STUDY OF THE HYDROFLUOROCARBONS (HFCs) MARKET IN COLOMBIA

FINAL REPORT

NATIONAL OZONE UNIT OF COLOMBIA
MINISTRY OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT
UNITED NATIONS DEVELOPMENT PROGRAMME – UNDP

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HFC consumption Survey in Colombia - Executive Summary

Introduction

Colombia is apartner of the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC). In February 2012, the governments of Bangladesh, Canada, Ghana, Mexico, Sweden and the United States, and the United Nations Environment Programme (UNEP), have formed the Climate and Clean Air Coalition to Reduce Short Lived Climate Pollutants (CCAC); a unique initiative to support fast action to reduce short-lived climate pollutants (SLCPs) such as black carbon (soot), methane and some hydrofluorocarbons (HFC). Colombia ratified the United Nations Framework Convention for Climate Change (UNFCCC) and the Kyoto Protocol and is making progress in the implementation of a national policy for Climate Change, the development of a country adaptation system and the formulation of a Colombian strategy for a sustainable low-in-carbon development with sectorial mitigation plans. The country has also ratified the Vienna Convention and the Montreal Protocol with all its amendments to control the consumption of the substances that deplete the Ozone layer and currently is engaged in the implementation of the first phase of the HCFC Phase-out Management Plan (HPMP).

It is in this context, that the current HFC survey was undertaken. A top-down methodology was followed that involved the analysis of the government´s information, particularly the databases prepared by the Ministry of Trade, the National Ozone Unit, the National Office of Environmental Licenses and the interaction with upstream chemical and equipment suppliers and importers, industry associations and key end users.

Brief overview of the country's HFC consumption from 2008 to 2012

There is no HFC production in Colombia. Table 1 presents the country´s consumption of HFC during the years 2008-2012 by substance calculated as imports minus exports:

Table 1. HFC consumption by substance (kg)

Substance	2008	2009	2010	2011	2012
HFC-134a	596,947	681,309	847,898	629,209	963,372
HFC-152a	8,263	16,135	1,771	7,082	14,755
HFC-125	0	2,636	3,596	0	1,740
HFC-227ea	0	2,925	2,500	2,700	3,614
R-404A	61,221	57,041	73,987	67,988	122,799
R-407C	35,854	15,347	18,118	13,698	19,142
R-410A	4,953	13,308	24,931	35,299	44,872
R-413A	0	16,572	86,749	75,768	49,632
R-417A	0	2,270	2,946	1,349	1,816
R-422A	0	25,067	2,615	872	1,743

R-422D	0	454	6,810	9,060	11,895
R-413A	0	16,572	86,749	75,768	49,632
R-507A	55,390	26,660	80,992	59,221	108,418
R-508B	9	9	82	68	18
Chesterton® 296 EU[1]	0	0	172	1,586	2,132
TOTAL	**762,637**	**859,732**	**1,153,165**	**903,905**	**1,346,399**

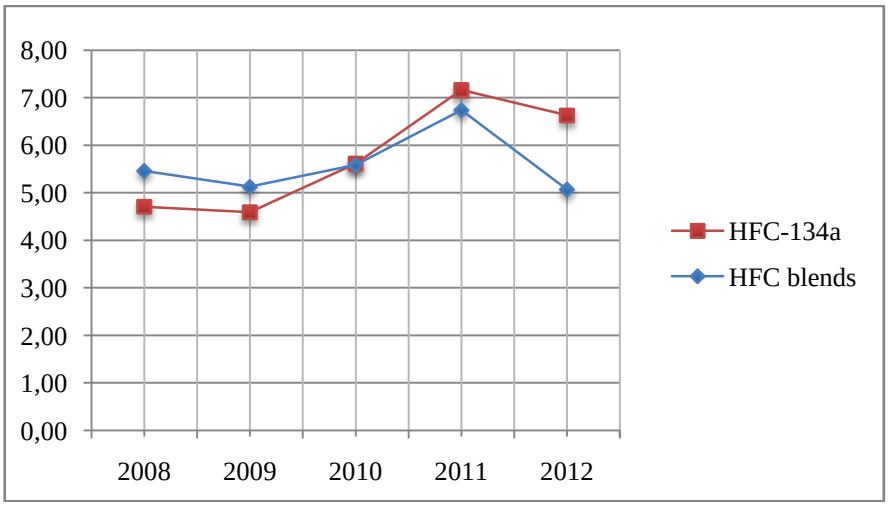
The United States and China are the source of the HFC imported by Colombia. Table 2 shows the imported quantities from each sourcing point and the corresponding shares. Since 2009 the United States has enjoyed a dominant position for the HFC supply that fluctuated around a participation of 70 %.

