protection, the co-ordinating agency for all policy and actions on Ozone Depletion as well.

F-gases are HFC, PFC and SF_6, as defined under the Kyoto Protocol. However, in this report we define F-gases as fluorinated gases which include ozone depleting substances (CFCs and HCFCs) and greenhouse fluorinated gases (HFCs)). The focus of this inventory is on HFCs as these are the most dominant substances which are used in the RAC sectors. Potential emission in the RAC sector is calculated for HCFCs and HFCs while actual emissions (Tier 2 approach) are given for HFCs.

The Mexican HPMP reveals that by phasing out HCFC from Mexico, reductions in emission equal to 4.47 GT CO_2eq can be achieved. Considering that certain HFCs, which are the intended phase-in substances, have GWP higher than that of HCFCs, it could lead to higher emissions (especially from RAC and Foam sector) if these HFCs are indeed used to replace HCFC. However this can be avoided through introduction of natural refrigerants to replace HCFC. A significant portion of Mexico's emission reduction target could be met by reducing the usage high GWP F-gases. In case of high cost implications, there is the possibility of supported NAMAs (e.g. through NAMA facility fund).

To prepare a 'NAMA Project' in the RAC&F sector, it is required to study detailed emissions from these gases. The emissions log can then form the basis for establishing an MRV system, the Business-as-usual and mitigation scenarios.

This report provides detailed emission pattern of CFCs, HCFCs and HFCs from different sectors in Mexico. The report also provides historical and projected estimates of HFCs under a business-as-usual scenario (BAU) from different subsectors of RAC sector. The detailed inventory does not only build the basis for NAMA in the RAC sectors, but HFC emissions can be reported to the UNFCCC within the National Communication.

The inventory was done as a basis for the project "NAMAs in the refrigeration, air conditioning and foam sector" under the International Climate Initiative by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

2.2 EMISSION INVENTORISATION METHODOLOGY:

To develop estimates included in this report, data have been collected from companies and publicly available reports. The calculation method to derive emission follows the IPCC Revised Guidelines for National Greenhouse Gas Inventories (IPCC 1997). Emission estimates are prepared in a consistent manner using Tier 1 (a & b) and Tier 2 methodology. Tier 1 and Tier 2 refer to the top-down and bottom-up approach respectively. Tier 1a needs data on chemical production, imports and exports in bulk. Tier 1b is a refinement of the Tier 1a approach and additional need data on imported and exported equipment taking into account whether these are pre-charged or not. Tier 2 needs equipment production, sales & stock data for the different sectors. Several tools from the study "**Technical handbook on "NAMAs in the refrigeration, air conditioning and foam sectors**" were used to build the F-gas (CFC, HCFC and HFC) inventory in Mexico.

2.2.1 DATA COLLECTION METHODOLOGY:

The following steps were conducted to collect the data for both Tier 1 and Tier 2 level approach.

- Study of country background
- Study of institutional set-up in Mexico for ODS phase-out and climate change
- Study of legislative and policy arrangements
- Stakeholder consultation
- Survey and data collection

Stakeholder consultation:

EVI, in association with SEMARNAT, Mexico and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) organised a national consultation workshop on March 6, 2013 for the stakeholders in SEMARNAT office in Mexico City, Mexico. The Stakeholder Consultation Workshop was organized with the following aims:

- Discussion of the aims of the process
- Discussion of the scope of work for GIZ and the Consultant in the process and various stakeholders
- Discussion of the Survey and Data Collection Process including explanation of the questionnaire to be used for data collection.
- Discussion of the alignment of the project with Climate Change program of Mexico.

A second stakeholder consultation workshop was also organized on 9th December 2013 in Mexico city after completion of the inventory. The objective of this workshop was to:

- Present activity data and inventory developed based on data collected during survey
- Collect feedbacks and views from stakeholders and experts

The following are the stakeholders who were engaged in the process:

- Producers and importers of HCFCs and HFCs
- Manufacturers of equipments based on HCFCs and HFCs
- Various Industrial Sectors consuming HCFCs and HFCs
- Equipment Service Centres
- Foam Manufacturers
- National Ozone Unit, Mexico
- Various Government ministries and councils
- GIZ

The list of participants from different stakeholder groups in the workshops appears as annex-III & IV of this report.

Survey and data collection:

The survey process was aimed to collect data from all producers, importers, exporters of gas and equipments. Based on the study of country and stakeholder consultation, the following sectors were identified as the target groups of the survey:

- Producers
- Importers & Distributors
- Domestic refrigerator
- Domestic air conditioning
- Commercial refrigerator
- Industrial refrigerator
- Commercial air conditioning
- Polyol suppliers
- Foam manufacturer
- Mobile air conditioning
- Transport refrigerator

The following table provides the data type with data source (i.e. stakeholder group) collected for emission inventorisation:

Table 2-1: Data type with data source collected for Emission Inventorisation

Data type	Tier 1 data	Tier 2 data	Data source
Gas Production	×		Producers
Gas Import	×		Importers & Distributors

Gas Export	×		Importers & Distributors
RAC Equipment Production	×		Equipment Manufacturer
RAC Equipment Import	×		Equipment Manufacturer
RAC Equipment Export	×		Equipment Manufacturer
RAC Equipment Sales data		×	Equipment Manufacturer
RAC Equipment Stock data		×	Equipment Manufacturer
Foam Production		×	Foam Manufacturer
Foam Import/Export		×	Foam Manufacturer and Polyol supplier
Initial Charge in equipments		×	Equipment Manufacturer
Emission factors		×	Equipment Manufacturer & Equipment servicing centre.
Sector specific Historical and projected growth rate		×	Importers & Distributors, Equipment Manufacturer, Various government Ministries & Councils including NOU, Mexico.
Equipment life time		×	Equipment manufacturer & Sectors consuming CFCs, HCFCs and HFCs.

The following steps were followed to complete the survey process:

Step 1 – Preparation of questionnaire and list of stakeholders for each subsector

Step 2 – Sending questionnaires to stakeholders (List of sector specific stakeholders and response rate are in annex-IV) in each subsector

Step 3- Conduct meeting with the stakeholders to understand the data provided

Step 4 – Compiling the data receiving through questionnaires in Data Input Sheet (DIS)[6]

2.2.2 EMISSION INVENTORISATION METHODOLOGY

2.2.2.1 TIER 1 (A & B) METHODOLOGY:

Tier 1 methodology is applied for potential emission calculation. Potential emissions of a certain gas are equal to the amount of virgin gas consumed in the country minus the amount of chemical recovered for destruction. Since net consumption of a gas equals production plus imports minus exports, the calculation formula for the basic method (Tier 1) is as follows:

Potential Emissions = Production + Imports – Exports – Destruction

[6] DIS tool from the handbook on "NAMAs in the refrigeration, air conditioning and foam sectors (GIZ 2013)"

There are two versions of Tier 1 (a and b) depending upon whether products are taken into account. In Tier 1a, chemicals contained in products are not considered, only chemicals imported or exported in bulk are considered in the calculation of potential emission, i.e.

Imports = Imported HCFCs/HFCs in bulk

Exports = Exported HCFCs/HFCs in bulk

Tier 1b is an extension of Tier 1a and includes HCFCs and HFCs contained in various products which are imported and exported.

Imports = Imported HCFCs/HFCs in bulk + Quantity imported in HCFCs/HFCs containing products

Exports = Exported HCFCs/HFCs in bulk + Quantity Exported in HCFCs/HFCs containing products

2.2.2.2 TIER 2 METHODOLOGY:

Tier 2 methodology contains actual emission calculations for each individual gas. The Tier 2 methodology: estimates emission of each individual gases at detailed level e.g., refrigerators, air conditioning, foam, aerosols etc. It estimates emission on the basis of gas emitted during system assembly, operation and at system disposal, also taking current service and recovery practices into account.

Emission estimation of refrigeration and air conditioning (RAC) sector:

The total emission from RAC equipment is calculated as below:

$$E_{total,t} = E_{assembly,t} + E_{operation,t} + E_{disposal,t}$$

Where,

$E_{total,t}$ = Total emission in year t

$E_{assembly,t}$ = Emissions during system manufacture/assembly in year t

$E_{operation,t}$ = Amount of HFCs emitted during system operation in year t

$E_{disposal,t}$ = Amount of HFCs emitted at system disposal in year t

The quantity of refrigerant emitted during system assembly is calculated by the following formula:

$$E_{assembly,t} = E_{charged,t} \times \left(\frac{k}{100}\right)$$

Where:

$E_{charged,t}$ = the amount of refrigerant charged into new systems in year t

k = assembly losses in per cent of the amount charged

The amount charged should include all systems which are charged in the country, including those which are made for export. Systems that are imported pre-charged should not be considered here, but contribute to the stock.

Annual leakage from the stock, including venting during service, is commonly expressed in percent of total amount of "banked" refrigerant in the existing stock of systems. It is calculated by applying following formulae:

$$E_{operation,t} = E_{stock,t} \times \left(\frac{x}{100} \right)$$

where:

$E_{stock,t}$ = amount of HFCs stocked in existing systems in year t

x = annual leakage rate in percent of total HFCs charge in the stock.

In calculating the refrigerant "bank" ($E_{stock,t}$) all systems in operation in the country (that have been sold in the country) have to be considered.

To estimate emissions at system disposal, the following calculation formula is applicable:

$$E_{disposal,t} = Ei_{charge(t-n)} \times (y/100) \times (100-z)/100$$

Where:

$Ei_{charge\ (t-n)}$ = amount of HFCs initially charged into new systems installed in year (t-n)

n = average equipment lifetime, years

y = amount of HFCs in systems at time of disposal in percent of initial charge,

z = amount of HFCs recovered in percent of actual charge ("recovery efficiency"),

Q = amount of HFCs emitted at system disposal in percent of the quantity of chemical originally charged into the system,

Q=y (100-z)/100

The report follows the steps of GIZ Proklima "HFC Inventory and Projection tool" from the study of **Technical handbook on "NAMAs in the refrigeration, air conditioning and**

foam sectors (hereafter referred as tool)" for estimation of actual emission of HFCs from RAC sector. This tool describes the calculation steps to derive emission, demand and banks of HFCs under BAU scenario for the inventory. The report uses the terminology of subsectors and appliance systems under refrigeration and air-conditioning sector from the tool.

Table 2-2: Definition of Subsectors and Appliance systems used in the report under refrigeration and air conditioning sector[7]

Subsector	Systems
Unitary air conditioning	Self-contained air conditioners Split residential air conditioners Split commercial air conditioners Duct split residential air conditioners Commercial ducted splits Rooftop ducted Multi-splits
Chillers	Air conditioning chillers Process chillers
Mobile air conditioning	Car air conditioning Large vehicle air conditioning
Domestic refrigeration	Domestic refrigeration
Commercial refrigeration	Stand-alone equipment Condensing units Centralized systems for supermarkets
Industrial refrigeration	Stand-alone equipment Condensing units Centralized systems
Transport refrigeration	Refrigerated trucks/trailers

The primary input parameters for the model (tool) are current sales and stock figures for each system as well as historical data reaching back to year 2000. The sales figures refer to the number of domestically sold units. These were partly derived by domestic production, imports and export figures. All relevant data were entered in an electronic data input sheet (DIS) for the country which serves as a guidance to collect all relevant data. Later these data were transferred into the tool to get emission, bank and demand of HFCs.

In case reliable stock data are not available from the survey, the report estimates stock data applying the procedure mentioned in the tool.

[7] Definition of subsectors and appliance systems are taken from GIZ Proklima "HFC Inventory and Projection tool" from the study of Technical handbook on "NAMAs in the refrigeration, air conditioning and foam sectors".

3 TIER-1 DATA AND POTENTIAL EMISSION

In the first section of this chapter, production, export and import of CFCs, HCFCs and HFCs have been presented and under the same section, the potential emission (as per tier-1a approach) of these gases from year 2002 to 2012 is reported. The chapter also provides the distribution of these gases in various subsectors and potential emission (as per tier-1a approach) of CFCs, HCFCs and HFCs from RAC and foam sector. Further, the equipment import and export data for RAC sector has been showcased and potential emission as per tier-1b approach has been presented for year 2012. Minutiae of the approach followed for calculating emission (by IPCC Tier 1a and Tier 1b) are explained in section 2.2.2.1 of the report. The derivative analyses, based on assumption, survey and other data source, for respective sectors are provided in the annex-V to VIII.

3.1 PRODUCTION, IMPORT & EXPORT-GASES IN BULK

3.1.1 CFCs, HCFCs AND HFCs PRODUCED IN THE COUNTRY

Of all the F-gases (CFCs, HCFCs and HFCs) used in Mexico, at present, only HCFC-22 is produced in the country. Though CFCs were produced in the country, but as per the commitment made by Mexico under the Montreal Protocol, CFC(s) production (throughout the country) stopped in September 2005. Also, there are no production facilities of HFCs in the country, neither was in the past. Table 3.1 shows the CFC and HCFC-22 production[8] in Mexico from year 2002 to 2005.

Table 3-1: CFCs and HCFCs Production data (in tonnes)

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC-11	758	1,291	1,177	278	0	0	0	0	0	0	0
CFC-12	4,895	7,403	6,867	4,923	0	0	0	0	0	0	0
HCFC-22	4,947	5,117	7,548	8,776	12,506.2	14,151	14,022	12,725	12,618.8	11,812.7	7,872

HCFC-22 is the only F-gas produced in the country, by a sole manufacturer- Quimobasicos, which supplies 60 percent of its total production to the domestic markets and exports the rest. While other HCFCs used in the country are all imported. Also, the entire demand of HFCs in the country is fulfilled by imports from various countries, including USA, which has the largest share in the imports.

During the manufacturing of HCFC-22, HFC-23 is produced as a byproduct, of which a large share is destroyed by the company (Quimobasicos). Quimobasicos has two production lines (for HCFC-22): Line-1- which destroys HFC-23 produced using Plasma Destruction

[8] The CFC and HCFC Production figures have been sourced from the data recorded by SEMARNAT.

Technology since 2006 (Registered CDM project under UNFCCC, Reference number-0151)[9], while from the other line (Line-2) produced HFC-23 escapes directly in the environment, as it is not managed. The quantity of HFC-23 produced as a byproduct in production of HCFC-22 is 2.8 percent[10] (mass ratio; approximate) of HCFC-22 produced. The table below provides the quantity of HFC-23 (in tonnes) discharged into the environment from 2007-2012[11].

[9] Source- http://cdm.unfccc.int/Projects/DB/DNV-CUK1138260062.21/view

[10] 2.8% is a calculated figure based on the HFC production data reported to UNFCCC for CDM registered project 0151.

[11] This is calculated by multiplying a mass ratio of 2.8% with the HCFC-22 production from Line 2. The HCFC production from Line-2 is calculated by subtracting HCFC-22 production data reported to UNFCCC for Line-1 from the total HCFC-22 production data recorded by SEMARNAT

Table 3-2: Quantity of HFC-23 discharge into environment during production of HCFC-22

Year	2007	2008	2009	2010	2011	2012
Quantity of HFC-23 discharged (tonnes)	196.480	147.595	136.240	102.498	85.852	43.381

3.1.2 CFCs, HCFCs AND HFCsIMPORTED BY THE COUNTRY

Though Mexico closed its production of CFC in year 2005, the complete phase-out of CFCs was achieved in the year 2010. Apart from production, the country also imported CFCs (until the complete phase-down) to fulfill its domestic demand. The table 3.3 shows the import of CFCs and HCFCs into the country from 2002 till 2012 and import of HFCs from 2007 to 2012.

The import data of CFCs and HCFCs has been sourced from the records of SEMARNAT. While, the import data of HFCs has been gathered from two sources: the first, from companies having large shares in overall imports, respectively; the second from the Custom department of Mexico. Upon comparing, the variation was found to be even less than 5 percent. For further analysis, the company data has been considered. Customs data has been considered for importers who have not shared their data during market survey.

Table 3-3: CFCs, HCFCs and HFCs import data (in tonnes)[12]

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC-11	83	277.75	47.3	0	18.3	41.09	19.86	29	0	0	0
CFC-12	956	837	333.6	146.24	397.2	385.7	326.43	90	0	0	0
HCFC-22	3,082.82	3,520	7,642.26	3,546.26	5,684.98	4,483.3	2,646	5,130	5,065.9	3,512.8	3,614.34
HCFC-141b	4,678	3,847	7,759.38	7,317.4	7,474.11	7,161.51	7,566.9	5,733	7,071.4	7,362.3	6,017
HCFC-142b	0	0	0	262.67	12.74	4.37	15.97	20	158.3	456.2	725.52
HCFC-123	16	4	42.92	45.8	48.44	50.1	13.88	54	92.1	72	36.95
HCFC-124	9.62	1	36.88	0	42.21	46.72	2.72	5	10.9	161.3	98.53
HFC-152a						170.27	198.30	161.08	172.63	276.42	1,313.91

[12] Source: Custom department and company data

HFC-125	0.48	1.06	4.12	8.07	9.80	15.97
HFC-134a	5,627.38	9,018.12	5,984.55	8,101.02	8,623.02	7,892.73
HFC-23	0.73	1.32	1.823	1.587	0.583	1.203
HFC-245fa	1,372.30	2,286.95	2,296.40	2,355.17	2,221.56	2,426.01
HFC-404A	678.95	710.07	814.59	914.38	1,285.29	1,233.95
HFC-407C	86.782	102.09	53.525	64.339	93.684	161.006
HFC-410A	1,438.42	2,509.63	2,960.83	6,227.40	5,818.73	6,857.33

3.1.3 CFCs, HCFCs AND HFCsEXPORTED BY THE COUNTRY

Mexico exports significant quantities of CFCs, HCFCs and HFCs to neighboring countries in Central and Southern America, such as Brazil, Venezuela, Columbia etc. These exports are sources via trading giants (such as DuPont, Arkema, Qumiobasicos etc), which are also responsible for large imports of the same gases to Mexico. These organizations have large distribution network, spread in this continent as well as neighboring countries. The exports of CFCs and HCFCs, from 2002-2012 and the exports of HFCs, from 2007 to 2012 have been shown in table 3-4 below. The data of CFCs and HCFCs has been sourced from SEMARNAT, and HFC's, from the Custom department, Mexico.

Table 3-4: CFCs, HCFCs and HFCs export data (in tonnes)[13]

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC-11	414	1,421	1,066	268.97	0	0	0	0	0	0	0
CFC-12	4,390	6,451	6,188.15	4,659.34	0	0	0	0	0	0	0
HCFC-22	2,974.31	3,079	4,362	5,823.96	9,200.54	6,675.4	9,526	8,436	10,093.3	8,620.9	4,058.3
HCFC-141b	7	6	10	9.3	308.11	210.01	107.16	230	327.2	1,166.1	253.4
HCFC-142b	0	0	0	0	0	0	0	0	0.04	18.5	0
HCFC-123	0	0	0	0	0	0.34	0	0	0	8.7	0
HCFC-124	1.5	0	0	0	24.52	0.36	0	0	0	4	69.2
HFC-152a						4.88	22.83	9.21	4.07	22.32	41.57

[13] Source: Data of CFCs and HCFCs have been sourced from SEMARNAT, and HFC's, from the Custom department, Mexico.

HFC-125	0	0	1.58	0	0	0
HFC-134a	518.70	1,629.30	1,438.85	1,196.23	1,374.72	974.44
HFC-23	0.02	0.06	0	0	0	0
HFC-245fa	0	0	0	12.08	0	29.92
HFC-404A	14.67	36.46	28.59	44.78	43.82	52.13
HFC-407C	2.09	2.27	0.45	1.80	0.65	3.81
HFC-410A	2.03	157.18	891.10	1,840.67	1,634.78	1,577.58

3.2 NET CONSUMPTION (POTENTIAL EMISSION) OF CFCs, HCFCs AND HFCs IN BULK

The consumption data have been calculated as per Tier 1a approach, i.e. sum of production and imports, less the exports in a given year (of quantity in bulk). The table below shows the consumption data for CFCs, HCFCs and HFCs in Mexico (in tonnes) from 2002 till 2012.