Table 2. Source of imported HFC

Substance	2008		2009		2010		2011		2012	
	kg	%	kg	%	kg	%	kg	%	kg	%
HFC-134a										
China	166,750	27.9	156,992	23.0	192,942	22.1	159,173	21.9	220,246	22.4
United States	430,197	72.1	524,317	77.0	682,073	77.9	566,511	78.1	761,792	77.6
HFC-152a										
United States	8,263	100.0	15,979	100.0	3,541	100.0	8,263	100.0	14,755	100.0
HFC blends										
China	132,972	83.6	85,687	54.7	117,441	38.9	71,356	24.7	200,589	55.3
United States	15,606	9.8	69,406	44.3	184,744	61.1	217,711	75.3	161,985	44.7
Europe	10,500	6.6	1,635	1.0						

The HFC used in the refrigeration/air conditioning (RAC) market (HFC-134a and HFC blends) are not summited to any repackaging process in the country. They are imported in containers in the same presentation that will reach the end users (cylinders from 10.9 to 13.6 kg and small cans of around 340, 425 and 750 g). Graph 1 shows the evolution of the average FOB prices of relevant HFC. A peak in the price of all substances is observed in 2011.

[1] Chesterton® 296 is a mixture of HFC-134a (40-50 %), HFC-365mfc (20-30%), HFC-245fa (20-30%) and isopropyl alcohol (1-5%).

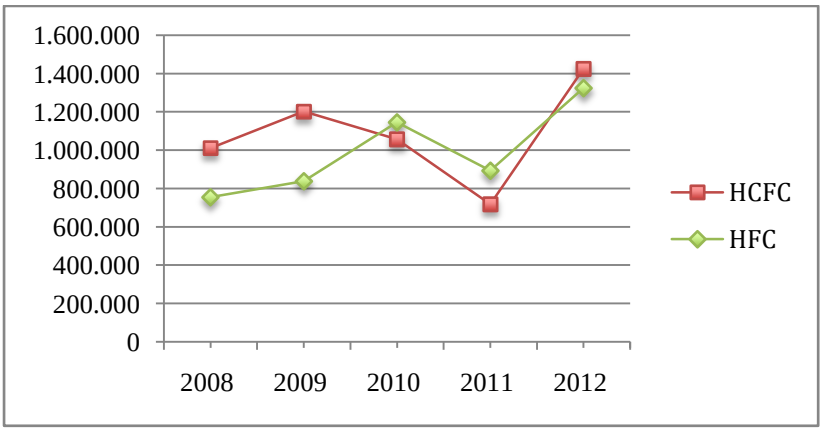


Graph 1. Average FOB prices (US$/kg) of HFC products imported by Colombia

Since 2010 amajor Colombian distributor of chemicals started to export HFC-134a and HFC-based refrigerant blends to Central America (Guatemala and Costa Rica). In 2012 exports represented 1.9 % of the total imports but in 2011 they reached a peak of 11.9 % of the total imports.

The HFCs are basically consumed in the RAC sector. In 2012 this market segment accounted for 98.3 % of the total HFC used in the country. The remaining 1.7 % is represented by the use of HFC-152a in the glass industry (1.1 %), Chesterton® SP 296 as cleaning agent for electronics (0.2 %) and HFC-227ea and HFC-125 for fire protection (0.4 %). There is no HFC consumption in the foam industry, where pentanes -for domestic refrigeration- and HCFC-141b -for commercial refrigeration, discontinuous panels and spray- are the preferred blowing agents.

The main product used in 2012 in the RAC sector was HFC-134a (72.8%), followed by R-404A (9.3%), R-507A (8.2%), R-437A (3.7%), R-410A (3.4%) and R-407C (1.4%). These six products accounted for 98.8% of the total HFCs used in RAC. Along with the HFCs, the other important players in the refrigeration industry are HCFC-22 and the HCFC refrigerant blends (R-406A and R-409A), introduced in the market as CFC-12 replacement. The graph 2 shows the evolution of its consumption compared to that of the HFC used in RAC.



Graph 2. HFC consumption (kg) vs. HCFC-consumption (kg) in RAC

Table 3 describes the RAC sub-sectors where the different products are used:

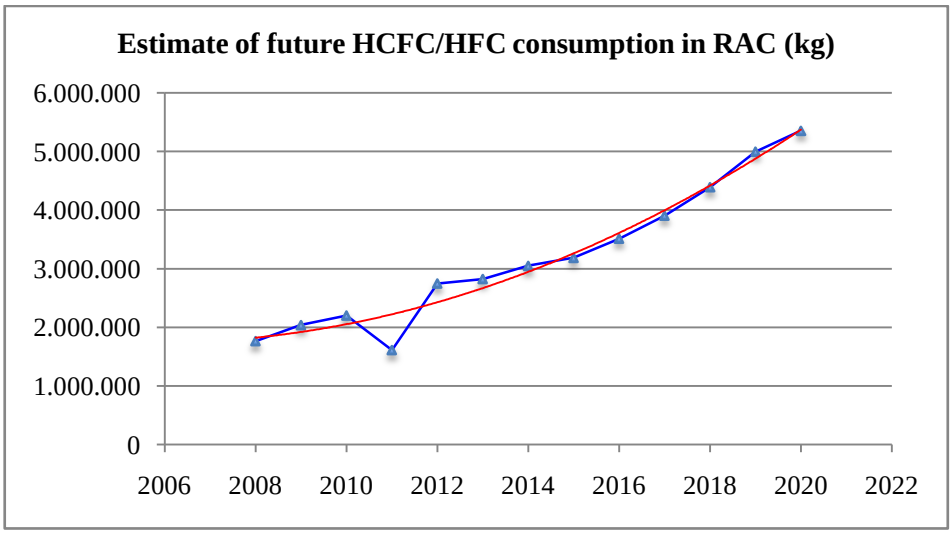
Table 3. Products used in RAC subsectors

Sub-sector	HFC-134a	R-404A	R-407C	R-410A	R-437A	R-507A
Refrigeration						
Domestic	X				X	
Commercial (stand-alone equipment, cold rooms, super-markets, etc.)	X	X			X	
Industrial		X				X
Transportation (reefers, trucks)	X	X				
Air Conditioning						
Fixed						
Compact equipment (residential and commercial)			X	X		
Systems	X		X	X		
Mobile air conditioning	X					

Projection of HFC consumption for the years 2013-2020

Table 4 shows the estimated HFC consumption for the years 2013-2020 in a business-as-usual (BAU) scenario. This projection was calculated assuming the following items:

- Through 2008-2012 the refrigeration sector in Colombia grew at an average compounded growth rate of 11.70%. Based on the interviews held with sector experts it was defined as the growth rate to forecast the future market consumption; a figure three points lower than that of the historical growth (8.70%).



Graph 3.Estimate of future HCFC/HFC consumption in RAC (kg)

Blue: actual and calculated consumption, Red:calculated consumption trend

- The HCFC consumption will follow the chronogram defined by the Montreal Protocol in Decision XIX/6 for HCFC phase-out in Article 5 parties.
- In accordance with historical data, refrigeration products will grow at differentiated rates following in magnitude the same historical order (R-410A> R-404A> R-507A> HFC-134a> R-437A>R-407C).
- The rest of the HFC products that go to the fire protection and solvents markets; and to the glass production industry, which will grow at the same rate of the GDP: 4.7 %.

Table 4. Estimated HFC consumption for 2013 - 2020, Business-as-usual scenario, kg

	2013	2014	2015	2016	2017	2018	2019	2020
HFC-134a	1,085,822	1,223,836	1,379,392	1,554,720	1,752,333	1,975,064	2,226,105	2,509,055
R-404A	146,140	173,918	206,975	246,315	293,134	348,851	415,158	494,069
R-507A	128,239	151,683	179,413	212,213	251,010	296,899	351,177	415,379
R-410A	66,348	98,103	145,057	214,483	317,138	468,925	693,360	1,025,212
R-413A	55,587	62,258	69,729	78,096	87,468	97,964	109,720	122,886
R-407C	16,362	13,986	11,955	10,219	8,735	7,467	6,383	5,456
Other HFC refrigerant blends	15,608	15,764	15,922	16,081	16,242	16,404	16,568	16,734
HFC-152a	15,448	16,175	16,935	17,731	18,564	19,437	20,350	21,307
Chesterton	2,232	2,337	2,447	2,562	2,682	2,808	2,940	3,079

Table 4. Estimated HFC consumption for 2013 - 2020, Business-as-usual scenario, kg								
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
296EU								
HFC-125	1,822	1,907	1,997	2,091	2,189	2,292	2,400	2,513
TOTAL	**1,533,608**	**1,759,966**	**2,029,821**	**2,354,511**	**2,749,494**	**3,236,110**	**3,844,160**	**4,615,687**

Based on table 4, in the business-as-usual scenario HFC consumption by 2020 (4,615 tonnes) will be three times as much as the value of2012(1,534 tonnes). The two most popular products will be HFC-134a and R-404A. They will represent 54.4 and 22.2% of the total HFC consumption respectively.

Future Actions & Projects

The significant growth in HFC consumption in the BAU scenario, driven partially by the HCFC phase-out, represents a significant challenge for the country because of the associated climate change impact.

Based on the recent reports published by the Refrigeration Technical Options Committee of the Montreal Protocol (RTOC) low GWP options have been identified for several market subsectors (table 5).

Table 5. Low GWP options for relevant RAC sectors			
Sector	**Subsector**	**Current substance**	**Low GWP options**
Refrigeration	Domestic	HFC-134a	HC-600a, HFO-1234yf.
	Commercial	Stand-alone equipment: HFC-134a y R-404A.	HC-600a and HC-290 for small units with charges lower than 1.5 kg. HFO-1234yf and CO_2.
	Supermarkets	R-404A, R-507A y HFC-134a.	Transcritical CO_2, cascade systems using CO_2 at the low temperature level combined with a variety of refrigerants at the high temperature level such as ammonia, HC-290 and HC-1270
	Transportation, trucks	R-404A, HFC-134a.	HFO-1234yf as replacement of HFC-134a
	Transportation, reefers	R-404A, HFC-134a.	CO_2
Air Conditioning	Split and window type	R-407A, R-410A.	HC-290
	Mobile	HFC-134a	HFO-1234yf, CO_2

The preparation of a national strategy for the HFC phase down includes the actions to undertake, the time line and the associated costs represents a path forward.

In the RAC sector the following demonstration/investment projects are pertinent:

Additional to on-going activities:

1. Installation of a District Cooling System in the city ofMedellin,phasing out the consumption of high GWP substances in a selected number of buildings:
   - ✓ Cogeneration System with Heat Recovery Absorption Chillers providing cooling capacity as an alternative to existing CFC, HCFC and HFC based Chillers.