Table 3-5: CFCs, HCFCs and HFCs consumption data (in tonnes) from 2002 to 2012[14]

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC-11	427	147.75	158.3	9.03	18.3	41.09	19.86	29	0	0	0
CFC-12	1,461	1,789	1,012.45	409.9	397.2	385.7	326.43	90	0	0	0
HCFC-22	5,055.51	5,558	10,828.26	6,498.3	8,990.64	11,958.9	7,142	9,419	7,591.4	6,704.6	7,428.04
HCFC-141b	4,671	3,841	7,749.38	7,308.1	7,166	6,951.5	7,459.74	5,503	6,744.2	6,196.2	5,763.6
HCFC-142b	0	0	0	262.67	12.74	4.37	15.97	20	158.26	437.7	725.52
HCFC-123	16	4	42.92	45.8	48.44	49.76	13.88	54	92.1	63.3	36.95
HCFC-124	8.12	1	36.88	0	17.69	46.36	2.72	5	10.9	157.3	29.33
HFC-152a						165.39	175.47	151.87	168.56	254.1	1,272.34
HFC-125						0.48	1.06	2.54	8.07	9.8	15.97
HFC-134a						5,108.68	7,388.82	4,545.7	6,904.79	7,248.3	6,918.29
HFC-23						0.71	1.26	1.823	1.587	0.583	1.203
HFC-245fa						1,372.3	2,286.95	2,296.4	2,343.09	2,221.56	2,396.09
HFC-404A						664.28	673.61	786	869.6	1,241.47	1,181.82
HFC-407C						84.692	99.82	53.075	62.539	93.034	157.196
HFC-410A						1,436.39	2,352.45	2,069.73	4,386.73	4,183.95	5,279.75

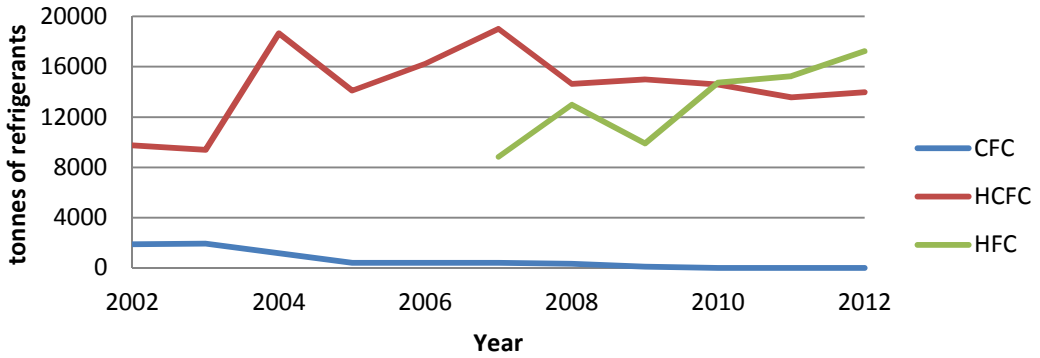
[14] Due to constraint of data availability, HFC data have been presented from 2007 onwards.

The following table gives total consumption (in tonnes) of respective type gases, for the same time period:

Table 3-6: CFC, HCFC and HFC consumption data (in tonnes) from 2002 to 2012

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC	1,888	1,936.75	1,170.75	418.93	415.5	426.79	346.29	119	0	0	0
HCFC	9,750.63	9,404	18,657.44	14,114.87	16,235.51	19,010.89	14,634.31	15,001	14,596.86	13,559.1	13,983.44
HFC						8,832.926	12,979.455	9,907.143	14,744.985	15,252.819	17,222.634

Figure 3-1: Consumption trend of CFCs, HCFCs and HFCs (in tonnes)



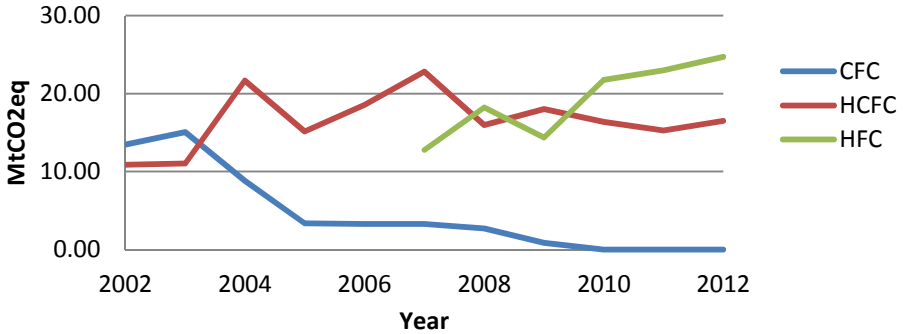
- The figure shows a consistent decrease in consumption of CFCs. The reason for the same can be attributed to the phase-down activities of CFCs, as implemented by Mexico.
- The increase in consumption of HCFCs from 2002 till 2004 can be attributed to the market growth as well as the increased dependency on HCFCs, as CFCs were being phased-down.
- Following 2004, with a slight variation in between, the consumption of HCFCs reached highest in 2007, which again happened due to the above mentioned factors.
- Post start of first decade of the 21st century, HFCs gained a lot of popularity as HFCs had greater advantages such as zero ODP, higher efficiency etc. The same trend was witnessed in Mexico, which is clearly visible in the figure above, as the overall consumption of HFCs is seen to be increasing, indirectly affecting consumption of HCFCs.
- In year 2009, a significant drop in consumption of HFCs occurred, due to the economic slowdown (economic recession; 2008), which affected the market growth; hence decrease in the sale of equipments which use HFCs.

The table 3-7 provides the potential emissions of CFCs, HCFCs and HFCs, calculated by IPCC Tier 1a methodology, using bulk import, export, production and destruction data of these gases in the country. Please note that there is no destruction of these gases in the country. Emission in tonnes is converted to CO_2-equivalent basis using 100-year GWP values as published in the IPCC's second assessment report (IPCC 1995). However, some of the these gases used in Mexico do not have GWPs in the second assessment report. In those cases, GWPs from IPCC third assessment report (IPCC 2001) have been used.

Table 3-7: Potential emission of CFC, HCFC and HFC in bulk (in $MtCO_2eq$)

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC	13.46	15.05	8.80	3.35	3.29	3.28	2.72	0.84	0.00	0.00	0.00
HCFC	10.86	11.03	21.69	15.34	18.54	22.84	15.97	18.02	16.41	15.26	16.50
HFC						12.75	18.23	14.35	21.76	23.01	24.71

Figure 3-2: Trend of Potential Emission of CFC, HCFC and HFC in bulk (in $MtCO_2eq$)



- The trend followed by potential emissions of all three categories of F-gases is similar to consumption trend.
- For similar reasons, as depicted in consumption analysis (via Tier 1a approach), the emissions of CFCs decreased from 2002 till 2012.
- Further, due to added advantages of HFCs over HCFCs, the potential emissions of HCFCs decreased from 2007, since HFCs gained popularity.
- Even the HCFC consumption is higher than the consumption of HFC in year 2008, the emission from HFC is higher than emission from HCFC, as GWP of HFCs is higher than HCFCs.

3.2.1 POTENTIAL EMISSION OF CFC, HCFC AND HFC IN BULK BY SECTOR

The Potential emission of CFC, HCFC and HFC in bulk has been calculated for both RAC and foam sector separately based on the refrigerant and blowing agent distribution in different sectors. The distribution of CFCs and HCFCs in these two sectors has been sourced from SEMARNAT, whereas HFCs distribution is based upon the understanding from the survey (conducted during site visits). The table 3-8 and 3-9 shows the potential emission from RAC sector in tonnes and $MtCO_2eq$ respectively.

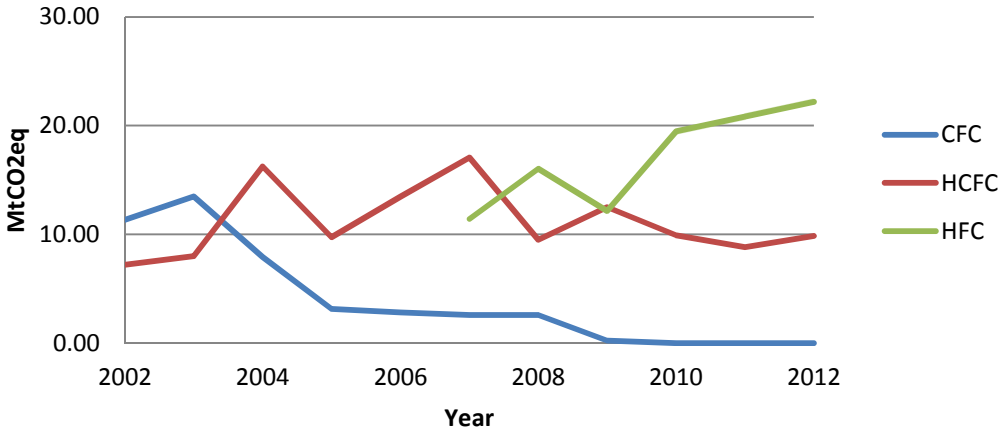
Table 3-8: Potential emission of CFC, HCFC and HFC in bulk from RAC sector in tonnes (2002 to 2012)

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC	1,399	1,664	977.8	387.01	350	320	320	30	0	0	0
HCFC	4,820.63	5,333	10,833.26	6,544.1	9,036.77	11,466.12	6,358.6	8,387.06	6,704.8	6,060.2	6,624.32
HFC						7,294.743	10,515.953	7,456.326	12,225.252	12,767.349	13,522.744

Table 3-9: Potential emission of CFC, HCFC and HCFC in bulk from RAC sector in $MtCO_2eq$ (2002 to 2012)

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC	11.33	13.48	7.92	3.13	2.84	2.59	2.59	0.24	0.00	0.00	0.00
HCFC	7.20	7.99	16.24	9.75	13.47	17.08	9.52	12.52	9.92	8.84	9.85
HFC						11.42	16.03	12.14	19.49	20.84	22.19

Figure 3-3: Trend of Potential Emission of CFC, HCFC and HFC in bulk from RAC sector (in $MtCO_2eq$)



The above result shows that:

- HFC is the main contributor to the emission in the RAC sector, accounting for an average of 58 percent of emission from 2007 to 2012. The percentage contribution of HFCs towards the total emission from RAC sector is increasing, accounting of 69 percent of emission in year 2012 whereas in 2007 the contribution was 36 percent.
- HCFC is the other major contributor to the emission in the RAC sector, accounting for an average of 38 percent of emission from year 2007 to 2012.

The result of Potential emission from foam sector is presented in table 3-10 and 3-11 in tonnes and $MtCo_2eq$ respectively.

Table 3-10: Potential emission of CFC, HCFC and HFC in bulk from foam sector in tonnes (2002 to 2012)

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC	222.00	147.00	104.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

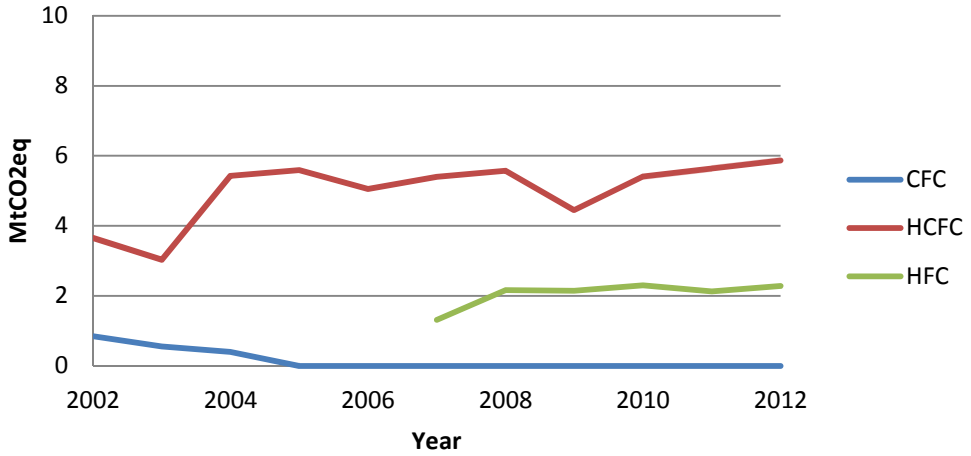
HCFC	4,930.00	4,071.00	7,749.38	7,570.77	7,195.50	6,963.50	7,320.71	5,755.00	6,841.06	6,813.90	6,684.12
HFC						1,380.17	2,269.45	2,252.32	2,414.55	2,233.22	2,399.69

Table 3-11: Potential emission of CFC, HCFC and HFC in bulk from foam sector in $MtCO_2eq$ (2002 to 2012)

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CFC	0.84	0.56	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCFC	3.66	3.03	5.42	5.59	5.05	5.40	5.57	4.45	5.41	5.64	5.87
HFC						1.32	2.16	2.15	2.30	2.13	2.29

The figure 3-4 illustrates the trend of Potential emission of CFC, HCFC and HFC from foam sector.

Figure 3-4: Trend of Potential emission of CFC, HCFC and HFC in bulk from Foam sector in $MtCO_2eq$



- As shown in the figure, HCFCs, even till 2012, dominate as blowing agent in the Mexican foam Industry.

- Few companies which are into the domestic refrigeration sector, produces foam based on HFC-245fa. HFC-245fa based rigid polyurethane is used for insulation in domestic refrigeration system.

- XPS foam is other type of foam manufactured in Mexico based on HFCs, which is used in insulating walls and roofs (for offices and houses). HFC-134a is the only HFC used as blowing agent in this type of foams apart from HFC-134a,

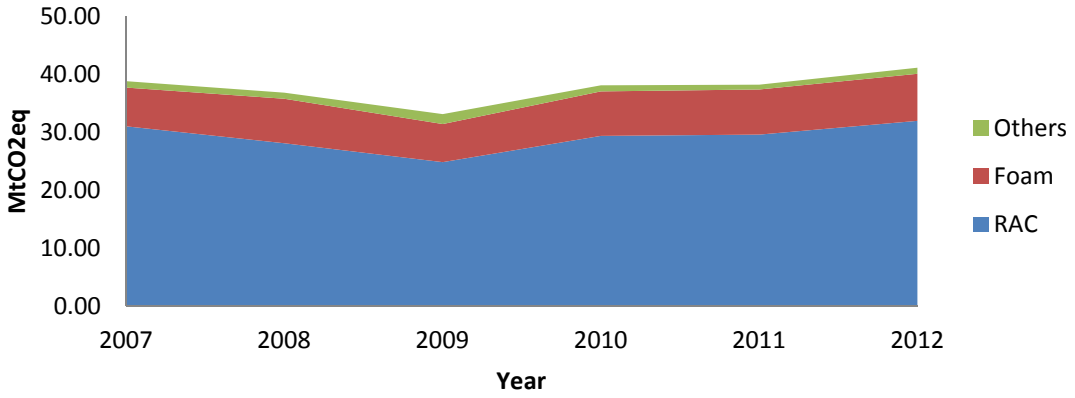
- In year 2005-06, various companies manufacturing rigid polyurethane foam partially shifted to HFC-245fa based foams, which is why there was increase in consumption of HFC-245fa from 2007-2008.

- Consumption of HFC-245fa also increased with an increased production of domestic refrigerators. Following that, the consumption of HFC-245fa grew overall from 2008 till 2012, with slight variation in between.

CFCs, HCFCs and HFCs are also used in aerosol, fire fighting and flushing sectors due to some favorable chemical properties such as inert nature, heat absorption properties etc. But, the overall share in total consumption in these sectors remains very less.

The emission of CFC, HCFC and HFC is grouped in three sectors: RAC, foam and others. The aerosol, fire fighting, flushing sectors are covered under “Others” sector. The following figure shows the emission trend from 2007 to 2012 by sectors. As illustrated in figure 3-5, emission from RAC sector accounted for an average of 77 percent of the total emission from year 2007 to 2012. The foam sector and others account for an average of 17 percent and 3 percent respectively from year 2007 to 2012.

Figure 3-5: Potential Emission of CFC, HCFC and HFC in bulk by sector (in $MtCO_2eq$)



3.2.1.1 POTENTIAL EMISSION OF CFC, HCFC AND HFC IN BULK FROM VARIOUS SUBSECTOR OF RAC SECTOR

As explained in the above section, RAC sector is the main contributor to the total emission of F-gases (CFCs, HCFCs and HFCs) in Mexico. Hence it is very essential to know the contribution of various subsectors under RAC sector to the total emission. The figure 3-6 displays the breakdown of total emission of RAC sector by various subsectors for the year 2012. The emission for a subsector under RAC sector is calculated multiplying the refrigerant distribution (in percent) with the total quantity of gases consumed in RAC sector for a given year for a specific type of gases. The refrigerant distribution has been sourced from HPMP and discussion with various stakeholders during the survey. The refrigerant distribution for the year 2012 is presented in annex-IX of this report.

Figure 3-6: Share of Potential emission of HCFCs and HFCs in bulk from RAC sector (in tonnes) in year 2012

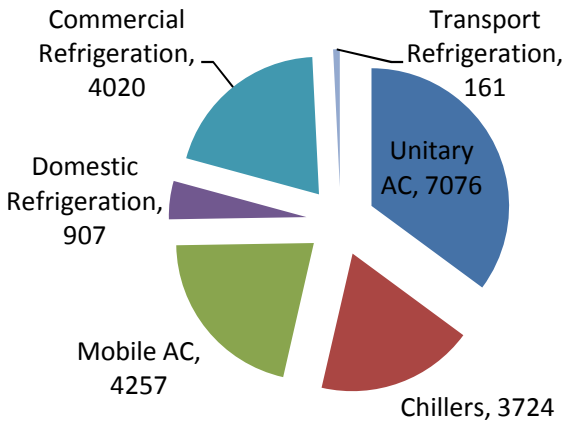
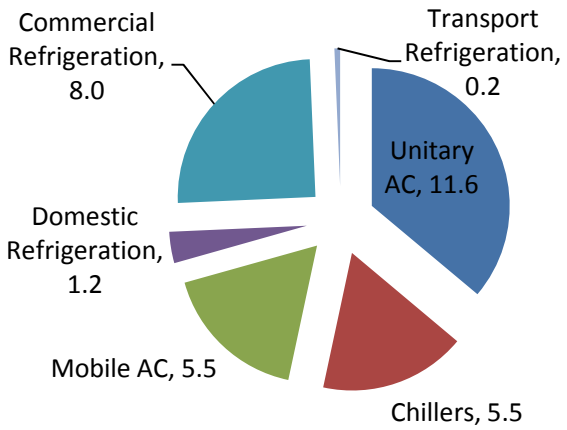


Figure 3-7: Share of Potential emission of HCFCs and HFCs in bulk from RAC sector (in $MtCO_2eq$) in year 2012



The unitary AC sector accounts for largest share of emission (11.57 $MtCO_2eq$) in year 2012. The second highest contributor is the commercial refrigeration sector, accounting for 8.02 $MtCO_2eq$ to the total emission from RAC sector. The mobile AC, chillers, domestic refrigeration, and transport refrigeration sector account respectively 5.534 $MtCO_2eq$, 5.53 $MtCO_2eq$, 1.18 $MtCO_2eq$ and 0.21 $MtCO_2eq$ of emission in year 2012.

The largest emission from unitary AC sector is associated with the consumption of HFC-410a and HCFC-22. The consumption of HFC-410A and HCFC-22 in this sector is 4223.80 tonnes and 2695.12 tonnes respectively. Apart from these two gases, approximately 157.18 tonnes of HFC-407C has been consumed by this sector in year 2012. The figure 3-8 and 3-9 illustrates the potential emission of HFCs in Bulk from various subsectors of RAC sector for year 2012.

Commercial refrigeration sector is the second largest emission source of HCFCs and HFCs, accounting for 8.02 $MtCO_2eq$ of emission in year 2012. Emission from this subsector is contributed by both consumption of HCFCs and HFCs. Approximately 2379.41 tonnes of HCFC-22 was consumed by this sector in year 2012. The HFC-404A and HFC-134a are commonly used refrigerants in this sector with a consumption of 1181.81 tonnes and 459.12 tonnes respectively. However consumption of HFCs is growing at a faster rate in this sector.

Mobile AC sector emission is the third largest emission source of HCFCs and HFCs, accounting for approximately 907.14 tonnes of HFC-134a consumption in year 2012.

The fourth largest source of emission under RAC sector is chillers, accounting for 5.53 $MtCO_2eq$ of emission in year 2012. The chiller consumes both HCFCs and HFCs. The HCFCs consumed in this sector are HCFC-22, HCFC-123 and HCFC-124 with an approximate consumption of 1483.50 tonnes, 36.95 tonnes, 29.33 tonnes respectively in year 2012. However, consumption of HFCs is growing at a faster rate in this sector. HFC-134a and HFC-410A are mostly used HFCs in this sector with a consumption of 1117.71 tonnes and 1055.95 tonnes in year 2012.

The above four important subsectors are followed by the domestic refrigeration and transport refrigeration sectors with 907.14 tonnes and only 161.47 tonnes in the year 2012 respectively. Both subsectors are dominated by HFC-134a.

Figure 3-8: Share of Potential emission of HFCs in bulk from RAC sector (in tonnes) in year 2012

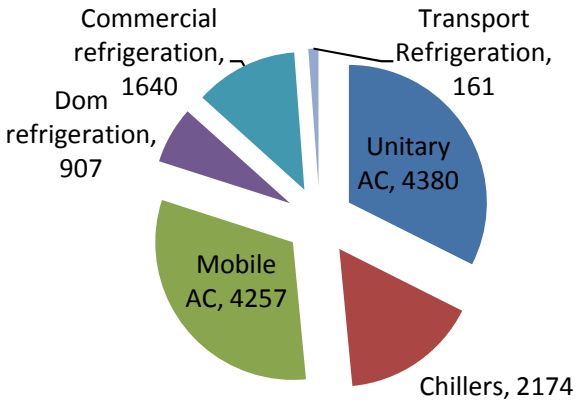
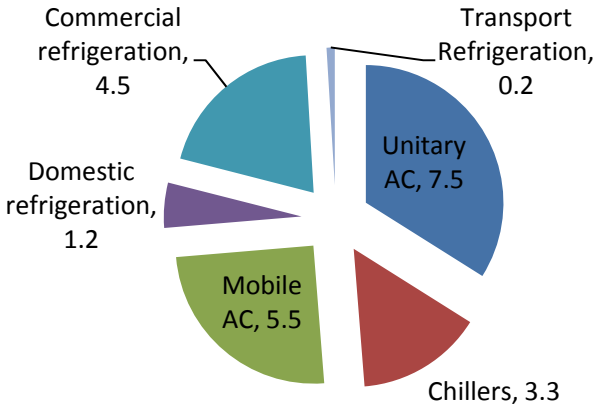


Figure 3-9: Share of Potential emission of HFC in bulk from RAC sector (in MtCO2eq) in year 2012



The above pie charts show that the share of emission changes significantly for the unitary air conditioning, commercial refrigeration and chiller sector when only HFC emissions are considered. Considering only HFCs emission, the unitary AC sector accounts for largest share of emission (4380.99 tonnes) in year 2012. The second largest contributor is the mobile air conditioning sector, accounting for 4257.28 tonnes. The chillers, commercial refrigeration, domestic refrigeration, and transport refrigeration sector account respectively 2174.87 tonnes, 1640.90 tonnes, 907.14 tonnes and 161.47 tonnes in year 2012.

3.3 IMPORT & EXPORT-PRODUCTS & EQUIPMENTS

Emission as per Tier 1b approach considers import and export of gases those contained in imported and exported products & equipments. In this section data on import and export of

equipments are presented along with information on type and quantity of refrigerant that are contained in the equipments. Finally the potential emission as per Tier 1b approach has been calculated and compared with the potential emission as per Tier 1a approach.

3.3.1 EQUIPMENT IMPORT AND EXPORT DATA-RAC SECTOR

The use of residential and commercial air conditioning & refrigeration equipment has seen a dramatic increase in Mexico within the past few years. Further, the country is in the process of transitioning from window units to mini-split units.

Until recently, air conditioned automobiles were only sold in Mexico's northern cities. Today, most automobiles are equipped with air conditioning during manufacturing itself. In addition to the large manufacturing firms, many smaller companies have also started production of RAC products in Mexico. RAC products manufactured by these companies are for domestic markets as well as exported to various countries, in particular to USA. Small companies that provide parts and maintenance services import components mainly from USA including South Korea, Germany, Italy, France, Thailand, Argentina, Japan, Spain and Canada. Table 3-12 and 3-13 displays Mexico's import and export figures of various appliances in RAC sector from year 2007 to 2012.

Table 3-12: Equipment import data in RAC sector[15]

Sector	Sub sector	2007	2008	2009	2010	2011	2012
Unitary Air Conditioning	Self-contained air conditioners	288,944	103,740	97,874	56,706	61,543	66,793
	Split residential air conditioners	416,265	617,975	965,212	1468,215	1512,261	1557,629
Chillers	Air conditioning chillers	29,990	76,107	13,882	7,414	8,046	8,733
Mobile AC	Car air conditioning	668,208	579,195	439,229	432,430	451,154	470,689
	Large vehicle air conditioning	-	-	885	1,154	1,212	1,272
Domestic refrigeration	Domestic refrigeration	1,778,461	1,046,675	808,291	597,376	615,297	633,756
Commercial Refrigeration	Stand-alone equipment	315,598	376,299	132,155	144,342	158,776	174,654
Transport Refrigeration	Refrigerated trucks/trailers	6,656	7,133	7,514	1,122	1,218	1,322

[15] The import and export data of cars and large vehicles are sourced from AMIA and ANPACT respectively and vehicles equipped with air conditioning system have been derived from the analysis presented in annex-V & VI of this report. Import and export data for remaining subsectors are sourced from custom department.

Table 3-13: Equipment Export data in RAC sector[16]

Sector	Sub sector	2007	2008	2009	2010	2011	2012
Unitary Air Conditioning	Self-contained air conditioners	55,281	24,553	20,801	18,788	20,391	22,130
	Split residential air conditioners	3,753	16,516	13,790	20,907	21,534	22,180
Chillers	Air conditioning chillers	3,913	20,236	2,055	1,592	1,728	1,875
Mobile AC	Car air conditioning	1,613,313	1,661,403	1,223,333	1,859,182	1,939,685	2,023,673
	Large vehicle air conditioning	-	-	73	68	71	75
Domestic refrigeration	Domestic refrigeration	5,624,527	6,001,874	5,233,310	5,976,733	6,156,035	6,340,716
Commercial Refrigeration	Stand-alone equipment	326,828	422,516	265,440	268,283	295,111	324,622
Transport Refrigeration	Refrigerated trucks/trailers	331	516	427	16	17	19

The equipment import and export data of unitary AC, chillers, domestic refrigeration, commercial refrigeration & transport refrigeration sector are sourced from custom. For the sector MAC-car, the vehicle import and export data have been sourced from AMIA[17] and cars equipped with air conditioning system have been derived from analysis presented in annex-V of this report. The import and export data for large vehicles have been sourced from ANPACT[18], which has been further analyzed to arrive at vehicles equipped with AC[19]. Information on equipments imported and exported containing refrigerant were gathered from Custom as well as from different stakeholders. The table 3-14 shows the charging status (whether equipment is pre-charged or not) of various appliance systems imported and exported, to and from Mexico.

Table 3-14: Charging status of various appliance systems (Import and Export)

Sector	Sub sector	Charging status of Imported equipments	Charging status of Exported equipments
Unitary Air Conditioning	Self-contained air conditioners	All Window ACs are pre-charged with HCFC-22. 50% of total packaged units imported to Mexico are per-charged with HFC-410A	All are pre-charged with HFC-410A
	Split residential air conditioners	All are pre-charged with HCFC-22	All are pre-charged with HFC-410a
Chillers	Air conditioning chillers	Not pre-charged	Not pre-charged

[16] The import and export data of cars and large vehicles are sourced from AMIA and ANPACT respectively and vehicles equipped with air conditioning system have been derived from the analysis presented in annex-V & VI of this report. Import and export data for remaining subsectors are sourced from custom department.

[17] Mexican Automotive Industry Association (AMIA); http://www.amia.com.mx/ventasd.html

[18] National Association of Manufacturer of Buses, Trucks & Tractors (ANPACT); http://www.anpact.com.mx/

[19] Please refer annex-VI for analysis.

Mobile AC	Car air conditioning	Pre-charged with HFC-134a	Pre charged with HFC-134a
	Large vehicle air conditioning	Pre-charged with HFC-134a	Pre charged with HFC-134a
Domestic refrigeration	Domestic refrigeration	Pre-charged with HFC-134a	Pre charged with HFC-134a
Commercial Refrigeration	Stand-alone equipment	Pre-charged with HFC-134a	Pre charged with HFC-134a
Transport Refrigeration	Refrigerated trucks/trailers	Not pre-charged	Not pre-charged

Self-contained air conditioner includes window AC and Packaged unit, whereas Split residential air conditioners include residential spilt AC, all of various capacities. The Window ACs which are used in the country are mostly imported. These imported units are all pre-charged with HCFC-22, mainly coming from China. In case of packaged units (self-contained AC), about 50 percent of total imports are pre-charged with HFC-410a; the remaining part is charged in Mexico. Self-contained ACs exported by Mexico are all pre-charged with HFC-410a.

3.3.2 POTENTIAL EMISSION OF HCFCs AND HFCs (TIER-1B) FROM VARIOUS SUBSECTORS OF RAC SECTOR

The Figure 3-10 shows the emissions according to the Tier 1b approach for the year 2012

Figure 3-10: Share of Potential emission of HCFCs and HFCs in bulk from RAC sector (in tonnes) in year 2012

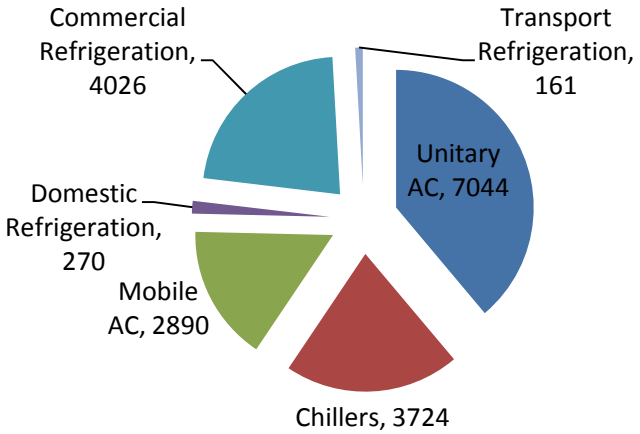
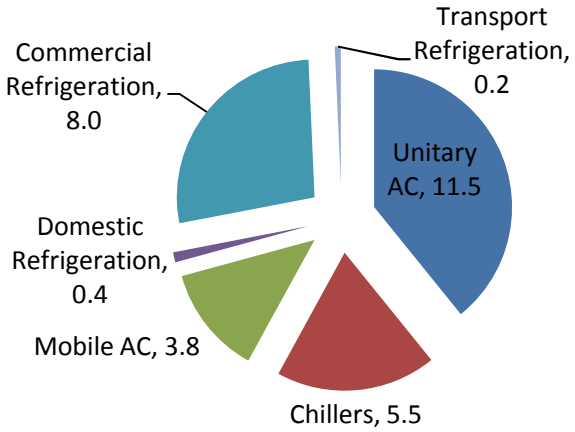
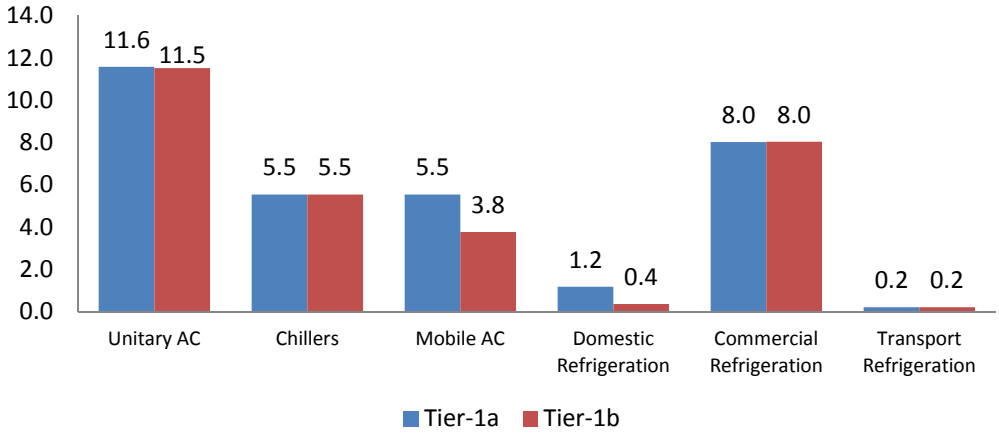


Figure 3-11: Share of Potential emission of HCFCs & HFCs from RAC sector (in $MtCO_2eq$) in year 2012



Results are similar to those derived by Tier-1a approach and only differ in the subsectors: unitary AC, mobile AC and domestic refrigeration. This is because of export of pre-charged equipments. The slight variation in the results of unitary AC is because the export of pre-charged equipments, which is very less, is not accounted in Tier 1a emission calculation.

Figure 3-12: Comparison between Potential emission ($MtCO_2eq$) of HCFCs and HFCs from tier 1a and tier 1b approaches in year 2012



For mobile AC subsector, the variation is due to huge exported equipment charged with refrigerant HFC-134a (refer table 3-13), Consequently Tier 1b emission are lower than Tier 1a emissions. Further, as domestic refrigeration subsector also records significant exports, similar variation in emission calculation from both the approaches is observed.

4 TIER-2 DATA AND ACTUAL EMISSION

This chapter presents demand, bank and emissions of HFC (as per tier-2 approach) as well as future projections under the BAU scenario for the following sectors:

- Unitary air conditioning
- Chillers
- Mobile air conditioning
- Domestic refrigeration
- Commercial refrigeration
- Transport refrigeration

The industrial refrigeration sector is not covered by this study because industrial refrigeration sector shifted to ammonia based systems instead of HFCs after substituting CFCs. Hence, the inventory for HFC consumption in this sector is considered extremely less, and restricted to only some specific applications, which are considered as negligible.

To congregate activity data, the information was either sourced from equipment manufacturer or was analyzed through various secondary data sources. To derive historic activity data, the historic growth rate[20] was applied to available activity data from 2007-2012 (in most cases). Further, to estimate projected data, the projected growth rate derived from historic sales trend from 2007-2012 was applied to available activity data.

4.1 UNITARY AIR CONDITIONING (UAC) SECTOR

Under the unitary air conditioning sector, four categories of air-conditioning systems are commonly used in Mexico. These categories are: Self-contained air conditioners, Split residential air conditioners, Commercial ducted splits & Rooftop ducted. The section below provides the production, sales and stock data for all these categories in Mexico.

4.1.1 EQUIPMENT PRODUCTION, SALES & STOCK DATA-UAC

Due to low response rate in this sector, the primary data on production, sales and stock of equipments could not be gathered. However, the sales and stock data have been sourced from a secondary data source[21] for 2000 to 2010 period. The growth rate has been applied to the available activity data to get the complete time series till 2030. The trend of sales and

[20] Please refer table-6 under annex-XI for sources of Historical and projected growth rate.

[21] MEXICO Refrigerant and blowing agents inventories 1990 to 2010 Refrigerant and blowing agents inventories, Denis CLODIC – EreIE, Stéphanie BARRAULT, Stéphane LEVASSOR - CEP ARMINES (2012)

stock data of equipments in various appliance systems of unitary AC, from 2000-2030, is presented in table 4-1 & 4-2 respectively.

Table 4-1: Equipment sales data-unitary air conditioning sector

Sub sector	2000	2005	2010	2015	2020	2025	2030
Self-contained air conditioners	229,075	375,392	224,472	337,996	508,933	766,318	1,153,874
Split residential air conditioners	64,009	186,094	614,369	712,222	1,072,419	1,614,780	2,431,434
Commercial ducted splits	11,395	14,238	14,227	21,422	32,256	48,569	73,132
Rooftop ducted	7,200	8,718	8,637	13,005	19,582	29,485	44,397

Table 4-2: Equipment stock data-unitary air conditioning sector

Sub sector	2000	2005	2010	2015	2020	2025	2030
Self-contained air conditioners	1,292,552	2,735,911	3,977,676	3,995,156	4,603,286	5,931,035	8,272,116
Split residential air conditioners	292,013	907,450	2,784,422	4,838,585	7,164,507	10,702,073	16,053,744
Commercial ducted splits	272,040	304,915	314,810	297,623	323,209	398,185	536,894
Rooftop ducted	69,225	103,169	134,723	140,742	167,928	221,698	311,751

4.1.2 BANK AND EMISSION OF HFC-UAC

According to stakeholders from the sector[22], in year 2000, significant share of unitary ACs were operating on CFCs, i.e. about 40 percent of total stock (based on CFC-12 refrigerant) and remaining 60 percent of equipments were operational on HCFC-22. However, all the equipments sold in the same year were based entirely on HCFCs (HCFC-22 as refrigerant).

By 2010, 98 percent of self-contained and split residential air conditioners were operating on HCFC-22, and the rest on HFC-410A. However, about 95 percent of both type of equipments sold in the market in the same year were based on HCFC-22, and the rest with HFC-410A. Further, equipments other than the ones mentioned, were also based majorly on HCFC-22, i.e. about 90 percent; 9.5 percent on HFC-410A and the rest on HFC-407C. However, none of these equipments, sold in the market in the same year, were based on HCFCs, rather 98 percent of the sold units were based on HFC-410A and 2 percent on HFC-407C.

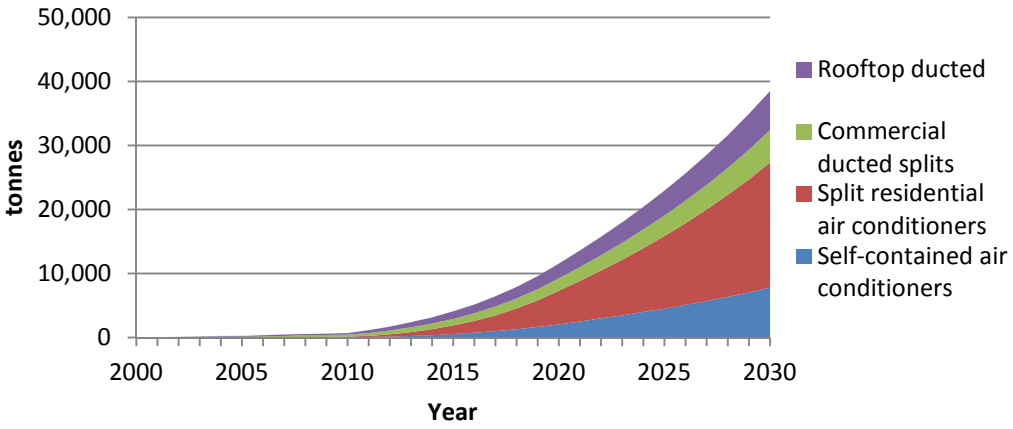
Further, according to survey conducted, and opinions from experts from this sector, by 2020, HFCs would dominate this sector, with prediction of about 50 percent equipments based on

[22] Manufcaturer of air conditioner “Trane, Mexico”.

HFC-410A and the rest on HFC-407C. Also, the same pattern is predicted to continue post 2020, till 2030.