Demonstration projects in the RAC sector represent a path forward to the HFC phase-down:

2. Conversion of the production of domestic and stand-alone commercial units to hydrocarbon technology (replacement of R-134a by R-600a).
3. Demonstration/installation projects in the supermarket subsector aiming at the HFC replacement by CO_2 based technology:
   - ✓ Cascade system using R-717 (ammonia)/R-744 (CO_2)
   - ✓ Cascade system using R-290 (propane)/R-744 (CO_2)
   - ✓ Trans-critical CO_2 system (demonstration project)
4. Demonstration/installation project to use a low GWP option for air conditioning in a public building.

In the Colombian foam sector, particularly in the commercial refrigeration sector of discontinuous panels and spray foams currently using HCFC-141b; lies an opportunity to intrudoce and offer safe low-GWP alternatives while enhancing energy efficiency. The importance of the following projects is visualized:

- Demonstration project to develop cost effective non-flammable PU formulations based on unsaturated HFCs (HFO), for sprays to be applied in low and high altitudes over sea level.
- Demonstration project to develop cost effective PU formulations based on unsaturated HFCs (HFO) for discontinuous panels (small and medium enterprises).
- Demonstration project to develop cost effective PU formulations based on unsaturated HFCs (HFO) for commercial refrigeration (small and medium enterprises that produce stand-alone units).

1. Background

During the last two years, the international forum has started an initiative called Climate and Clean Air Coalition (CCAC) to Reduce Short-Lived Climate Pollutants (SLCP). This initiative was launched in February 2012 by the United States, Bangladesh, Canada, Ghana, Mexico, Sweden, and the United Nations Environment Programme (UNEP) which hosts the secretariat of the CCAC. Currently, the Coalition is formed by 60 partners include the European Commission and a wide number of international organizations (governmental and nongovernmental).[1]

The SLCPs are pollutants that relatively have a low residence time in the atmosphere and contribute to climate change because they are compounds of high global warming potential. The pollutants covered by the initiative are Methane, Black carbon, Hydrofluorocarbons (HFCs), and Tropospheric Ozone. Efforts to reduce these pollutants can be carried out by short-term actions involving multiple co-benefits in public health, energy and agricultural productivity, among others, which in turn can lead a reduction of effects on climate change and contribute to sustainable development in developing countries such as Colombia.

HFCs are human-made greenhouse gases used as refrigerants, foam blowing, fire retardants, solvents and aerosols. Their use has been growing because they are widely adopted as replacements for ozone depleting substances (ODS), since their use is being phased out under the Montreal Protocol on Substances that Deplete the Ozone Layer. HFCs are found in smaller quantities in the atmosphere; however studies have projected that their impact on the climate could increase up to 19% of global CO2 emissions by 2050[2].

Studies haveshown Colombia as a country particularly vulnerable toclimate change, because ofits geographical location and its historical changes suffered by ecosystems along with inappropriate uses to the land. The latest research by the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM, Spanish acronym)[3]calculated for the country, show an increase in the average temperature of 0.13°C between 1971 and 2000

[1]http://iipdigital.usembassy.gov/st/spanish/article/2013/04/20130423146312.html#ixzz2qww1kGwy. Accessed January 20, 2014

[2]http://www.unep.org/ccac/Short-LivedClimatePollutants/Definitions/tabid/130285/language/en-US/Default.aspx.AccessedJanuary 20, 2014

[3]http://www.cambioclimatico.gov.co/jsp/2307. Evidencias del cambio. Consultado el 20 de enero 2014

and the multi-model ensemble of climate change scenarios, projectedclimate changes in the average air temperature in the country. Such increases are relative to the same reference periodbetween 1971-2000: 1.4 ° C for 2011-2040, 2.4°C to 3.2°C from 2041 to 2070 and 3.2oC for 2071 to 2100. Throughout the century, precipitation volumes would decrease between 15% and 36% for large areas of the Caribbean and Andean regions.Precipitation would increase towards the centre and north of the Pacific Region. For this reason, many changes in climate have been observed and hence a high number of impacts on biodiversity and on ecosystems have been screened. Productive sectors in turn are represented by a lower contribution in economic growth for the contry.

Oneof the most significant examples isthe reduction of the area of glaciers; If it were to continue at the same rate, the glaciers would disappear sometime between 2030-2040. As a consequence of this, the rise of sea level has been increasing in the order of 3.5 mm / year in the Caribbean, related disasters with rains increased 16.1% during the "La Niña" phenomenon in relation to the normal conditions associated with drought disasters, which, have shown an increase of about 2.2 times during periods of "El Niño" and the consequent decrease in water and energy availability [4].

Among the advances to face climate change, one of the high points has been that Colombia has ratified[5] the United Nations Framework Convention on Climate Change and the Kyoto Protocol. Consequently, the National Development Plan 2010 -2014 was established, to adequately address the issue of climate change, the country should have: 1) A National Climate Change Policy underimplementation, 2) A National Climate Change system created 3) A National Plan forAdaptation to Climate Change formulated with their respective financial strategy, and 4) A Colombian strategy for Low Carbon Development formulated and implemented through sectorial mitigation plans.

In response to these lines, the Ministry of Environment and Sustainable Development (MADS, Spanish acronym), the Department of National Planning (DNP Spanish acronym), and interrelated ministries of Colombia began to structure the Colombian Strategy for Low Carbon Development (CLCDS) which is a long term development program, that aims to promote national economic growth with low greenhouse gas (GHG) emissions through the implementation of plans, projects, measures and policies that contribute to GHG mitigation

[4]NationalPlanfor Adaptation toClimate Change.ReducingClimateImpactsin the development ofColombia.DNP,MADS, IDEAM, UNGRD, 2001.

[5]Law164 of1994ratifiedtheUNFramework Conventionon Climate Changeand the Law629 of2000ratified theKyoto Protocol.

and, at the same time and strengthen Colombia's economic and social development while meeting the global requirements of efficiency, competitiveness and environmental performance.

Having promoted changes in policies and developed programs and projects at the Central Government level, the next step is to help industries and companies to reduce their emissions in their industrial processes. These key buyers can help drive their suppliers into mitigation efforts or NAMAs. Pilots of this type of initiative are being approachedby the national industry association (ANDI Spanish acronym), which can provide useful guidance to a broader process.

Like most countries in the region, Colombia has submitted two National Communications to the United Nation Framework Convention on Climate Change (UNFCCC) in December 2001, laying out the actions that the government has already taken and the analytical basis for its policy response to climate change and its commitment to take future actions within an official international framework. The Communication established the first National GHG inventories for 1990 and 1994; including the actions done by the country to mitigate GHG emissions in Colombia, as well as preparing vulnerability and adaptation studies for the coastal area, water resources, agricultural sector and land management.

The climate scenarios presented in Colombia´s Second National Communication predict an increase in the average temperature between 2º and 4º by 2070, along with changed hydrological conditions (for example, certain regions may see their rainfall reduced by up to 30%). Furthermore, the impacts of climate change will affect the Colombian's quality of life, but will especially affect the way of life of the rural population.

Colombia has been an active Party to the Montreal Protocol as an Article 5 country, having acceded to the Vienna Convention and Montreal Protocol in 1990 and 1993 respectively and subsequently to all amendments[6]. Implementation of the Montreal Protocol in Colombia has been developed in phases, through the coordination of the Ozone Technical Unit (UTO) and supported by the resources approved by the Multilateral Fund for the implementation of the Montreal Protocol.

[6]Law 30 of 5 March 1990, Congress adopted the Vienna Convention for the Protection of the Ozone Layer. Law 29 of December 28, 1992, Congress adopted the Montreal Protocol on Substances that Deplete the Ozone Layer and its amendment and adjustment (London and Nairobi).

In order to accomplish the commitmentsrelated to the Montreal Protocol, Colombia has included in its National Environmental Policy, as one of its highest priorities, the objective of reducing consumption of ODS. Among the components of the environmental policy, there is the National Policy for Clean Production and one of its main pillars is the Country Programme for the *Phase-out of Ozone Depleting Substances*. The National Environmental Policy underlines the following elements related to the Montreal Protocol[7]:

- Industrial re-conversion processes for the protection of the ozone layer;
- Training on good refrigeration practices;
- Training for customs officers controlling trade of ozone depleting substances;
- Tariff exemption for the Montreal Protocol equipment;
- Development of a regulation framework for the implementation of the Country Programme for the Phase-out Plan of Ozone Depleting Substances; and
- Institutional strengthening for the national and regional implementation of the Montreal Protocol.

Colombia has included the objective of guaranteedenvironmental sustainability as one of its seven goals forthe Millennium Development Goals. One of the three targets of this objective is the elimination by year 2010, of ozone depleting substances (CFCs) (DNP, 2005). This was accomplished via it'sinclusion in the Country Program for the Phase-out Plan of Ozone Depleting Substances. In addition, the Colombian National Development Plan 2006-2010 included as a target the elimination of ODS (CFCs) by 2010, a National strategy to refrigerants and ODS residuals good management, and an inter-institutional control of illegal trade at frontiers[8]

Finally, the Colombian National Development Plan 2010-2014 opens up the opportunity to technology changes towards use of cero ODS and low GWP alternatives. It aims at the promotion of early retirement of energy inefficient electrical devises, encouraging a change in the current unsustainable consumption and production patternsthrough a policy of sustainable development with emphasis on the reduction of energy intensity and boosting the demand for goods or services that are environmentally friendly. In particular, this Plan

[7]Colombia-MAVDT, 2002
[8]National Planning Department – (DNP, Spanish acronym), 2006

provides a technological change conducive to the efficient use of energy in cooling, air conditioning and architecture bioclimatic housing systems equipment.

Basedon the country´s environmental strategy focused on the protection of the unique biodiversity, and consequently, on climate change (emission control of greenhouse gases and energy efficiency), the government designed a two-steps strategy to comply with the Montreal Protocol control measures for 2013 –freeze- and 2015 and to achieve a complete phase out by the year 2030. A 2.5 % HCFC consumption will be allowed in the period 2030-2040 for maintenance in the refrigeration sector. In 2015 the country will review the progress of the strategy implementation to analyse the possibility of a more drastic reduction schedule.

Presently the implementation of Phase I of the Management Plan for the Elimination of hydroclofluorocarbons (HCFC) substances in Group I of Annex C of the Montreal Protocol is in progress. In order to achieve the objectives of eliminating ODS consumption promotional strategies have been implemented and financial assistance for the reconversion of the manufacturingsectors, technical assistance to end users; awareness to consumers of goods and services related to ODS regulation of flow and the ODS consumption chain; promotion of ODS free programs technologies, recovery and recycling of refrigerants in the refrigeration and air conditioning service sector.The first stage of the HPMP will be implemented in the period between 2010 and 2015, and is aimed at reaching the goal of eliminating 10% of HCFC consumption.