The bank, demand & emissions of HFCs from unitary AC sector were calculated using the above refrigerant distribution in year 2000, 2010 and 2020-30. (Please refer annex-X for detail refrigerant distribution in sold and stock units). Following figure represents the trend of HFC bank in unitary AC sector, from 2000-2003:

Figure 4-1: HFC Bank in UAC, by appliance system

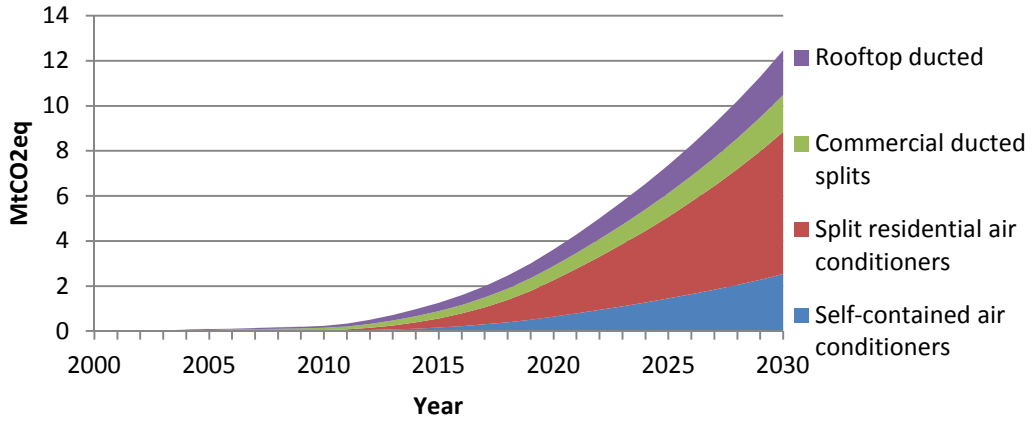


The emissions of HFCs from unitary AC sector, by appliance systems are provided in the table below from 2000 till 2030:

Table 4-3: Emission of HFC from UAC, by appliance system ($MtCO_2eq$)

Sub sector	2000	2005	2010	2015	2020	2025	2030
Self-contained air conditioners	0.000	0.009	0.027	0.164	0.649	1.458	2.535
Split residential air conditioners	0.000	0.003	0.021	0.403	1.614	3.629	6.314
Commercial ducted splits	0.000	0.047	0.101	0.326	0.628	1.043	1.639
Rooftop ducted	0.000	0.031	0.085	0.368	0.743	1.252	1.981
Total	**0.000**	**0.090**	**0.234**	**1.262**	**3.634**	**7.382**	**12.469**

Figure 4-2: Trend of HFC emission from UAC, by appliance system



The unitary air conditioning sector is the fourth largest contributor to total HFC emission from RAC sector, accounting for 5 percent of emissions in 2010. The emissions of HFCs from unitary AC equipment are seen to be increasing consistently from 2000-2030. In the year 2000, HFCs were not introduced in this sector. By 2005, post introduction of HFCs in this sector, commercial ducted AC system accounted for 52 percent of total HFC emissions from the sector followed by emissions from rooftop ducted AC units with 35 percent share, Self-contained and split residential air conditioners with share of 10 percent and 4 percent respectively of the total emission from the sector. Since, the residential and smaller AC units (self-contained and split) had a very small market in 2005, the share of emissions from the respective sectors accounted for less share in net emissions.

Further, from 2010 till present, due to increase in market size (stock and sales) of self-contained and split residential AC units, share of both sectors in total HFC emissions grew. In 2010, the share of both the sectors combined was 29 percent (10 percent and 19 percent, respectively), whereas, the share of commercial ducted split and rooftop ducted AC units was 35 percent and 26 percent respectively.

By 2030, HCFCs are predicted to be completely phased-out from this sector, and HFCs would dominate in this sector. With 50: percent of HFC-407C and 50 percent of HFC-410A in this sector, split AC units will contribute largest in total HFC emissions (51 percent), followed by self-contained (20 percent), rooftop ducted (16 percent) and commercial ducted (13 percent) AC units.

4.2 CHILLERS

Under the Chillers sector, the emission estimates have been carried out only for air conditioning chillers. Process chillers which are mostly used in industrial refrigeration are not covered under the study as they predominantly use ammonia.

4.2.1 EQUIPMENT PRODUCTION, SALES & STOCK DATA-CHILLERS

Due to constraints of primary data availability on production, sales and stock of chillers sector, the data has been sourced from the secondary data source[23] for the year 2000 to 2010. The growth rate[24] has been applied to the available data series to get the complete time series from 2000 to 2030. The sales and stock data of chillers from 2000-2030 is presented in the table below.

Table 4-4: Equipment sales & stock Data – air conditioning chillers

Equipment	2000	2005	2010	2015	2020	2025	2030
Sales	363	511	710	1,069	1,483	2,424	3,650
Stock	3,629	5,314	7,636	9,134	12,080	17,003	24,762

4.2.2 BANK AND EMISSION OF HFC-CHILLERS

According to expert's opinion[25] the majority of chiller units sold in year 2000 were based on CFC-12 (80 percent). But, due to developments in phase down activities of CFCs, HFC-134a based units were introduced in the market (around year 2000), which were catching up fast on the net sales. But, since before CFC phase down developments, majority of the sold chiller units were based on CFCs, their share in stock (for the year 2000) was almost 100 percent.

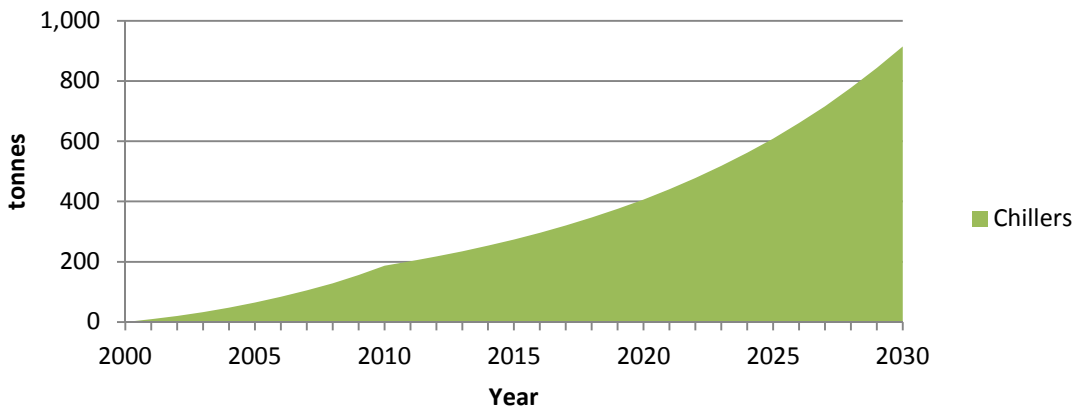
By 2010, CFC based chiller units were totally eliminated from the market. The majority of units sold were based on HFC-134a, which grew from 20 percent (in year 2000) to about 80 percent share in net sales. Also, HFC-410A based units had a significant share of about 20 percent in net sales, because of added advantages such as comparatively lower GWP and the chillers charged with it are more energy efficient. Further, HFC-134a was the dominating refrigerant in the same year with a share of 60 percent; whereas, 30 percent of the units

[23] MEXICO Refrigerant and blowing agents inventories 1990 to 2010 Refrigerant and blowing agents inventories, Denis CLODIC – EreIE, Stéphanie BARRAULT, Stéphane LEVASSOR - CEP ARMINES (2012)
[24] Please refer table-6 under annex-XI for sources of Historical and projected growth rate
[25] Experts from "Trane, Mexico".

were operational on HCFC-22, followed by HFC-410A (9.5 percent) and HFC-407C (0.5 percent).

Further, it is expected that HFC-134a will be the dominant refrigerant by 2020 onwards. The bank and emissions of HFCs from AC Chillers were calculated using the above refrigerant distribution (refer annex-X for detail refrigerant distribution in sold and stock units) for a time period from 2000 to 2030. The figure 4-3 represents the trend for HFC bank in chillers from 2000-2030:

Figure 4-3: HFC Bank in air conditioning chillers

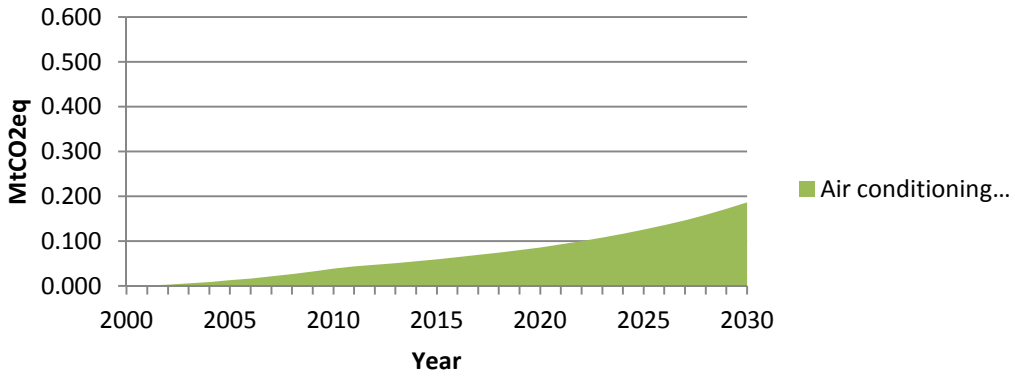


The table below represents the emissions of HFCs from AC chiller from year 2000 to 2030:

Table 4-5: Emission of HFC from air conditioning chillers ($MtCO_2eq$)

Subsector	2000	2005	2010	2015	2020	2025	2030
AC Chillers	0.000	0.013	0.040	0.060	0.087	0.126	0.187

Figure 4-4: Emission of HFC from air conditioning chillers



The chillers was the smallest contributor to total HFC emissions from RAC sector in 2010, accounting for only 1 percent of total emissions, but it has also grown the fastest of all sectors. Due to predominance of CFCs in this sector around 2000, the increase in emissions of HFCs from the chillers is less compared to emissions between years 2010 to 2030. During the 30 years period from 2000 to 2030, the replacement of ODSs with HFCs will lead to increase in emission of HFCs in this sector. Emission of HFCs from this sector has grown between 2000 and 2010, from zero to 0.040 $MtCO_2eq$. As predicted, HFC-134a will dominate the sector post 2020 (till 2030) and HFC emissions are expected to increase by a factor of 4.7 between 2010 and 2030.

4.3 MOBILE AIR CONDITIONING (MAC) SECTOR

4.3.1 EQUIPMENT PRODUCTION, SALES & STOCK DATA-MAC

In Mexico, not all the operational automobiles are equipped with AC facility due to several reasons such as climatic conditions etc. It was established through survey that the cars sold with AC facility ranged from 15 percent (of the total sales) till 35 percent, in the time period 2005-2012. Hence, the data of MAC in cars was derived[26] applying the above mentioned ratio to sales figures. Total car production, sales & export data were taken from AMIA[27] (for the period 2005 to 2012).

It was found that under the large vehicle segment, all the long distance buses in Mexico are equipped with AC whereas only minor percentages of city buses have AC. Trucks and tractors equipped with ACs are almost zero, only higher class trucks imported from USA are having AC facility and the quantity is very low. Applying the above assumptions on the total production, sales & export data of large vehicles, sourced from ANPACT[28], the MAC in large vehicle units for production, sales and stock are calculated[29] for year 2009 to 2012.

The historical and projected growth rate[30] has been applied to the available production and sales data from the analysis (as mentioned above) to get the entire time series from 2000 to 2030. The production and sales data of MAC units, from 2000-2030, is presented in table below.

[26] Refer annexure V for the detailed analysis of MAC-car sector
[27] Mexican Automotive Industry Association (AMIA); http://www.amia.com.mx/ventasd.html
[28] National Association of Manufacturer of Buses, Trucks & Tractors (ANPACT); http://www.anpact.com.mx/
[29] Refer annexure VI for detailed analysis of MAC-large vehicle sector
[30] Please refer annex-XI for sectoral growth rates.

Table 4-6: MAC production data, by appliance system

Sub sector	2000	2005	2010	2015	2020	2025	2030
Car AC	1,010,603	1,248,958	1,979,661	2,447,016	3,024,704	3,738,772	4,621,415
Large Vehicle AC[31]	455	662	958	1,223	1,560	1,992	2,542

Table 4-7: MAC sales data, by appliance system

Sub sector	2000	2005	2010	2015	2020	2025	2030
Car AC	623,997	771,170	552,909	683,439	844,784	1044,219	1,290,737
Large Vehicle AC	867	1,263	2,044	2,609	3,329	4,249	5,423

As per Report on "**International Trade in used vehicles, the environmental consequences of NAFTA**", the total Vehicle Stock (Car segment) in Mexico in year 2008 was 24,800,000. The total vehicle stock for the consecutive years is calculated by adding sales data and subtracting number of vehicles disposed off in the same year from the stock figure of previous year. It was established through survey that the cars stock equipped with AC facility has grown from 20 percent to 36 percent in between year 2009 and 2012. The data on total stock of MAC-cars has been estimated by applying the percent growth mentioned above in the total stock of vehicles (refer to annex-V for detailed calculation). To cover the entire period from 2000 to 2030, the historical and projected growth rate has been applied to available stock data from the analysis.

The stock data on MAC-Large vehicle has been estimated by a back calculation method. A back-calculating procedure was used to estimate historical sales figures first, which are used in turn to build up the stock. The stock data of MAC units, from 2000-2030, is presented in the table below.

Table 4-8: MAC stock data, by appliance system

Sub sector	2000	2005	2010	2015	2020	2025	2030
Car AC	3,387,980	4,187,048	6,277,454	6,963,675	8,058,293	9,581,428	11,581,574
Large Vehicle AC	8,807	12,825	18,675	23,178	29,118	36,833	46,776

4.3.2 HFC BANK, DEMAND AND EMISSION-MAC SECTOR

According to the different stakeholders[32] from the sectors, CFCs had a large share in MAC sector (70 percent) in year 2000, followed by HFC-134a. Post phase-down activities of CFCs

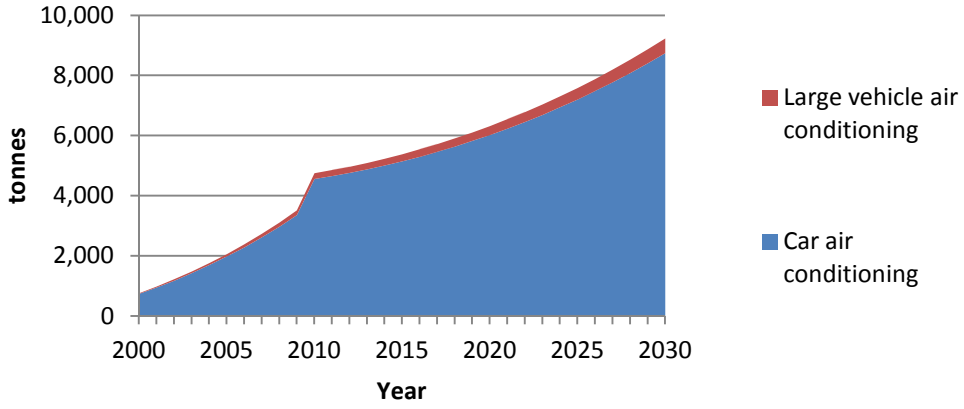
[31] The figure represents the total production of bus as AC equipped vehicles are almost zero for other categories of vehicles (Trucks, Trailers etc.)
[32] Car Manufacturer Nissan & General Motors

in the country, HFC-134a were readily substituted for CFCs. Also, the entire share (100 percent) of units sold in the same year was based on HFC-134a

Further, HFC-134a dominated the entire sector, as the stock and sales of units in MAC sector were entirely based on HFC-134a, and as predicted, will continue to do so till 2030.

Applying the above mentioned refrigerant distribution in MAC sector, the bank, demand and emission of HFCs have been estimated for the sector. The figure below depicts the trend of HFC bank from year 2000-2030:

Figure 4-5: HFC Bank in MAC sector, by appliance systems



The figure below shows the HFC demand in MAC sector, from year 2000-2030:

Figure 4-6: HFC Demand in MAC sector, by appliance system

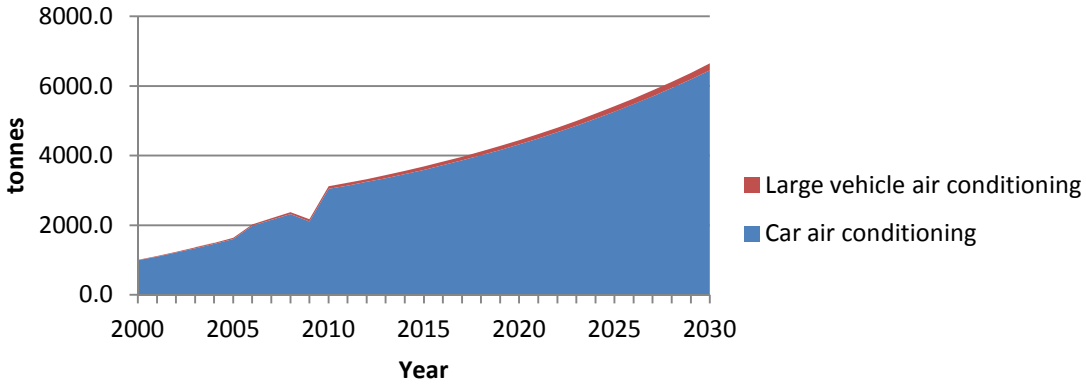
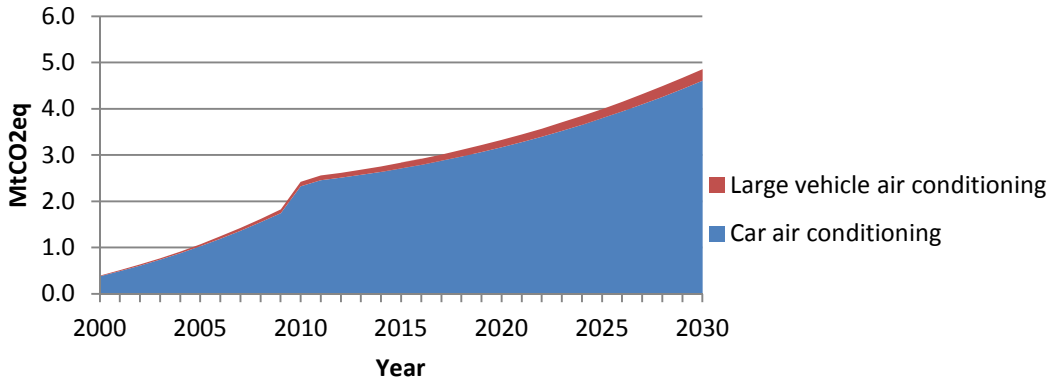


Table 4-9: HFC emissions from MAC sector, by appliance system ($MtCO_2eq$)

Sub sector	2000	2005	2010	2015	2020	2025	2030
Car AC	0.381	1.031	2.330	2.715	3.174	3.798	4.608
Large Vehicle AC	0.013	0.043	0.096	0.123	0.156	0.199	0.253
Total	**0.394**	**1.073**	**2.426**	**2.837**	**3.330**	**3.997**	**4.861**

Figure 4-7: Trend of HFC emissions from MAC sector, by appliance system



HFC-134a is the only refrigerant used in Mobile Air Conditioning (MAC) since the phase out of CFCs and it is expected that the same refrigerant would continue till 2030 under the BAU scenario. The Mobile air conditioning sector is the largest contributor to total HFC emission from RAC sector, accounting for 53 percent of emissions in 2010. The emission of HFCs in MAC sector has grown dramatically between 2000 and 2010 from 0.4 $MtCO_2eq$ to 2.4 $MtCO_2eq$. It is projected that HFC emission will increase by 100 percent over the period from 2010 to 2030, driven by strong demand of AC equipped vehicles in the country. In 2010, a sharp increase in emission is witnessed, which is due to massive increase in sales for the same year, i.e. 55 percent, as compared to previous year. In 2009, Mexico witnessed economic slowdown due to global recession, which affected each and every sector of market, including automobiles sectors, due to which the sales of vehicles went down.

In 2000, 100 percent sector emission is from the MAC- Car. However, emission from MAC-Large vehicle is growing slowly and it is expected that by 2030, it would constitute 5 percent of the total emission from the mobile AC sector.

4.4 DOMESTIC REFRIGERATION SECTOR

4.4.1 EQUIPMENT PRODUCTION, SALES & STOCK DATA-DOMESTIC REFRIGERATION SECTOR

The companies who shared production data during survey have combined share of over 60 percent of the total domestic production. The surveyed data has been upscaled to represent the entire market.

Sales data of equipment for the year 2007 to 2012 have been calculated based on production, import and export data. The import and export data have been sourced from the custom. To derive the stock figure, refrigerators per thousand household for various years was used for the assessment. Please refer to annexure-VII for further analysis of sales and stock data in the sector. The historical and projected growth rate has been applied to the derived sales and stock data to get the time series from 2000 to 2030. The table below provides the trend of production, sales & stock data of domestic refrigerator from 2000-2030:

Table 4-10: Equipment production, sales & stock data – domestic refrigerator

Data type	2000	2005	2010	2015	2020	2025	2030
Production	4,379,714	5,077,289	7,787,356	9,027,680	10,465,555	12,132,446	14,064,831
Sales	1,252,511	1,452,003	2,407,999	2,791,531	3,236,149	3,751,584	4,349,114
Stock	14,472,091	16,777,120	17,861,042	21,082,393	24,662,622	28,722,033	33,374,236

4.4.2 HFC BANK, DEMAND AND EMISSION-DOMESTIC REFRIGERATION SECTOR

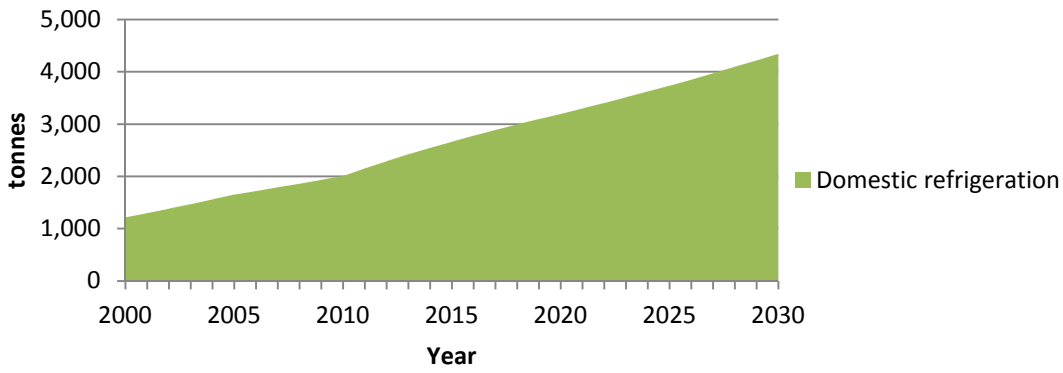
According to the HPMP and stakeholders[33] from the sector, HFC was introduced in domestic refrigeration sector as refrigerant in the early nineties. By 2000, about 40 percent of the stock of domestic refrigerators was based on CFC-12 refrigerant and rest was replaced with HFC-134a based systems. Following which, over 80 percent of the stock in 2010 (of domestic refrigeration sector) was based on HFC-134a. Also, entire sold units were based on HFC-134a in the same year.

Further, from survey, it was estimated that the natural refrigerant butane (HC-600a) would have a share of approximately 10 percent in overall sales of 2020, and further till 2030, with share of HFC-134 based units of 90 percent.

[33] Manufacturer “Whirlpool” & “Mabe”.

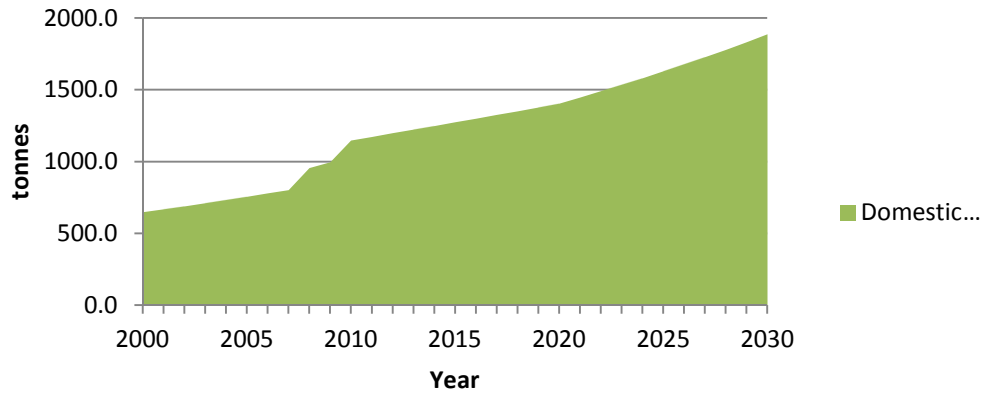
With this refrigerant distribution, the bank, demand and emission of HFCs have been estimated for the period from 2000 to 2030. Following figure provides the trend of HFC bank in this sector from the year 2000-2030:

Figure 4-8: HFC bank in domestic refrigerator



The figure below depicts demand trend of HFC in this sector from the year 2000 till 2030:

Figure 4-9: HFC demand in domestic refrigerator

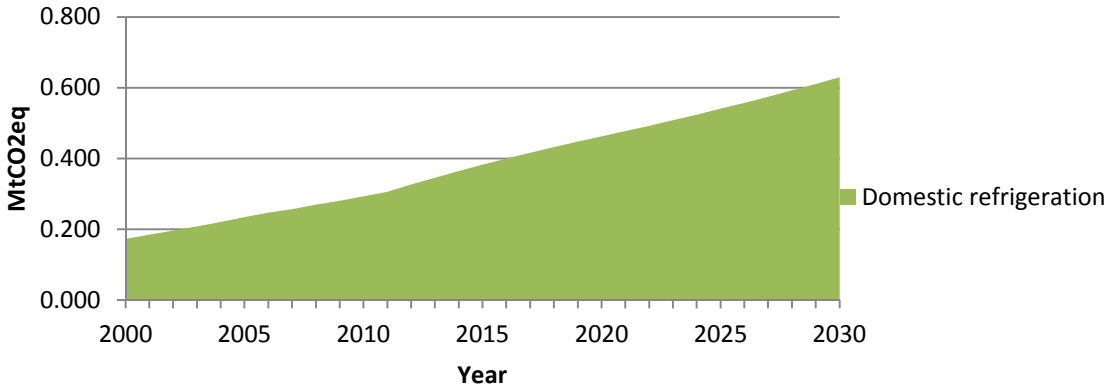


The trend of HFC emission from the domestic refrigeration sector has been presented in table below:

Table 4-11: HFC emissions from domestic refrigeration sector ($MtCO_2eq$)

Sub sector	2000	2005	2010	2015	2020	2025	2030
Domestic Refrigerator	0.173	0.235	0.293	0.383	0.463	0.541	0.630

Figure 4-10: Trend of HFC emissions from domestic refrigeration sector



This sector is the third largest contributor to total HFC emission from RAC sector, accounting for 6 percent of emissions in 2010. In 2000, the sector accounted for about 0.173 $MtCO_2eq$ of HFC emissions. Between 2000 and 2010, emissions from this sector have grown 70 percent, to about 0.293 $MtCO_2eq$. Emissions from this sector are projected to further increase by 115 percent untill 2030 to about 0.630 $MtCO_2eq$. The market growth rate of this sector has been consistent, which is why emissions are also increasing consistently from the year 2000 to 2030.

4.5 COMMERCIAL REFRIGERATION SECTOR

4.5.1 EQUIPMENT PRODUCTION, SALES & STOCK DATA-COMMERCIAL REFRIGERATION SECTOR

Of all type of equipments (stand-alone, condensing and centralized) in commercial refrigeration sector, production data could only be gathered for stand-alone units. The sales data for stand-alone units have been derived from the production, import and export data. The stock data of standalone units is calculated by analysis of retail sector in the country (refer to annex-VIII for detail analysis).

It was established from the survey that most of the condensing and centralized equipments are imported, and charged (with refrigerant) in the country itself. Further, a few units is assembled on site domestically. Since no database is available for such assembled units and assembly enterprises did not respond the questionnaires, domestic sales and stock data was calculated by retail sector analysis (based on discussion with retail stores and annual reports of companies operating retail chains. Please refer to annex-VIII for detail analysis). The results for production (only stand-alone units), sales and sock are presented in the table below:

Table 4-12: Production data-commercial refrigeration sector, by appliance system

Sub sector	2000	2005	2010	2015	2020	2025	2030
Stand-alone unit	122,416	229,401	456,703	735,525	1,184,570	1,907,762	3,072,469

Table 4-13: Sales data-commercial refrigeration sector, by appliance system

Sub sector	2000	2005	2010	2015	2020	2025	2030
Stand-alone unit	117,755	220,667	332,762	535,917	863,099	1,390,029	2,238,656
Condensing unit	179	311	1,247	1,878	2,827	4,257	6,410
Centralized system	28	42	149	223	333	498	744

Table 4-14: Stock data-commercial refrigeration sector, by appliance system

Sub sector	2000	2005	2010	2015	2020	2025	2030
Stand-alone unit	708,615	1327,904	2488,417	3,166.505	4,603,017	7,119,927	11,293,535
Condensing unit	5,980	10,396	14,172	17,712	23,863	33,760	49,153
Centralized system	965	1,443	1,851	2,327	3,121	4,373	6,297

4.5.2 HFC BANK AND EMISSION - COMMERCIAL REFRIGERATION SECTOR

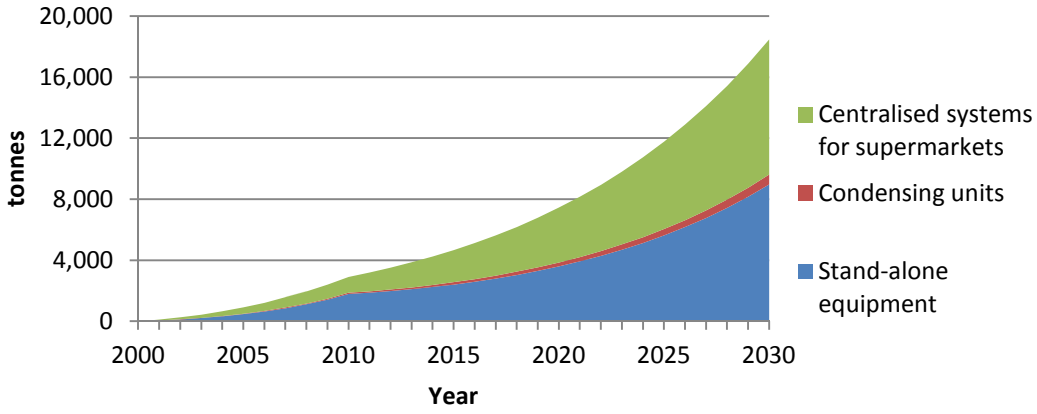
Accroding to “Groupo Refrigerantes”, the major company in servicing sector, stand-alone equipments, sold in year 2000 in the country, were entirely based on HFC-134a, whereas in the same year, the stock of all type of equipments in this sector - standalone, condensing, centralized were dominated by HCFC-22 (60 percent), followed by CFC-12 (40 percent).

However, in 2010, apart from standalone units (sales based on HFC-134a), sales unit for other two types of equipments were also based on 100 percent HFCs (HFC-404A). In the same year, of the total operational units of condensing and centralized units, 40 percent is based on HFC-404A and the rest on HFCF-22 (60 percent).

It is also projected that HFC consumption in this sector as refrigerant will grow up and by 2020, and further till 2030, the condensing and centralized units sold will be entirely based on HFC-404A, and standalone units will be based on HFC-134a.

The figure below represents the HFC bank trend in this sector from the year 2000-2030:

Figure 4-11: HFC Bank in Commercial Refrigeration sector

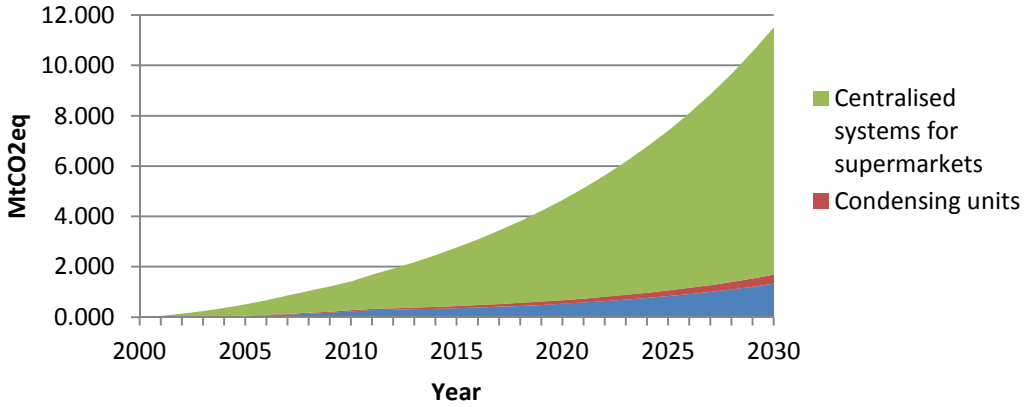


The table below provides the trend of HFC emissions from this sector for the year 2000-2030:

Table 4-15: HFC emissions from commercial refrigeration sector, by appliance system ($MtCO_2eq$)

Sub sector	2000	2005	2010	2015	2020	2025	2030
Stand-alone unit	0.001	0.061	0.242	0.365	0.540	0.841	1.337
Condensing unit	0.000	0.014	0.040	0.083	0.143	0.230	0.357
Centralized system	0.000	0.443	1.156	2.330	3.981	6.357	9.833
Total	**0.001**	**0.517**	**1.438**	**2.778**	**4.664**	**7.427**	**11.527**

Figure 4-12: Trend of HFC emissions from commercial refrigeration sector



The commercial refrigeration sector is the second largest contributor to the total HFC emission from the RAC sector. The emission from this sector was only 0.001 $MtCO_2eq$ in year 2000. In the year 2005, the major share of emissions was by centralized units (86

percent), followed by standalone units (12 percent) and condensing units (3 percent). Since centralized systems are charged with high amount of refrigerant during installation (up to 1500 kg of refrigerant) and show high leakage rates, the over-all emissions of centralized system in comparatively high. In the year 2010, due to increase in market size of stand-alone units, the share of emissions from these units for this year grew till 17 percent, with majority of emissions still by centralized units, i.e. 80 percent of net emissions. It is projected that by the year 2020, the share of emissions by centralized units will be the highest amongst all, i.e. 85 percent, followed by standalone units (12 percent) and condensing units (3 percent). The same trend is expected to continue till 2030.

4.6 TRANSPORT REFRIGERATION SECTOR

4.6.1 EQUIPMENT PRODUCTION, SALES AND STOCK DATA-TRANSPORT REFRIGERATION SECTOR

In Mexico, there is no production facility of transport refrigeration units; the country is dependent entirely on imports of these units. Hence, sales data has been derived for the year 2007 to 2012 from import and export data sourced from custom department. The stock data has been estimated by the back calculation method. Historical and projected growth rate has been applied to the available activity data to get the time period from 2000 to 2030. The table below provides the trend of sales data of transport refrigeration units, along with stock data, from 2000-2030:

Table 4-16: Sales & stock data of transport refrigeration sector

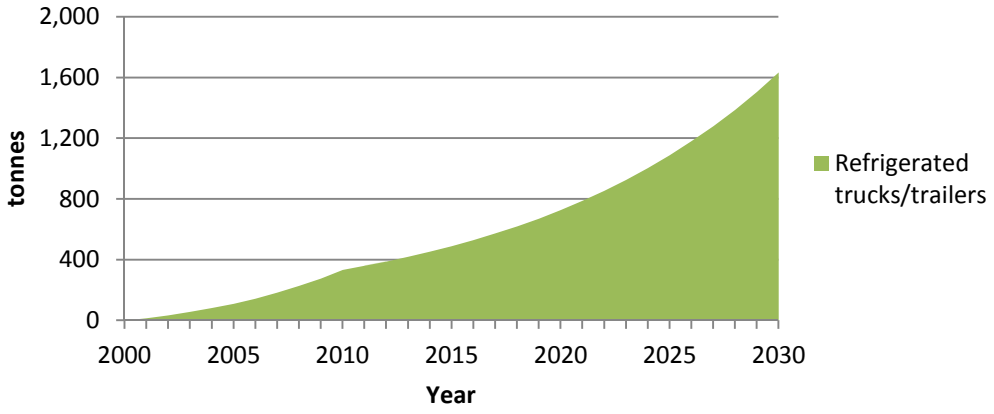
Data type	2000	2005	2010	2015	2020	2025	2030
Sales	3,567	5,370	6,832	10,287	15,490	23,324	35,119
Stock	27,041	40,710	61,288	79,260	110,121	159,280	235,207

4.6.2 HFC BANK AND EMISSION-TRANSPORT REFRIGERATION SECTOR

In the year 2000, HCFC-22 was the dominant refrigerant in this sector, with 100 percent share in sales as well as stock (of 2000). However, HFC-134a soon started replacing HCFC-22, and by 2010, just 16 percent of the units operational were based on HCFC-22. HFC-134a dominated the sector in 2010, with about 78 percent share of net transport refrigeration units operational in the country on this refrigerant. Also, 80 percent of units sold in 2010 were based on HFC-134a and the rest on HFC-404A. HFC-404A based units also got more popular in Mexico due to its advantages of high efficiency. About 8 percent of the units operational in 2010 were based on HFC-404A refrigerant.

As per the survey, it is projected that HFC-404A based units would dominate the sector (transport refrigeration) by 2020, and hence forward (till 2030). The share of HFC-134a based units (in operation and sold units) might decrease from current, i.e. about 70 percent, to less than 50 percent, and the rest of the equipments would be entirely based on HFC-404A refrigerant. The figure below provides the trend of HFC bank in this sector from 2000-2030:

Figure 4-13: HFC Bank in Transport Refrigeration sector

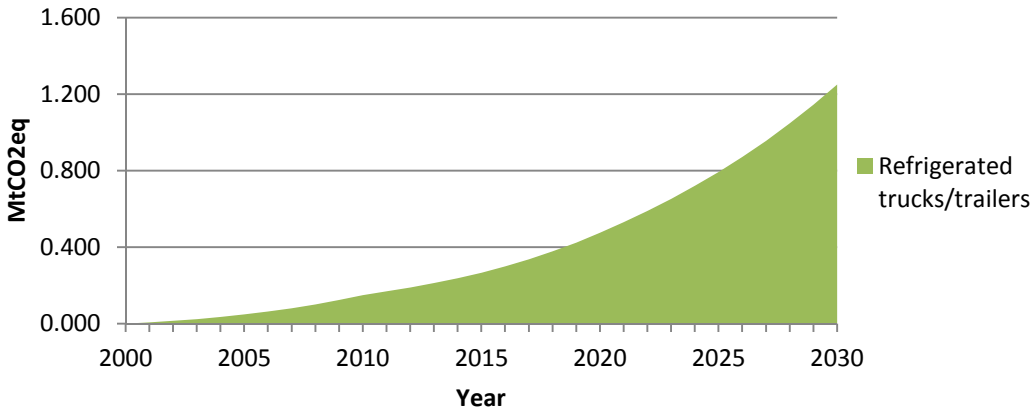


The table below provides the trend of emission of HFCs from transport refrigeration sector from 2000 to 2030.

Table 4-17: HFC emission from transport refrigeration sector ($MtCO_2eq$)

Sub sector	2000	2005	2010	2015	2020	2025	2030
Refrigerated trucks & trailers	0.000	0.049	0.149	0.267	0.475	0.794	1.250

Figure 4-14: Trend of HFC emission from transport refrigeration sector



The transport refrigeration sector is the fifth largest contributor under RAC sector to total HFC emission, accounting for 3 percent of emissions in year 2010. Between 2000 and 2010, the HFC emissions from the sector have grown from zero to 0.149$MtCO_2eq$. Emissions from this sector are projected to further increase and it will reach at 1.25 $MtCO_2eq$ in year 2030. Post 2015, a steep growth in the emission can be attributed to the rigorous growth in the sector.

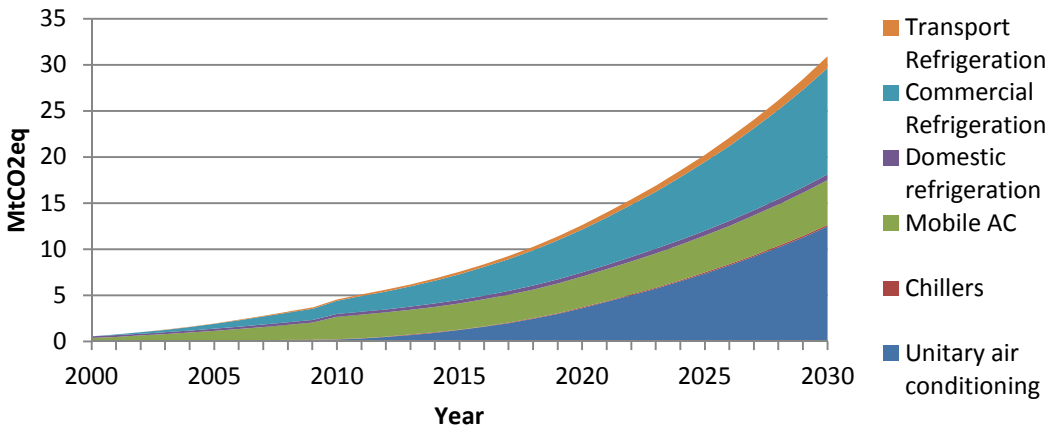
4.7 SUMMARY

Between 2000 and 2010, the total emissions of HFCs from the RAC sector grew by a factor of eight from about 0.57 to 4.58 $MtCO_2eq$; emissions are expected to reach 31 $MtCO_2eq$ by 2030 under the BAU scenario. Historical emissions of HFCs have increased from 0.39 to 2.43$MtCO_2eq$ in MAC sector, 0.001 to 1.44 $MtCO_2eq$ in commercial refrigeration sector, 0 to 0.234 MtCO2eq in unitary AC sector, 0 to 0.149 $MtCO_2eq$ in transport refrigeration sector, 0.173 to 0.294 $MtCO_2eq$ in domestic refrigeration sector and 0 to 0.0396 $MtCO_2eq$ in chillers from 2000 to 2010.