More recently, underthe framework of voluntary initiative towards the Climate and Clean Air (Coalition CCAC) to Reduce Short-Lived Climate Pollutants, Colombia sent the official request to join the CCAC on April 2012, looking forward to a complementary approach to each others efforts related to facing the greenhouse gases in the sectors considered relevant which are chosen according to national priorities.

Colombia prioritized to work in the CCAC under following initiatives:

- Brick Production: Colombia has received support on establishing and assessing strategies to modernize the Colombian brick maker in a sustainable, efficient, productive and competitive way whilereducing black carbon emission to enhance health conditions of brick workers.
- Municipal Solid Waste Initiative (MSW): CCAC has a city based approach for MSW focused on to mayor cities, Cali and Barranquilla. Cali has designed an action plan under CCAC according to its needs and has partnered through the city exchange program of CCAC with San Diego (USA). San Diego has experience in organics management and specifically in composting programs they will provide technical exchange and support.

- HFCs: CCAC has supported the construction and update of HFCs inventory for the Technical Ozone Unit of the MADS.

Despite the progress achieved with national actions within the framework of international commitments, the use of HFCs in Colombia has increased the last two decades, from when the process of eliminating the consumption of CFC and HCFC began. HFCs have been used as a substitute for CFC excellence in domestic refrigeration and commercial refrigeration and replacement of CFCs and HCFCs in refrigeration systems for medium and low temperature for the commercial and industrial sector. HFCs also replaced the use of fire extinguishing systems fixed halon, and in some applications as solvents or aerosols in other industries. Therefore, to characterize the consumption and use of HFCs is essential for the establishment of a future strategy and evolution of the measures necessary to ensure compliance with international commitments.

The Ministry of Environment and Sustainable Development in Colombia, through the UTO, has developed this market study HFC consumption in Colombia between 2008 and 2012, by which it establishes a baseline of information to identify usage trends in each sector and subsector user, tending to facilitate decision making against the adoption of alternative low Global Warming Potential (GWP) in these different sectors.

The present work under the CCAC has been great support for all efforts being conducted by the country as part of compliance with international commitments and priority will be the interest of Colombia that based on the already developed assessments may have continuity in implementing the actions necessary to promote the adoption of low-GWP alternatives.

This document is organized by an outline of HFC consumption, by means ofthe quantification of imports and exports; which then presents the analysis of the consumer market in the user sectors and develops some HFC consumption trends, in consideration of their potential increase as a result of the elimination of HCFCs, particularly HCFC-22. Finally, it presents the current alternatives and those that are being introduced as the ultimate replacement of these substances.

2. HFCs Imports

Table N° 1 shows the quantities of the different HFCs, pure substances and blends, imported to Colombia throughout the years 2008-2012. During this period,a significant increase of the total imported amount reflected in an annual compounded growth rate (CGR) of 15.82% is observed. There is a peak in 2010 that can be explained by an overstocking strategy followed by the major importers under the expectation of governmental control regulations to comply with the Montreal Protocol.

HFC-134a and HFC blends are the dominant substances. In 2012 they accounted for 72.02 and 26.48% of the total HFC imports (figure N° 2). R-404A and R-507A were the blends that registered the largest amount of imports (figures N° 3).

Meanwhile HFC-134a grew at an annual growth rate of 13.44% in the analysed period the HFC blends as a whole presented an annual growth of 26.48%. R-507A and R-410A, particularly, showed a rate value of 59.78 and 50.32% in the last four years, followed by R-404A with 29.24%.