Table 4-18: Total HFC emissions, by sectors ($MtCO_2eq$) from 2000 to 2030

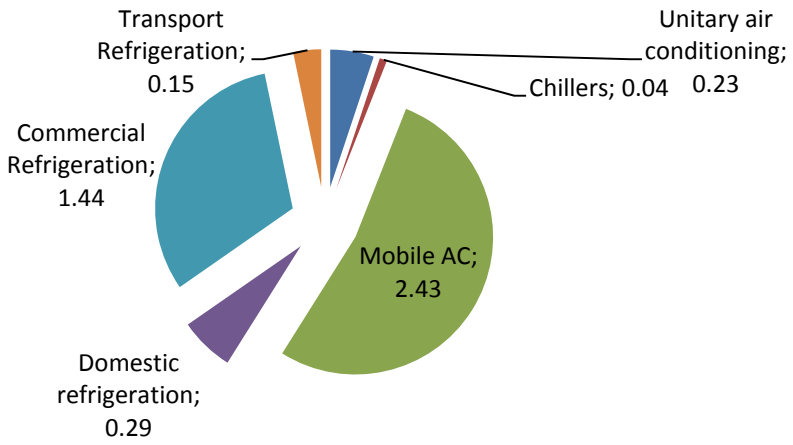
Sector	2000	2005	2010	2015	2020	2025	2030
Unitary air conditioning	0.000	0.090	0.234	1.262	3.634	7.382	12.469
Chillers	0.000	0.013	0.040	0.060	0.087	0.126	0.187
Mobile AC	0.394	1.073	2.426	2.837	3.330	3.997	4.861
Domestic refrigeration	0.173	0.235	0.293	0.383	0.463	0.541	0.630
Commercial Refrigeration	0.001	0.517	1.438	2.778	4.664	7.427	11.527
Transport Refrigeration	0.000	0.049	0.149	0.267	0.475	0.794	1.250
Total	**0.568**	**1.977**	**4.580**	**7.587**	**12.653**	**20.267**	**30.924**

Figure 4-15: Trend of HFC emissions, by subsectors under RAC sector



Emissions of HFCs are projected to increase in unitary AC from 0.234 to 12.47 $MtCO_2eq$, in transport refrigeration sector from 0.149 to 1.25 $MtCO_2eq$, in commercial refrigeration sector from 0.144 to 11.53 $MtCO_2eq$, in chillers from 0.0396 to 0.1868 $MtCO_2eq$, in domestic refrigeration sector from 0.294 to 0.630 $MtCO_2eq$ in MAC sector from 2.43 to 4.86 $MtCO_2eq$ from 2010 to 2030.

Figure 4-16: Share of HFC emissions, by subsectors under RAC sector in year 2010



In year 2010, the MAC sector accounts highest emission of 53 percent, followed by commercial refrigeration sector (31 percent), domestic refrigeration sector (6 percent), unitary AC sector (5 percent), transport refrigeration sector (3 percent) and chillers (1 percent). However, it is projected to increase emission from unitary AC sector at a faster rate contributing to 40 percent of the total emission in 2030.

5 QUALITY ASSURANCE AND QUALITY CONTROL (QA & QC) PROCESS

As part of QC procedures, the following information are gathered and archived.

- Assumptions and criteria for selection of activity data and emission factors;
- Emission factors used, including references to the IPCC document for default factors or to published references or other documentation for emission factors used in tier-2 method;
- Activity data or sufficient information to enable activity data to be traced to the referenced source
- Information on the uncertainty associated with activity data and emission factors;
- Rationale for choice of methods;

- Worksheets and interim calculations for source category estimates and aggregated estimates and any re-calculations of previous estimates;
- Final inventory report and any analysis of trends from previous years;

The following provides the outline of the QA & QC process applied in analyzing the data collected for the project activity.

5.1 QC PROCEDURE

5.1.1 CROSS-CHECK OF ACTIVITY DATA

Production of CFCs and HCFCs: At present, HCFC-22 is the only F-gas produced in the country. The country stopped production of CFCs in the year 2005. The CFC production data has been sourced from the data recorded by SEMARNAT and the data has been cross verified with the official data reported to the Ozone secretariat. HCFC-22 production data has been sourced from companies. The production data provided by companies has been cross checked with the data reported to the Ozone secretariat.

Import and Export of CFCs, HCFCs and HFCs: The import and export data of CFCs and HCFCs has been sourced from the records of SEMARNAT. Comparison of import and export of CFCs and HCFCs data recorded by SEMARNAT has been carried out with the data reported in HPMP. No deviation has been observed. The import and export of HFCs has been gathered from two sources: the first is company data and the second is Custom data. A less than 5 percent deviation has been observed between company and custom data. Customs data has been considered for those companies who have not shared their data during market survey.

Equipment Production, Import & Export data: A QC check of the aggregated Production, Import and Export data for few sectors have been carried out against various national statistics available for the sector. The import and export data of Unitary air-conditioning sector has been taken from Custom department. The QC check of this data has been carried out by comparing the custom data with the data mentioned in the HPMP and US Commercial service report on Mexico Air conditioning sector, August 2011.

For the MAC sector, the company provided data has been cross checked with the data sourced from the associations i.e. AMIA and ANPACT. Since company has provided only one year data and variation between company data and association data is less than 1 percent, association data was used for analysis.

The activity data (Production, Import and Export data) for a particular year is compared with previous year's data for the sector being evaluated. Activity data for most sectors tend to exhibit relatively consistent changes from year to year without sharp increases or decreases. If the national activity data for any year diverge greatly from the historical trend, the activity data was checked for errors. If the general mathematical checks do not reveal errors, the characteristics of the sector were investigated and the change was identified.

Equipment Sales & Stock data: Since sales data has been derived from the production, Import and Export data, no further QC check has been made on sales data.

To calculate the stock data of equipments in the country, several methods were followed: the first, based on population and equipment ownership; second, based on secondary source and third, back-calculating procedure is used to estimate historical sales figures, which are used in turn to build up the stock. The results obtained from these methods were compared with the stock figure for the year 2012 gathered during survey. The method which results in lesser deviation from the survey data was adopted, which was again verified by experts.

5.1.2 EMISSION FACTORS & EMISSIONS

The emission factor of the equipment are either sourced from HFC Inventory and Projection tool, IPCC 1997 or based on discussion with sectoral experts. The emission factors are compared with various technical reports published by Technology and Economic Assessment Panel (TEAP) Report, UNEP.

The refrigerant charge in various equipments is majorly sourced from equipment manufacturers and cross verified with the experts and research reports available in public domains. The equipment lifetime data has been sourced from discussion with sectoral experts and it is compared with the various technical reports available in public domain.

The following QC check methods were adopted for emissions:

- The consumption trend of various gases was seen to be affected by other factors such as recession, inflation and other social and economic factors. So, in analysis of the trend has been linked to these factors which generally are dominant in the market and directly affect purchasing ability of the customer. Also, cross referencing is done in such scenarios.

- The consumption trend of CFCs and HCFCs are compared with the consumption trend shown in the HPMP and consumption data reported to MLF. Moreover, the

HFC emission has been compared with the emission reported in the National Communication to UNFCCC.

The refrigerant distribution considered for emission estimates has been verified with the market overview provided by the importers and distributors. The two major distributors of HFCs in Mexico i.e. Dupont and Quimobasicos have shared information on the overall market size and about their customers with approximate consumption. Dupont majorly supplies gases to OEM sector where as Quimobasicos has strong presence in after sale market.

5.1.3 HISTORICAL AND PROJECTED GROWTH RATE

Country-specific annual growth rates have been applied to the emission estimates to complete the historical as well as projected time series of emissions. If reliable sectoral growth rate is not available, GDP growth rate was used for that sector. GDP growth rate (per capita; historic and present) has been sourced from reliable data centres and it is compared with the data published by the World Bank, IMF etc.

5.1.4 UNCERTAINTIES

A high degree of uncertainty is associated with the equipment Stock data of air conditioning chillers as huge gap between HFC consumption (emission as per tier 1a approach) and HFC emission as per tier 2 approaches has been observed for this subsector. The prime reason for this gap may the underestimation of stock numbers. Further, no QC check was made to this data.

5.2 QA PROCEDURE

As per QA process, the peer review of the inventory was conducted in two levels: Internal Audit Process & External Audit Process.

Internal review Process: Consultant worked on the inventory has a well-defined internal audit process which is managed by Quality Assurance and Quality Control Team engaged in the project. The work was led by QA/QC team of the consultant along with experts from GIZ. To achieve the objective of maintaining and enhancing quality, the team leveraged both internal resources and (also sometimes) external resources to benchmark, and constantly re-engineer processes and procedures before they become standard practice. Quality Assurance Team consists of a core quality team from GIZ

and EVI, which brings a very strong Quality and Functional experience. The team collectively has an experience of 30 man years on working on projects for multilateral agencies. Internal audits were carried out periodically and result in an indication of overall quality of data collation being delivered.

External review process: All the data received from equipment manufacturing companies has been reviewed by the sectoral experts. ING Gildardo Yaanez from Groupo Refrigerantes (Mexico) was consulted for review of RAC equipment servicing sector data. Mr. Horacio de la Rosa M. from DUPONT (Mexico) and Mr. Antonio Nieto from Puntual Media (Mexico), editor for a leading HVAC magazine was consulted for opinions on sectoral distribution of CFCs, HCFCs and HFCs in various sectors. In addition to this, the activity data and emission estimates were presented in a national stakeholder workshop conducted on 9th December 2013 in Mexico city. The workshop was used as a platform to gather stakeholders and expert's feedback & views on data presented. Further, Agustine Sanchez Guevara (National Ozone Officer, Mexico) and R. Alan Bastida Morales (Project Officer, Ozone cell, SEMARNAT) were consulted to review the report. The purpose of this review was to check data quality and consistency. Changes recommended in the review process were being incorporated in the report.

ANNEX-I: LEGISLATIVE AND POLICY FRAMEWORK ANALYSIS

REVIEW OF THE ODS PHASE-OUT PROJECTS IN THE COUNTRY

REVIEW OF NATIONAL CFC PHASE-OUT PLAN

Mexico has always been committed to protecting earth's stratospheric ozone layer. It was the first Article 5 country to ratify the Montreal Protocol. To comply with it, various agreements were signed between producers and importers of Ozone Depleting Substances (ODS), like Chlorofluorocarbons (CFCs), Halons and Carbon tetrachloride. A National Ozone Unit (NOU) was set up under Secretariat of Environment and Natural Resources (SEMARNAT), Mexico's environment ministry. In collaboration with United Nation Industrial Development Organization (UNIDO), SEMARNAT drafted the National CFC Phase-out Plan in the year 1989.

Consumption trend of ODS in Mexico, as of 1989:

Of five CFCs listed in Group I of the substances controlled under the Montreal Protocol, two CFCs- CFC 11 and CFC 12 were domestically produced in Mexico. Other CFCs- CFC-113 and CFC-114 were entirely imported, and CFC-115 was neither produced nor imported in the country. CFC-11 and CFC-12 were produced in three production facility in the country as of 1989, with no new plant in construction, producing just 35 percent of their plant capacity, each. All the plants shifted to manufacturing of HCFC-22 shortly after the implementation of the protocol in the country. The consumption of overall CFCs in the country as of 1989 was 8,128 Metric Tons (TONNES), which was predicted to grow at 2.2 percent annually (in absence of protocol restrictions). In 1989, the most consumed CFC was CFC-12 with about 68.8% share (5578 TONNES), followed by CFC-11 (25.9% i.e. 2106 TONNES), CFC-113 (4.4% i.e. 200 TONNES) and CFC-115 (0.5% i.e. 44 TONNES). The most dominating sector which consumed the CFCs was Refrigeration Sector with about 59% share i.e. 4796 TONNES, followed by Foam Manufacturing- 20% i.e. 1629 TONNES and Aerosol- 12.2% i.e. 993, and the rest in Solvent Cleaning and Sterilizing.

The Halons, categorized in Group II of controlled substances under the Montreal Protocol, were both imported. Only two Halons- Halon-1211 and Halon-1302 were being used in the country with about 260 TONNES of consumption as of 1989.

Two other ODS restricted under the Montreal Protocol are Methyl Chloroform (MC) and Carbon Tetrachloride (CTC), The consumption of these in the country as of 1989 was about 8000-1000 TONNES and 9200 TONNES respectively. 45-50 percent of Carbon tetrachloride was produced domestically.

Overview of the National CFC Phase-out Plan:

When the protocol was ratified, an estimate of 64.4 million USD to 118.7 million USD was calculated which would be required to phase out CFCs, Halons, CTC and MC completely. Following is an overview of the Country Programme:

- Summarizing the consumption pattern of the controlled substances
- Outline the activities Government of Mexico has already taken and nature of the future actions to comply with the requirements of the Montreal Protocol
- Propose a timeline and budget for activities to be supported by the Multilateral Fund.

Following was proposed timeline to comply with the requirements of the Montreal Protocol:

- Freezing 1990 consumption at 1996's consumption level,
- Reducing CFC consumption by 20 percent by year 2003,
- Reducing CFC consumption by additional 30 percent by 2008,
- Phasing out completely all ODS by 2010.

Highlights of agreement between Mexico and the Executive Committee for the phase-out of ODS:

In the forty-second Meeting of the Executive Committee, the agreement between the Government of Mexico's National Ozone Unit (under SEMARNAT) and the Executive Agency was approved with UNIDO as the lead implementing agency. In the forty-fifth Meeting of the Executive Committee, the agreement was amended, such as to include the World Bank as the cooperating implementing agency.

- A total principle of 31.85 million USD was approved by the Executive Committee in funding for total permanent closure of CFC (all Group I CFCs listed under the Montreal Protocol) production capacity and development of capacity to produce CFC alternatives. The principle also included 0.85 million USD for the project management in Mexico. Following timeline was framed as a part of the agreement for Mexican CFC production capacity:

Year	2003	2004	2005	2006	2007	2008	2009	2010	Total
Maximum	12,355	12,355	6,739	6,739	2,808	2,808	2,808	0[35]	46,612

allowable production (metric tonnes)[34]									
Maximum production levels agreed (metric tonnes)	22,000[36]			0	0	0	0	0	22,000
MLF funding (US$ millions)	5.3	10.7	4	11.85	0	0	0	0	31.85
Agency fees (US$)	397,500	802,500	300,000	888,750	0	0	0	0	2,388,750

Source: The Multilateral Fund Secretariat

- Following timeline lists outs the Overall CFC Phase-out targets and funding:

Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Montreal Protocol reduction schedule (ODP tonnes)	4,625	2,312	2,312	694	694	694	0
1. Max allowable total consumption of CFCs (ODP tonnes)[37]	4,403	2,205	150	50	50	50	0
2. Total demand of CFCs (ODP tonnes)[38]	1,932	1,667	1,190	725	425	195	1403
3. Reduction from on-going projects (ODP tonnes)[39]	40	165	77	15	0	0	0
4. New reduction under plan (ODP tonnes)[40]	0	100	400	450	300	230	55
5. Total annual reduction (ODP tonnes)	40	265	477	465	300	230	55

[35] Save for any CFC production that may be agreed by the Parties to meet essential uses for Mexico.
[34] Including 10% of its baseline production for meeting the basic domestic needs of other Article 5 countries.

[36] Total maximum production for the years 2003 to 2005. It is understood that Mexico may not exceed its allowable production limit during any one year.
[37] Article 7 data (production – export + import) constitute the target under this Agreement.

[38] Estimated
[39] Save for essential uses.

[40] Reduction of the demand for virgin CFCs in all consumption sectors from the estimated CFC total demand.

6. Stockpile (ODP tonnes)[41]	2,815	3,353	2,314	1,639	1,264	1,119	979
7. Lead I.A. agreed funding (US $)	3,517,000	4,478,000	299,500	0	0	0	0
8. Lead I.A. support costs (US $)	263,775	335,850	22,463	0	0	0	0
9. Co-operating I.A. agreed funding (US $)	0	500,000	0	0	0	0	0
10. Co-operating I.A. support costs (US $)	0	37,500	0	0	0	0	0
11. Total agreed funding (US $)	3,517,000	4,978,000	299,500	0	0	0	0

Source- The Multilateral Fund Secretariat

- The country had to ensure the timeline is monitored for the phase-out activities listed under the Agreement. The agreement also mandated independent technical audits administered by the Implementing Agency, which may be directed by the Executive Committee, to verify the CFC production level as agreed above.
- The Executive Committee allowed the flexibility in using the agreed funds in any way Mexico believed will achieve the smoothest possible phase-out of CFCs, as long as Mexico remained consistent with this Agreement.
- Mexico was required to meet the reduction requirements outlined in the timeline, failing to which it was agreed that the Implementing Agency and the Multilateral Fund can withhold funding for the subsequent tranche until the required reductions were met.
- Mexico was required to cooperate and comply with any reasonable request of the Executive Committee and the two implementing agencies, and will also provide access to all the necessary information to comply with the Agreement.

REVIEW OF NATIONAL HCFC PHASE-OUT PLAN

Mexico is a fairly developed country with a huge economy which ranks 84th in the world (2010 estimate). Industries contribute to about 62.5% of its economy[42]. So, it has a substantial consumption of ozone-depleting substances, of which many are also Green House Gases (GHGs). Nevertheless, Mexico has always been on forefront in implementing ODS phase-out plans in accordance with the Montreal Protocol. Now, Mexico is investing in a number of projects to assist industries in monitoring their HCFCs consumption, so as to comply with the Montreal protocol. UNIDO, as a lead implementing agency, with support from UNDP, prepared and submitted Mexico's 'Stage-1 HPMP', on behalf of the Government

[41] For information purposes
[42] The World Fact book, Central Intelligence Agency (CIA) of United States of America (USA)

of Mexico, in the 64th meeting of Executive Committee of the Multilateral Fund (MLF). The total cost of Mexico's Stage-1 HPMP is estimated to be USD 27,385,346 to phase-out 613.1 ODP tonnes of HCFC, which also includes support cost (of UNDP to assist) and project cost to phase out 11.1 ODP tonnes of HCFC, as approved in 63rd MOP and 55.7 ODP, as approved in 59th MOP. The reduction in HCFC is planned in accordance to meet the Montreal Protocol's compliance target of 10% reduction by 2015, and to contribute to 35% reductions target by 2020. Baseline for the compliance targets was set to 1148.80 ODP which was established based on surveys conducted by UNIDO and UNDP. UNDP established production and consumption patterns of HCFCs in foam sector, whereas UNIDO developed the data based on surveys from HCFCs used in RAC, solvent, fire extinguishers, equipment servicing HCFC production sectors and other major sectors.

In accordance with MOP's decision XIX/16 (2007), Mexico is focusing on an accelerated phase-out plan of HCFCs, prioritizing HCFCs with highest ODP values first. This includes in cooperating strategies like:

- Controlling all import and export of HCFCs in accordance with the compliance targets.
- Allocating separate quota to foreign-owned and local-owned enterprises in simultaneous phase-out HCFCs.
- Banning the new HCFC based plants and production unit and gradually limiting import of HCFC based equipments.
- Spreading public awareness about the effects of HCFCs.

Accordingly, Mexico will achieve its freeze target in 2013, and make 10% reductions by 2015 followed by reduction of 35% in the consumption of HCFCs by 2020, from its baseline.

ANALYSIS OF THE EXISTING CLIMATE CHANGE REGULATIONS AND POLICIES

Mexico is not bound by Annex 1 of the Kyoto Protocol, but it is significantly advancing towards sustainable development by lowering its carbon emissions and establishing policies and regulations for various mitigation strategies. Following are some of the major developments in recent years:

- In 2007, Mexico launched a document titled *National Strategy and Climate Change* (ENAC) recognizing climate change as world's biggest challenge today. The document specifies various adaptation and mitigation measures Mexico needs to incorporate to tackle the climate change.