Table N° 1. HFC Imports - Pure substances and blends, 2008-2012 period, kg

Substance	2008	2009	2010	2011	2012
HFC-23	0	0	0	4	0
HFC-134a	596,947	681,309	875,016	725,900	988,437
HFC-152a	8,263	16,135	3,541	8,263	14,755
HFC-125	0	2,636	3,596	0	1,740
HFC-227ea	0	2,925	2,500	2,700	3,614
HFC-245fa	0	0	0	0	452
HFC Blends	157,427	156,728	302,075	288,954	363,471
R-404A	61,221	57,041	75,545	76,003	123,135
R-407C	35,854	15,347	18,118	13,698	19,142
R-410A	4,953	13,308	26,489	43,314	45,207
R-413A	0	16,572	86,749	75,768	49,632
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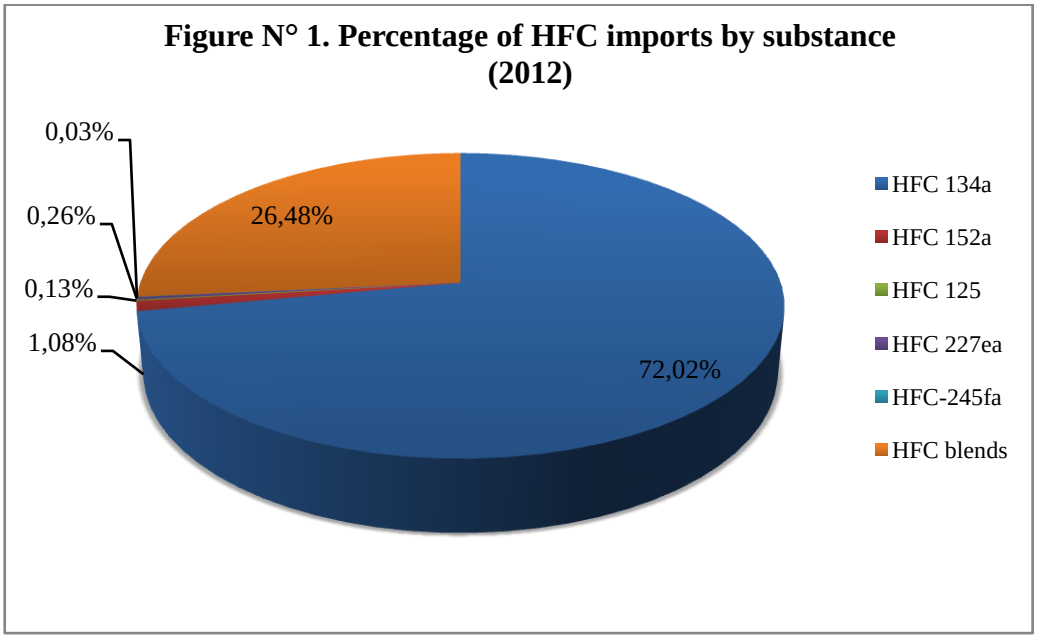
R-508B	9	9	82	68	18
Chesterton® 296 EU[9]	0	0	172	1,586	2,132
TOTAL HFC Blends	157,427	156,728	302,075	288,954	363,471
TOTAL	**762,637**	**859,732**	**1,186,728**	**1,025,821**	**1,372,470**

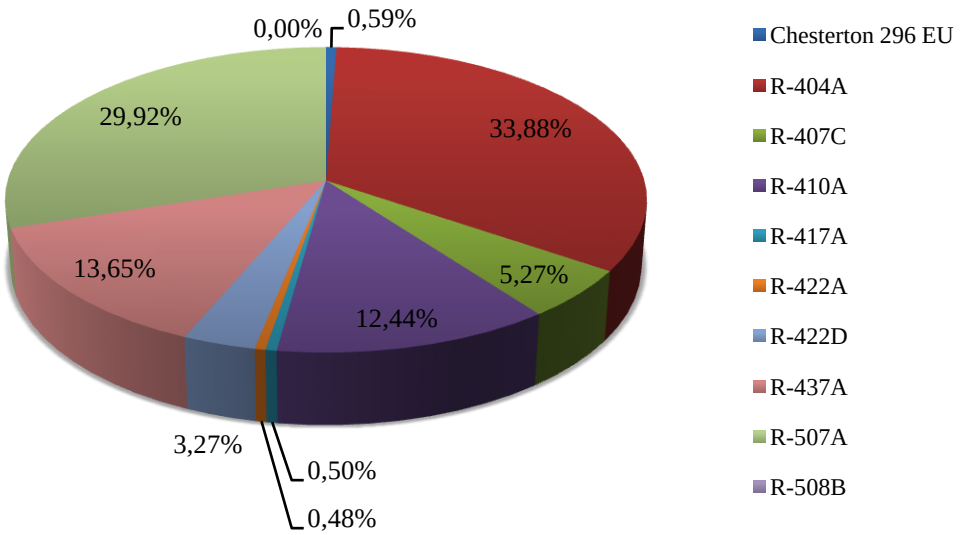
Source: Ministry of Commerce, Industry and Tourism

Figure N° 1. Percentage of HFC imports by substance (2012)



[9] Chesterton® 296 is a mixture of HFC-134a (40-50 %), HFC-365mfc (20-30%), HFC-245fa (20-30%) and isopropyl alcohol (1-5%).

Figure N° 2. Distribution of HFC blends



2.1. Importers

24 companies imported HFCs to the country in 2012 (Table N°2). The market is highly concentrated: two companies (DuPont and QuímicaComercialAndina) account for 56.1% of total imports and the largest six companies serve the 80.8% (Figure N°2). The imports of HFC blends were dominated by DuPont representing 41.4%of the total (Table N°3).

Table N° 1. HFC Importers in 2012, kg

Importer	HFC-134a	HFC-152a	HFC-125	HFC-227ea	HFC-245fa	HFC blends	TOTAL
Importer 1	337,512	14,755				150,572	**502,839**
Importer 2	205,207					61,644	**266,850**
Importer 3	101,880					22,614	**124,494**
Importer 4	88,623					11,575	**100,198**
Importer 5	67,550					0	**67,550**
Importer 6	38,356					9,070	**47,426**
Importer 7	36,984					8,000	**44,984**
Importer 8	8,721					31,049	**39,771**
Importer 9	15,260					22,997	**38,257**
Importer 10	28,975				452	0	**29,427**
Importer 11	13,954					11,400	**25,354**