- Soon after ENAC was launched, *Special Programme on Climate Change* (PECC) was established. The programme defined short term and long term emissions reduction plans, i.e., short term emission reduction of 51 tonnes CO2e/year for 2009-2012 and ultimately 20 percent reduction below Business As Usual (BAU) by 2020; long term emission reduction of 50% of 2000 levels, by 2050. Currently the targets are being revised for 2020.
- Various local plans are also being framed, for instance- Mexico City Plan. Mexico's largest city passed a *Climate Action Programme* aimed at reducing 7 Tonnes CO2 emissions (relative of levels of 2008) during 2008-2012. As of July, 2011, Mexico City met with 82 percent of its set target i.e. 5.7 Tonnes CO2 emission reductions.
- In 2008, Government of Mexico (GOM) passed law on *Renewable Energy Use and Financing Transition* (LAERFTE) aimed at empowering *National Electricity Commission* (NEC) to weigh Renewable sources of energy amongst conventional sources of energy.
- In 2010, GOM published a document focusing on *Reducing Emissions from Deforestation and Forest Degradation* (REDD) within the country. Mexico is now working towards establishing REDD offset programmes in collaboration with Brazil and California through the country.
- In December, 2010, in a UN climate conference conducted in Cancun, Mexico, pledges were put forward for the first time to reduce national carbon emissions by various developed and developing countries. According to Cancun Agreement-I, Mexico pledged to reduce absolute emissions by 30 percent (in BAU scenario). This step is a much more effective response to climate change as all major countries were involved in the agreement.
- In 2012, the former Mexican president *Calderon* signed *Mexico Global Climate Change Programme*, a five year USD 70 million bilateral agreement between Government of Mexico and USA, aimed to advance Mexico's green economy by funding for various programmes aimed towards reducing emissions and conserving forests.

In April 2012, Mexico congress passed General Climate Change Law, which was signed by both the houses by majority of votes and came into law in June 2012. The law featured establishment of a high level climate commission which is authorized to set-up a domestic Climate Market. The marker can include international transactions between Mexico and any other countries which enter into emissions trading agreement with it. The law also presents a scheme to develop domestic *Emission Trading System* (ETS), which is not mandatory. The law also addresses the goals for emissions reduction and development of renewable sources of energy, and decreasing dependence on fossil fuels, by developing a framework for climate change adaptation and mitigation which currently will not be mandatory.

HFCS IN THE CURRENT NATIONAL COMMUNICATION TO THE UNFCCC

At present, the climate change represents the greatest environmental challenge globally, and Government of Mexico is determined to counter this challenge by adapting newer and improvised technologies that will reduce the negative impact on global climate, and by mitigation through reduction in GHGs emission. In the Fifth National Communication to UNFCCC, submitted on 5th December, 2012, Mexico presented its National Development Plan (2007-2012). For the first time Mexico's 'National Development Plan' explicitly integrated 'Climate Change' into its agendas which established various objectives: strategies and priorities that could direct the federal government actions (through Environment Sustainability Development Policy).

As an outcome of Fifth National Communication, GHG inventory for five sectors have been prepared: energy, industrial processes, agriculture, land use (and forestry) and waste for the period of 1990-2009 on annual basis, with priorities given mainly to energy and waste sectors as they have been the sectors with the greatest GHGs emissions in the year 2006. Each category has been analyzed in terms of emissions based on the basis of six key GHGs, HFCs being one of them. The emission from HFCs in year 2010 as indicated in the fifth communication to UNFCCC was 18,692.3 Gg of CO_2 eq. The inventory will further help to study and establish methodologies to lower the emissions by HFCs.

ANALYSIS OF EXISTING NAMA PROJECTS IN THE COUNTRY:

In the climate negotiations in Copenhagen and Cancun, Germany and the United Kingdom (UK) together with other industrialized countries committed to mobilise $100 billion international climate finance per year by 2020. To source this finance, the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the UK Department of Energy and Climate Change (DECC) therefore jointly set up the "NAMA Facility". This Facility is designed to support developing countries that show initiative on tackling climate change problem and want to implement Nationally Appropriate Mitigating Actions (NAMA). NAMAs have developed from the process under the United Nations Framework Convention on Climate Change (UNFCCC) to focus mitigation planning and implementation at the country level. Transformational NAMAs are projects, policies, or programmes that shift a technology or sector in a country onto a low-carbon development trajectory. Developing countries are preparing NAMAs as part of their national strategies.

The number of NAMAs is growing which signifies that NAMAs are becoming an increasingly attractive vehicle for developing countries looking to attract climate finance for low-carbon development activities. As per Ecofys NAMA database, currently 66 NAMAs are in different stages. Latin America is most advanced not only in terms of the overall number of NAMAs, but also in terms of the amount of NAMAs which have moved closest towards implementation, such as the Sustainable Housing NAMA in Mexico, which is planned to start pilot implementation in 2013. Mexico has already begun establishing Nationally Appropriate Mitigation Actions (NAMAs) with regards to the Bali Roadmap. Pilot studies on NAMAs in the Housing sector and Transport sector are already being carried out in Mexico.The Ecofys NAMA database currently holds information on 15 NAMAs, the Sustainable Housing NAMA in Mexico, which is planned to start pilot implementation in 2013.

In the following tables, Mexico's NAMA has been analyzed based on various sectors. The detail has been sourced from Ecofys NAMA database:

NAMA in Building Sector:

NAMA	Current Stage	Subsector	Objectives
Domestic Refrigerators NAMA	Concept		Decrease emissions from refrigeration through efficiency increase and phase-out of HFCs in the sector
NAMA in the urban residential sector	Concept	Energy efficiency	Enhance opportunities for mitigation and its co-benefits in services for households (lighting, water supply, waste).
NAMA for sustainable housing in Mexico	Implementation		To extend penetration of basic efficiency standards to the entire new housing market in Mexico and upgrade efficiency standards to more ambitious levels.
NAMA for electric appliances in Mexico	Not known		Increase energy efficiency and water savings in sinks and toilets.

NAMA in Energy Supply Sector:

NAMA	Current Stage	Subsector	Objectives
Small and Medium Business (SME) NAMA	Concept	Energy efficiency	To promote energy efficiency in Mexican SMEs through equipment substitutions (electrical and thermal)
NAMA in the Mexican oil industry	Not known	Refining and energy production	Improve measures to prevent fugitive emissions and develop baselines to support identify appropriate mitigation measures in the sector.
NAMA for solar electricity in Mexico	Not known	Renewable energy (solar)	Increase generation of solar electricity
NAMA for the sustainable use and disposal of the biomass in Mexico, turning it into renewable energy	Feasibility study	Renewable energy (biomass)	To incorporation and compliance to a voluntary environmental program of the Tequila industry for the sustainable disposition of vinazas, bagasse and agave leaf, considered In the long term, the NAMA will incorporate to the voluntary environmental program, other biomasses considered a waste besides the Agave. Today as a waste, Replacement of fossil fuel in the Mexican industry with renewable biofuel derived from the agave, promoting the installation and operation of biomass based cogeneration systems that use agave waste from the Tequila industry, Accreditation of emissions reduction in the production of Tequila through the distinctive "Holohuella CO2" (hologram-carbon footprint) as a physical proof to adhere to the bottle.

NAMA in Industry Sector:

NAMA	Current Stage	Subsector	Objectives
NAMA in the Mexican mining sector	Not known		To implement energy efficiency measures, monitor process emissions and design a low emission development strategy for this industrial sector.
NAMA in the Mexican cement sector	Not known	Process emissions	Replace fuels by solid waste in cement production and increase clinker ratio of the final product
NAMA in the Mexican chemical industry	Not known	Process emissions	To implement energy efficiency measures, monitor process emissions and design a low emission development strategy for soaps and synthetic waxes sector.

NAMA in Transport Sector:

NAMA	Current Stage	Subsector	Objectives
Freight transport NAMA	Not known		Renovate freight transport fleet and adopt strategies, technologies and best practice in this transport mode, building on existing projects.
NAMA based on the Federal Mass Transit Programme	Proposal		To provide complementary support to the federal mass transit programme to undertake capacity building and to improve internal processes to speed up project development.
Enhancing vehicle renovation in Mexico	Feasibility study		Support of the national vehicle renovation program
Optimization of the conventional bus system in Mexico City	Feasibility study	Public transport	Optimization of the conventional bus system in the valley of Mexico

ANNEX-V: ESTIMATION OF SALES AND STOCK DATA FOR MAC-CAR AIR-CONDITIONING SECTOR

Mexico is a central hub of several vehicle manufacturers which have widespread presence globally. Various companies like General Motors, Chrysler, Nissan, Honda, Volkswagen, Toyota, Ford Motors, Fiat have large production facilities in Mexico because of the factors like cheap labour, land and other resources required. Table gives yearly (2005-2012) analysis of Vehicles manufactures, sold, imported and exported by these companies in Mexico. The Sales, Production and export data has been sourced from AMIA, AC monthly bulletin and Import data is calculated from Domestic Sales, Export and Production data.

Table 0-1: Data on Vehicle Production, Import, Export and Sales in Mexico

Year	Domestic sales	Import	Production	Export
2005	1,125,971	708,558	1,603,759	1,186,346
2006	1,157,356	715,479	1,978,645	1,536,768
2007	1,074,342	668,208	2,019,447	1,613,313
2008	1,019,153	579,195	2,101,361	1,661,403
2009	723,423	439,229	1,507,527	1,223,333
2010	834,024	432,430	2,260,776	1,859,182
2011	905,886	478,479	2,557,550	2,130,143
2012	987,747	508,066	2,884,869	2,405,188

Table: Assumptions considered

Parameters	Value	Reference/Remarks
% of Vehicles Exported with AC	100%	As per discussions with Dupont (Major Importer and provides major quantities to OEMs, Grupo Refrigerantes (Major company in Servicing Sector), SEMARNAT (Ministry of Environment in Mexico) and Car Manufacturers (Nissan, General Motors).
% of Vehicles sold in domestic market with AC		
Year-2005	15%	Based on discussions with Dupont (Major Importer and provides major quantities to OEMs, Grupo Refrigerantes (Major company in Servicing Sector), SEMARNAT (Ministry of Environment in Mexico) and Car Manufacturers (Nissan, General Motors)
Year-2006	20%	
Year-2007	20%	
Year-2008	20%	
Year-2009	20%	
Year-2010	30%	
Year-2011	30%	
Year-2012	35%	
Percentage of vehicles in stock		

with A/C		
Year-2009	20%	The value from the year 2009 is based on discussions with Dupont (Major Importer and provides major quantities to OEMs, Grupo Refrigerantes (Major company in Servicing Sector), SEMARNAT (Ministry of Environment in Mexico) and Car Manufacturers (Nissan, General Motors); the following values are calculated according to what realistically can be achieved.
Year-2010	25%	
Year-2011	31%	
Year-2012	36%	
% of vehicles Charged per annaum during servicing	35%	Based on discussions with Dupont (Major Importer and provides major quantities to OEMs, Grupo Refrigerantes (Major company in Servicing Sector), SEMARNAT (Ministry of Environment in Mexico) and Car Manufacturers (Nissan, General Motors). This has been calculated taking 5 times refilling in 13 years of life time of vehicle.
% of Vehicles disposed off per annum	3%	Considering 14 years life time of vehicle
Vehicle Ownership Per 1000 person in Mexico	191	World Bank data. This is for year 2010. http://data.worldbank.org/indicator/IS.VEH.PCAR.P3
Total Population in Mexico	112300000	As per 2010 census data.
Population growth per annum in Mexico from 2010 to 2012	1.20%	World Bank data. http://data.worldbank.org/indicator/SP.POP.GROW
Total Vehicle Stock in Mexico in year 2008	24800000	Report on International Trade in used vehicles, the environmental consequences of NAFTA

All the vehicles exported/imported from/to Mexico have air conditioning facilities, whereas the vehicles sold in the domestic market have varying percentage of air Conditioning. Mexico has moderate climatic conditions (average temperature lying between 24 to 29 degree Celsius) and many large cities in Mexico are located in the Valley of Mexico or in adjacent valleys with altitudes generally above 2,000 m. This gives them a year-round temperate climate with yearly temperature averages from 16 to 18 ℃ and cool nighttime temperatures throughout the year. Because of this reason, the air conditioning demand in Mexico is very low. In year 2012, about 35 percent of cars sold in Mexico have air conditioning installed, which is significantly high compared to 15 percent mark in early 2000's. Applying these percentages to the total number of vehicles, the vehicles equipped with AC are calculated. Given below is the yearly analysis of vehicles in Mexico with air conditioning:

Table 0-2: Data on Vehicles with AC

Year	Sales with AC	Export with AC	Production with AC
2005	771170	1,186,346	1,248,958
2006	803855	1,536,768	1,625,144
2007	749435	1,613,313	1,694,540

2008	667187	1,661,403	1,749,395
2009	496068	1,223,333	1,280,172
2010	552909	1,859,182	1,979,661
2011	606702	2,130,143	2,258,366
2012	675955	2,405,188	2,573,077

As of January 1st, 2009, an agreement was signed between Mexico and USA, based on the North America Free Trade Agreement (NAFTA), which prohibits Mexico to put any restriction on second hand car imports from USA or Canada into its territory. As the agreement was passed, a huge market was established in Mexico for second hand cars mainly imported from USA. In 2012 itself, about 70 thousand second hand cars were imported from USA. As per the Report on "International Trade in used vehicles, the environmental consequences of NAFTA[43]", the total Vehicle Stock in Mexico in year 2008 was 24,800,000. The total vehicle stock for the consecutive years is calculated by adding sales data and subtracting number of vehicles disposed off in the same year from the stock figure of previous year (refer table above for assumption considered for estimation of vehicle stock data). According to Dupont (Major Importer who provides major quantities of HFC to OEM), Grupo Refrigerantes (Major company in Servicing Sector), SEMARNAT and Car Manufacturers (Nissan, General Motors), the percentage of vehicles operational in the country with Air Conditioning increased from 20 percent in early 2009 to about 36 percent in 2012. The vehicle stock equipped with AC has been calculated by applying the percentage recommended by various stakeholders from year 2009 to 2012. Following is the vehicle stock data for the year 2009 till 2012; this also includes the second hand imported cars:

Table 0-3: Vehicle Stock data in Mexico from 2009 to 2012

Year	2009	2010	2011	2012
Total Vehicles under operation (With and without AC)	24,779,423	24,870,064	25,029,848	25,774,765
Total Vehicles under operation with AC	4,960,000	6,277,454	7,626,820	9,010,746

[43] http://faculty.haas.berkeley.edu/ldavis/dk.pdf

ANNEX-VI: ESTIMATION OF SALES AND STOCK DATA FOR MAC-LARGE VEHICLE

The large vehicle sector in Mexico includes: Trucks, Tractors, Chassis Passenger & Bus, however only buses are considered to have AC. The production, sales and export of these vehicle types are sourced from ANPACT. The import of this vehicle type is calculated based on the sales, export and production data. The table below provides the Production, Sales and export of large vehicle in Mexico from year 2009 to 2010.

Table 0-1: Production data of large vehicle

Vehicle type	2009	2010
Trucks	22568	31656
Tractors	28747	48944
Chassis passenger	4432	5190
Bus	895	958
Total	56642	86748

Table 0-2: Export data of large vehicle

Vehicle type	2009	2010
Trucks	16295	20243
Tractors	26220	41975
Chassis passenger	111	368
Bus	73	68
Total	**42699**	**62654**

Table 0-3: Sales data of large vehicle

Vehicle type	2009	2010
Trucks	25778	32057
Tractors	8048	14549
Chassis passenger	9668	9069
Bus	1707	2044
Total	45201	57719

During the survey, the following information are provided by various stakeholders for the large vehicle segment:

- All the long distance buses operated in Mexico are equipped with ACs whereas minor percentage of city buses is AC buses. For the city bus segment, mostly the Chassis are being manufactured by OEM and the body parts are built by local vendors. The air conditioning equipment is also installed in such vehicles by same vendors, but the share of AC vehicle in this category is almost zero. Hence, it is considered that total data for bus mentioned in the table above are considered as air conditioned.

- Trucks and tractors equipped with ACs are almost zero, only higher class trucks imported from USA are having AC facility and the quantity is very low.

Applying the above assumptions on the total production, sales & export data of large vehicles, sourced from ANPACT, the MAC in large vehicle units for production and sales are calculated for year 2009 to 2010. To derive the stock data for AC equipped large vehicle, a back-calculating procedure is followed. Back calculating procedure is used first to estimate historical sales figures, which are used in turn to build up the stock (by adding up sales figures over life time). The calculation accounts for appliance systems that are disposed at the end of their life. The table below provides the production sales and stock data of MAC – Large vehicle from year 2009 to 2010.

Table 0-4: Production data of MAC-Large vehicle

Vehicle type	2009	2010
Trucks	0	0
Tractors	0	0
Chassis passager	0	0
Bus	895	958
Total	895	958

Table 0-5: Sales & Stock data of MAC-Large vehicle

Vehicle type	2009	2010
Sales	1707	2044
Stock	17323	18675

ANNEX-VII: ESTIMATION OF STOCK DATA FOR DOMESTIC REFRIGERATION SECTOR

To arrive at stock figure for domestic refrigerator, refrigerators per thousand household for years 2006 to 2012 was used for the assessment. In Mexico, for 2005 the population was 104 million[44], and the total households were about 26 million (considering an average family size per household is 4[45]), of which 64 percent household owned a refrigerator[46].

Table: Assumption considered

Parameters	Value	Reference/Remarks
Total Population in year 2005	104857000	http://www.indexmundi.com/mexico/population.html
Population Growth rate		http://data.worldbank.org/indicator/SP.POP.GROW
2006	1.20%	
2007	1.30%	
2008	1.30%	
2009	1.30%	
2010	1.20%	
2011	1.20%	
2012	1.20%	
Family size	4.00	http://unstats.un.org/unsd/demographic/products/dyb/dybcensusdata.htm
Refrigerators per 100 households	64%	http://www.puebla.gob.mx/index.php/acerca-de-puebla/estadisticas-del-estado

The population of Mexico grew at an average rate of 1.2 percent[47] every year till 2012. The percentage of domestic refrigerators owned per 100 households and the average family size remained same till 2012. The stock data of domestic refrigerators was hence calculated by applying these assumptions. Given below is the stock data of Domestic Refrigerators in Mexico from 2007 till 2012:

Table 0-1: Total Stock Data on Domestic Refrigerator from 2007 to 2012

	Total number of Domestic Refrigerator under operation in Mexico					
Year	2007	2008	2009	2010	2011	2012
Stock data	**17,199,166**	**17,422,755**	**17,649,251**	**17,861,042**	**18,075,374**	**18,292,279**

[44] http://www.indexmundi.com/mexico/population.html
[45] http://unstats.un.org/unsd/demographic/products/dyb/dybcensusdata.htm
[46] According to a survey done by Government of Mexico, 64 per 100 households have domestic refrigerators in Mexico. Source- http://www.puebla.gob.mx/index.php/acerca-de-puebla/estadisticas-del-estado
[47] http://data.worldbank.org/indicator/SP.POP.GROW

ANNEX-VIII: ESTIMATION OF SALES & STOCK DATA FOR CONDENSING UNITS AND CENTRALIZED UNITS

Condensing Units and Centralized Units have large charge sizes, as they're used in multiple rack systems for supermarkets. In Mexico, large equipments (mostly units with charge size greater than 4 kg, like condensing and centralized units) are generally assembled on-site, with components sourced from various manufacturers like Hussmann, Heilphenix, Kyserwarner. The refrigerant charge is done on-site during assembling, and it depends upon the application and capacity of the unit. Since no database is available for such assembled units, domestic sales and stock data was calculated by retail sector analysis (based on discussion with retail stores and annual reports of companies operating retail chains).

Table: Assumptions considered

Table 2: Retail Market Growth rate data

Year	Supermarket	Express stores	Combined growth	Reference
2012			4.7%	http://www.reuters.com/article/2013/01/28/mexico-retail-idUSL1N0AXAE820130128
2011	12.50%	55%		http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Retail%20Foods_Mexico%20City%20ATO_Mexico_12-29-2011.pdf
2010	8.10%	8.80%		http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Retail%20Foods_Mexico%20ATO_Mexico_2-23-2011.pdf
2009			3%	Normal growth rate of 3% has been considered based on the understanding from the discussions with Trane.
2008			3%	Normal growth rate of 3% has been considered based on the understanding from the discussions with Trane.
2007			3%	Normal growth rate of 3% has been considered based on the understanding from the discussions with Trane.

The calculations for the stock data of condensing and centralized units is based upon the floor area of retail stores, as the refrigeration requirement depends upon the inventory of goods a store holds, and as the floor area increases, the inventory it holds also increases[48]. Based on the understanding from the discussions with technicians of the retail stores (Wal-mart, Oxxo and Seven Eleven Express Store), the refrigerant charge was allocated for various store types (catogorized according to floor area), and then is used to calculate the total consumption of HFCs in each store type. The total number of retail stores and floor area (average) of these stores (operational in the country) were sourced from the annual

[48] As per the evaluation of various retail stores in Mexico, from field survey and secondary research, it was concluded that stores having floor area greater than 1500 sq.mt deploy centralized refrigeration system for management of large inventory of goods. However, retails stores with floor area less than 1500 sq.mt deploy condensing refrigeration systems.

reports of the parent companies for 2012, which was used to calculate the stock data for the same year. The historic growth rate for this sector (refer annex-IV for all assumptions) was then incorporated to calculate the stock data for 2011, and then subsequently for 2007 till 2010. The sales data of the units was then calculated from difference in stock data for consecutive years.

ANNEX-IX: HCFCs AND HFCs DISTRIBUTION IN VARIOUS SECTORS IN YEAR 2012

Gas	Unitary Air conditioning		Chillers		Mobile Air conditioning		Domestic Refrigeration		Commercial Refrigeration		Industrial Refrigeration		Transport Refrigeration		Foam	Aerosol	Fire Fighting	Flushing
	OEM	SER	OEM	SER	OEM	SER	OEM	SER	OEM	SER	OEM	SER	OEM	SER				
HCFC-141b															90%	5%		5%
HCFC-142b															100%			
HCFC-22	5.28%	31%		19.97%						32.03%					6.6%	5.12%		
HCFC-123				100%														
HCFC-124				100%														
HFC-125																	100%	
HFC-134a			10%	6.16%	27.24%	34.29%	12.11%	1%	5.79%	0.84%			0.76%	1.58%	0.22%			
HFC-152a																100%		
HFC-23				100%														
HFC-245fa															100%			
HFC-404A									26%	74%								
HFC-407C	95%	5%																

HFC-410A	75%	5%	15%	5%													
R-717											50%	50%					

SER represents servicing & OEM represents Original Equipment manufacturing

ANNEX-X: REFRIGERANT DISTRIBUTION IN VARIOUS APPLIANCE SYSTEMS OF RAC SECTOR

REFRIGERANT DISTRIBUTION IN SALES (YEAR 2000)

Sector	Sub sector	HCFC-22	HFC-134a	R-717
Unitary air conditioning	Self-contained air conditioners	100%		
	Split residential air conditioners	100%		
	Split commercial air conditioners			
	Duct split residential air conditioners			
	Commercial ducted splits	100%		
	Rooftop ducted	100%		
	Multi-splits			
Chillers	Air conditioning chillers	80%	20%	
	Process chillers			
Mobile AC	Car air conditioning		100%	
	Large vehicle air conditioning		100%	
Domestic refrigeration	Domestic refrigeration		100%	
Commercial Refrigeration	Stand-alone equipment		100%	
	Condensing units	100%		
	Centralised systems for supermarkets	100%		
Industrial Refrigeration	Integral			100%
	Condensing units			100%
	Centralised systems			100%
Transport Refrigeration	Refrigerated trucks/trailers	100%		

REFRIGERANT DISTRIBUTION IN SALES (YEAR 2010)

Sectors	Subsectors	HCFC-22	HFC-134a	HFC-407C	HFC-404A	HFC-410A	R-717
Unitary Air conditioning	Self-contained air conditioners	95%				5%	
	Split residential air conditioners	95%				5%	
	Split commercial air conditioners						
	Duct split residential air conditioners						
	Commercial ducted splits			2%		98%	
	Rooftop ducted			2%		98%	
	Multi-splits						
Chillers	Air conditioning chillers		80%			20%	
	Process chillers						
Mobile AC	Car air conditioning		100%				
	Large vehicle air conditioning		100%				
Domestic refrigeration	Domestic refrigeration		100%				
Commercial Refrigeration	Stand-alone equipment		98%		2%		
	Condensing units				100%		
	Centralised systems for s supermarkets				100%		
Industrial Refrigeration	Integral						100%
	Condensing units						100%
	Centralised systems						100%
Transport Refrigeration	Refrigerated trucks/trailers		80%		20%		

REFRIGERANT DISTRIBUTION IN SALES (YEAR 2020-30)

Sectors	Sub sector	HFC-134a	HFC-407C	HFC-404A	HFC-410A	HC-600a	R-717
Unitary air conditioning	Self-contained air conditioners		50%		50%		
	Split residential air conditioners		50%		50%		
	Split commercial air conditioners						
	Duct split residential air conditioners						
	Commercial ducted splits		50%		50%		
	Rooftop ducted		50%		50%		
	Multi-splits						
Chillers	Air conditioning chillers	100%					
	Process chillers						
Mobile AC	Car air conditioning	100%					
	Large vehicle air conditioning	100%					
Domestic refrigeration	Domestic refrigeration	90%				10%	
Commercial Refrigeration	Stand-alone equipment	100%					
	Condensing units			100%			
	Centralised systems for supermarkets			100%			
Industrial Refrigeration	Integral						100%
	Condensing units						100%
	Centralised systems						100%
Transport Refrigeration	Refrigerated trucks/trailers	50%		50%			

REFRIGERANT DISTRIBUTION IN STOCK (YEAR 2000)

Sector	Sub sector	HCFC-22	HFC-134a	R-717	CFC-12
Unitary air conditioning	Self-contained air conditioners	60%			40%
	Split residential air conditioners	60%			40%
	Split commercial air conditioners				
	Duct split residential air conditioners				
	Commercial ducted splits	60%			40%
	Rooftop ducted	60%			40%
	Multi-splits				
Chillers	Air conditioning chillers				100%
	Process chillers				100%
Mobile AC	Car air conditioning		30%		70%
	Large vehicle air conditioning		30%		70%
Domestic refrigeration	Domestic refrigeration		60%		40%
Commercial Refrigeration	Stand-alone equipment	60%			40%
	Condensing units	60%			40%
	Centralised systems for supermarkets	60%			40%
Industrial Refrigeration	Integral			20%	80%
	Condensing units			20%	80%
	Centralised systems			20%	80%
Transport Refrigeration	Refrigerated trucks/trailers	100%			

REFRIGERANT DISTRIBUTION IN STOCK (YEAR 2010)

Sector	Sub sector	HCFC-22	HFC-134a	HFC-407C	HFC-404A	HFC-410A	HC-600a	R-717	CFC-12
Unitary air conditioning	Self-contained air conditioners	98%				2%			
	Split residential air conditioners	98%				2%			
	Split commercial air conditioners								
	Duct split residential air conditioners								
	Commercial ducted splits	90%		1%		10%			
	Rooftop ducted	90%		1%		10%			
	Multi-splits								
Chillers	Air conditioning chillers	30%	60%	1%		10%			
	Process chillers								
Mobile AC	Car air conditioning		100%						
	Large vehicle air conditioning		100%						
Domestic refrigeration	Domestic refrigeration		80%						20%
Commercial Refrigeration	Stand-alone equipment		100%						
	Condensing units	60%			40%				
	Centralised systems for supermarkets	60%			40%				
Industrial Refrigeration	Integral							100%	
	Condensing units							100%	
	Centralised systems							100%	
Transport Refrigeration	Refrigerated trucks/trailers	16%	78%		6%				

ANNEXURE XI: INPUT PARAMETERS FOR EMISSION CALCULATION & EMISSION PROJECTION FOR RAC SECTOR (TIER 2 METHOD)

Table-1: Initial Charge

Sector	Sub sector	Refrigerant used	Initial Charge (kg/unit)	Source
Unitary air conditioning	Self-contained air conditioners	HFC 410A	1.057	Information provided by "CARRIER, MEXICO"
Unitary air conditioning	Split residential air conditioners	HFC 410A	1.25	HFC inventory and projection tool
Unitary air conditioning	Split commercial air conditioners	HFC 410A	1.8	HFC inventory and projection tool
Unitary air conditioning	Duct split residential air conditioners	HFC 410A	5.0	HFC inventory and projection tool
Unitary air conditioning	Commercial ducted splits	HFC 410A	10.0	As per Grupo Refrigerantes (Major company in Servicing Sector)
Unitary air conditioning	Rooftop ducted	HFC 410A	20.0	As per Grupo Refrigerantes (Major company in Servicing Sector)
Unitary air conditioning	Multi-splits	HFC 410A	20.0	Based on discussion with “TRANE, MEXICO”
Chillers	Air conditioning chillers	HFC 134A	35.0	HFC inventory and projection tool
Chillers	Process chillers	HFC 404A	-	Not covered under this study
Mobile AC	Car air conditioning	HFC 134A	0.7274	The average of charge size in hatchbacks (and sedans) and SUVs (and light trucks). Source of data is respective car manufacturers and AMIA.
Mobile AC	Large vehicle air conditioning	HFC 134A	10	As per Grupo Refrigerantes (Major company in Servicing Sector)
Domestic refrigeration	Domestic refrigeration	HFC 134A	0.1408	The charge size is based upon the data provided by MABE.
Commercial Refrigeration	Stand-alone equipment	HFC 404A	0.7252	Weighted average of the charge provided by Metalfrio, Fersa and Imbera for these type of equipments

Commercial Refrigeration	Condensing units	HFC 404A	12.911	Weighted average of the charge used in these units in equipments of variable sizes and quantity. Source- Market research, annual reports and expert opinions
Commercial Refrigeration	Centralised systems for supermarkets	HFC 404A	1414.21	Weighted average of the charge used in these units in equipments of variable sizes and quantity. Source- Market research, annual reports and expert opinions
Industrial Refrigeration	Integral	R717		Not covered under this study
Industrial Refrigeration	Condensing units	R717		Not covered under this study
Industrial Refrigeration	Centralised systems	R717		Not covered under this study
Transport Refrigeration	Refrigerated trucks/trailers	HFC 404A	6.5	HFC inventory and projection tool

Table-2: Manufacture Emission factor/assembly losses in % of the amount charged (%)

Sector	Sub sector	Refrigerant used	Emission factor (%)	Source
Unitary air conditioning	Self-contained air conditioners	HFC 410A	1%	HFC inventory and projection tool
Unitary air conditioning	Split residential air conditioners	HFC 410A	2%	HFC inventory and projection tool
Unitary air conditioning	Split commercial air conditioners	HFC 410A	2%	HFC inventory and projection tool
Unitary air conditioning	Duct split residential air conditioners	HFC 410A	5%	HFC inventory and projection tool
Unitary air conditioning	Commercial ducted splits	HFC 410A	5%	HFC inventory and projection tool
Unitary air conditioning	Rooftop ducted	HFC 410A	1%	HFC inventory and projection tool
Unitary air conditioning	Multi-splits	HFC 410A	5%	HFC inventory and projection tool
Chillers	Air conditioning chillers	HFC 134A	1%	HFC inventory and projection tool
Chillers	Process chillers	HFC 404A	-	Not covered under this study
Mobile AC	Car air conditioning	HFC 134A	1%	HFC inventory and projection tool

Mobile AC	Large vehicle air conditioning	HFC 134A	2%	HFC inventory and projection tool
Domestic refrigeration	Domestic refrigeration	HFC 134A	1%	HFC inventory and projection tool
Commercial Refrigeration	Stand-alone equipment	HFC 404A	1%	HFC inventory and projection tool
Commercial Refrigeration	Condensing units	HFC 404A	5%	HFC inventory and projection tool
Commercial Refrigeration	Centralised systems for supermarkets	HFC 404A	5%	HFC inventory and projection tool
Industrial Refrigeration	Integral	R717	-	Not covered under this study
Industrial Refrigeration	Condensing units	R717	-	Not covered under this study
Industrial Refrigeration	Centralised systems	R717	-	Not covered under this study
Transport Refrigeration	Refrigerated trucks/trailers	HFC 404A	2%	HFC inventory and projection tool

Table-3: Servicing Emission factor/annual leakage rate in % of total gas charge in stock (%)

Sector	Sub sector	Refrigerant used	Emission factor (%)	Source
Unitary air conditioning	Self-contained air conditioners	HFC 410A	10%	Based on discussion with Grupo Refrigerantes and Trane.
Unitary air conditioning	Split residential air conditioners	HFC 410A	10%	Based on discussion with Grupo Refrigerantes and Trane.
Unitary air conditioning	Split commercial air conditioners	HFC 410A	10%	Based on discussion with Grupo Refrigerantes and Trane.
Unitary air conditioning	Duct split residential air conditioners	HFC 410A	10%	Based on discussion with Grupo Refrigerantes and Trane.
Unitary air conditioning	Commercial ducted splits	HFC 410A	10%	Based on discussion with Grupo Refrigerantes and Trane.
Unitary air conditioning	Rooftop ducted	HFC 410A	10%	Based on discussion with Grupo Refrigerantes and Trane.
Unitary air conditioning	Multi-splits	HFC 410A	10%	Based on discussion with Grupo Refrigerantes and Trane.
Chillers	Air conditioning chillers	HFC 134A	10%	Based on discussion with Grupo Refrigerantes and

				Trane.
Chillers	Process chillers	HFC 404A	10%	Based on discussion with Grupo Refrigerantes and Trane.
Mobile AC	Car air conditioning	HFC 134A	35%	Based on discussion with Grupo Refrigerantes and Trane.
Mobile AC	Large vehicle air conditioning	HFC 134A	35%	Based on discussion with Grupo Refrigerantes and Trane.
Domestic refrigeration	Domestic refrigeration	HFC 134A	2%	HFC inventory and projection tool
Commercial Refrigeration	Stand-alone equipment	HFC 404A	3%	HFC inventory and projection tool
Commercial Refrigeration	Condensing units	HFC 404A	10%	Based on the understanding from the discussions with technicians of the retail stores (Wal-mart, Oxxo and Seven Eleven Express Store)
Commercial Refrigeration	Centralised systems for supermarkets	HFC 404A	25%	Based on the understanding from the discussions with technicians of the retail stores (Wal-mart, Oxxo and Seven Eleven Express Store)
Industrial Refrigeration	Integral	R717	5%	HFC inventory and projection tool
Industrial Refrigeration	Condensing units	R717	25%	HFC inventory and projection tool
Industrial Refrigeration	Centralised systems	R717	35%	HFC inventory and projection tool
Transport Refrigeration	Refrigerated trucks/trailers	HFC 404A	25%	HFC inventory and projection tool

Table 4: Disposal Emission factor/amount of gas emitted at system disposal in % of gas originally charge into the system (%)

Sector	Sub sector	Refrigerant used	Emission factor (%)	Source
Unitary air conditioning	Self-contained air conditioners	HFC 410A	90%	IPCC 1997
Unitary air conditioning	Split residential air conditioners	HFC 410A	90%	IPCC 1997
Unitary air conditioning	Split commercial air conditioners	HFC 410A	90%	IPCC 1997

Unitary air conditioning	Duct split residential air conditioners	HFC 410A	90%	IPCC 1997
Unitary air conditioning	Commercial ducted splits	HFC 410A	90%	IPCC 1997
Unitary air conditioning	Rooftop ducted	HFC 410A	90%	IPCC 1997
Unitary air conditioning	Multi-splits	HFC 410A	90%	IPCC 1997
Chillers	Air conditioning chillers	HFC 134A	90%	IPCC 1997
Chillers	Process chillers	HFC 404A	-	Not covered under this study
Mobile AC	Car air conditioning	HFC 134A	75%	IPCC 1997
Mobile AC	Large vehicle air conditioning	HFC 134A	75%	IPCC 1997
Domestic refrigeration	Domestic refrigeration	HFC 134A	90%	IPCC 1997
Commercial Refrigeration	Stand-alone equipment	HFC 404A	90%	IPCC 1997
Commercial Refrigeration	Condensing units	HFC 404A	90%	IPCC 1997
Commercial Refrigeration	Centralised systems for supermarkets	HFC 404A	90%	IPCC 1997
Industrial Refrigeration	Integral	R717	-	Not covered under this study
Industrial Refrigeration	Condensing units	R717	-	Not covered under this study
Industrial Refrigeration	Centralised systems	R717	-	Not covered under this study
Transport Refrigeration	Refrigerated trucks/trailers	HFC 404A	90%	IPCC 1997

Table-5: Equipment Life time (years)

Sector	Sub sector	Life time (years)	Source
Unitary air conditioning	Self-contained air conditioners	15	As per information provided by "CARRIER MAEXICO"
Unitary air conditioning	Split residential air conditioners	15	As per information provided by "CARRIER MAEXICO"

Unitary air conditioning	Split commercial air conditioners	15	As per information provided by "CARRIER MAEXICO"
Unitary air conditioning	Duct split residential air conditioners	15	As per information provided by "CARRIER MAEXICO"
Unitary air conditioning	Commercial ducted splits	15	As per information provided by "CARRIER MAEXICO"
Unitary air conditioning	Rooftop ducted	15	As per information provided by "CARRIER MAEXICO"
Unitary air conditioning	Multi-splits	15	As per information provided by "CARRIER MAEXICO"
Chillers	Air conditioning chillers	15	As per information provided by "CARRIER MAEXICO"
Chillers	Process chillers	-	Not covered under this study
Mobile AC	Car air conditioning	14	Report on International Trade in used vehicles, the environmental consequences of NAFTA
Mobile AC	Large vehicle air conditioning	15	HFC inventory and projection tool
Domestic refrigeration	Domestic refrigeration	10	Data provided by Mabe & Whirlpool
Commercial Refrigeration	Stand-alone equipment	10	Data provided by Ojeda & Imbera
Commercial Refrigeration	Condensing units	20	Based on the understanding from the discussions with technicians of the retail stores (Wal-mart, Oxxo and Seven Eleven Express Store)
Commercial Refrigeration	Centralised systems for supermarkets	25	Based on the understanding from the discussions with technicians of the retail stores (Wal-mart, Oxxo and Seven Eleven Express Store)
Industrial Refrigeration	Integral	-	Not covered under this study
Industrial Refrigeration	Condensing units	-	Not covered under this study
Industrial Refrigeration	Centralised systems	-	Not covered under this study
Transport Refrigeration	Refrigerated trucks/trailers	15	HFC inventory and projection tool

Table-6: Historical & Projected growth rate

Sector	Sub sector	2000-10	2010-15	2015-20	2020-30	Source
Unitary air conditioning	Self-contained air conditioners	8.53%	8.53%	8.53%	8.53%	Based on GDP growth rate
Unitary air conditioning	Split residential air conditioners	8.53%	8.53%	8.53%	8.53%	Based on GDP growth rate
Unitary air conditioning	Split commercial air conditioners	8.53%	8.53%	8.53%	8.53%	Based on GDP growth rate
Unitary air conditioning	Duct split residential air conditioners	8.53%	8.53%	8.53%	8.53%	Based on GDP growth rate
Unitary air conditioning	Commercial ducted splits	8.53%	8.53%	8.53%	8.53%	Based on GDP growth rate
Unitary air conditioning	Rooftop ducted	8.53%	8.53%	8.53%	8.53%	Based on GDP growth rate
Unitary air conditioning	Multi-splits	8.53%	8.53%	8.53%	8.53%	Based on GDP growth rate
Chillers	Air conditioning chillers	8.53%	8.53%	8.53%	8.53%	Based on GDP growth rate
Chillers	Process chillers	-	-	-	-	Not covered under this study
Mobile AC	Car air conditioning	4.33%	4.33%	4.33%	4.33%	Estimated from historical sales data
Mobile AC	Large vehicle air conditioning	7.81%	5%	5%	5%	Estimated from historical sales data
Domestic refrigeration	Domestic refrigeration	3%	3%	3%	3%	Based on discussion with experts from the sectors
Commercial Refrigeration	Stand-alone equipment	13.38%	10%	10%	10%	Estimated from historical sales data
Commercial Refrigeration	Condensing units	11.69%	8.53%	8.53%	8.53%	Estimated from historical sales data
Commercial Refrigeration	Centralised systems for supermarkets	8.37%	8.37%	8.37%	8.37%	Estimated from historical sales data
Industrial Refrigeration	Integral	-	-	-	-	Not covered under this study
Industrial Refrigeration	Condensing units	-	-	-	-	Not covered under this study
Industrial Refrigeration	Centralised systems	-	-	-	-	Not covered under this study

Transport Refrigeration	Refrigerated trucks/trailers	8.53%	8.53%	8.53%	8.53%	Based on GDP growth rate