Table N° 1. HFC Importers in 2012, kg							
Importer	**HFC-134a**	**HFC-152a**	**HFC-125**	**HFC-227ea**	**HFC-245fa**	**HFC blends**	**TOTAL**
Importer 12	8,537					9,766	**18,303**
Importer 13						12,430	**12,430**
Importer 14	10,690					0	**10,690**
Importer 15	10,200					0	**10,200**
Importer 16	4,488					5,198	**9,686**
Importer 17	6,399					0	**6,399**
Importer 18	5,100					0	**5,100**
Importer 19						5,025	**5,025**
Importer 20						2,132	**2,132**
Importer 21				1,900		0	**1,900**
Importer 22			1,740			0	**1,740**
Importer 23				1,714		0	**1,714**
Importer 24	1					0	**1**
TOTAL	**988,437**	**14,755**	**1,740**	**3,614**	**452**	**363,471**	**1,372,470**

Source: Data from the Ministry of Commerce, Industry and Tourism & Analysis of customs importation records

Figure N° 3. Percentage of HFC imports by importer (2012)

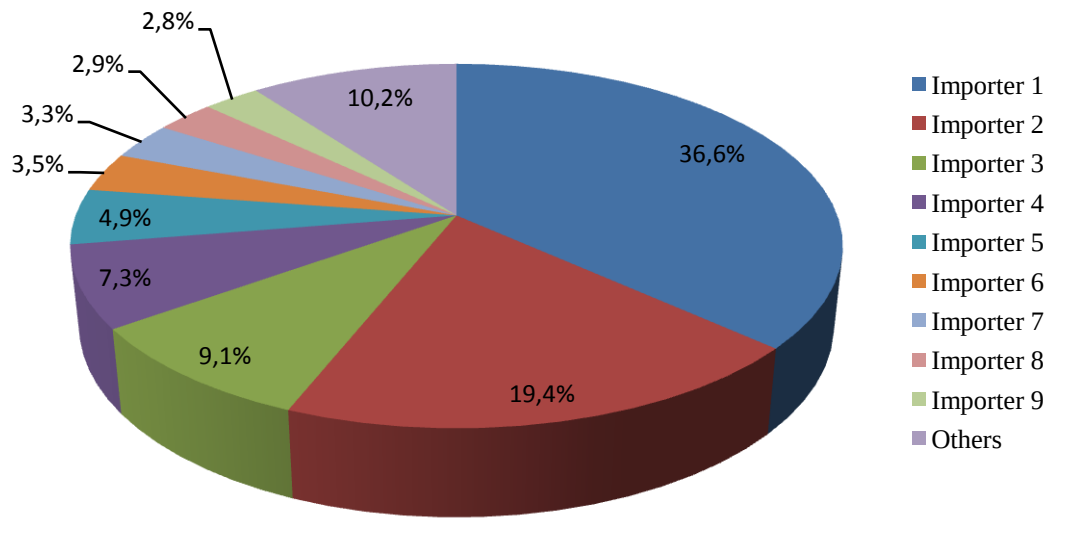


Table N° 3. Importers of HFC blends in 2012, kg											
Importer	**Chesterton 296 EU contact cleaner**	**R-404A**	**R-407C**	**R-410A**	**R-417A**	**R-422A**	**R-422D**	**R-413A**	**R-507A**	**R-508B**	**TOTAL**
Importer 1		37,797	6,810	12,258	1,816	1,743	11,895	49,632	28,603	18	150,572
Importer 2		23,001	1,456	1,513					35,674		61,644
Importer 8		6,213	3,865						20,972		31,049
Importer 9		16,325	1,135						5,537		22,997
Importer 3		11,766	3,390	1,356					6,102		22,614
Importer 13				12,430							12,430
Importer 4		4,230	0		0				7,345	0	11,575
Importer 11		5,276	1,356	4,769							11,400
Importer 12		2,082	1,130	6,554							9,766
Importer 6		6,810		1,130					1,130		9,070
Importer 7		8,000									8,000
Importer 16				5,198							5,198
Importer 19		1,635							3,390		5,025
Importer 20	2,132										2,132
TOTAL	**2,132**	**123,135**	**19,142**	**45,207**	**1,816**	**1,743**	**11,895**	**49,632**	**108,753**	**18**	**363,471**

Source: Data from the Ministry of Commerce, Industry and Tourism & Analysis of customs importation records

Three years ago the market dynamics changed with DuPont´s commercial decision to import HFCs directly to the country. This change is illustrated in table No. 4: from 2008 to 2012 DuPont grew its share as importer from zero to 36.64% at the expense of other companies, particularly, Cabarría and QuímicaComercialAndina.

Table N° 4. Distribution of HFC´s Importers, 2008 vs. 2012				
Importer	**2,008 (Kg)**	**% of total imports**	**2,012 (Kg)**	**% of total imports**
Importer 1	0	0.00	502,839	36.64
Importer 2	247,651	32.47	266,850	19.44
Importer 3	75,276	9.87	124,494	9.07
Importer 4	149,253	19.57	100,198	7.30
Importer 5	110,141	14.44	67,550	4.92
Importer 6	36,152	4.74	47,426	3.46
Importer 7	22,787	2.99	44,984	3.28
Importer 8	0	0.00	39,771	2.90
Importer 9	33,256	4.36	38,257	2.79
Importer 10	14,094	1.85	29,427	2.14

Source: Data from the Ministry of Commerce, Industry and Tourism &
Analysis of customs importation records

2.2. Source, Packaging& Pricing

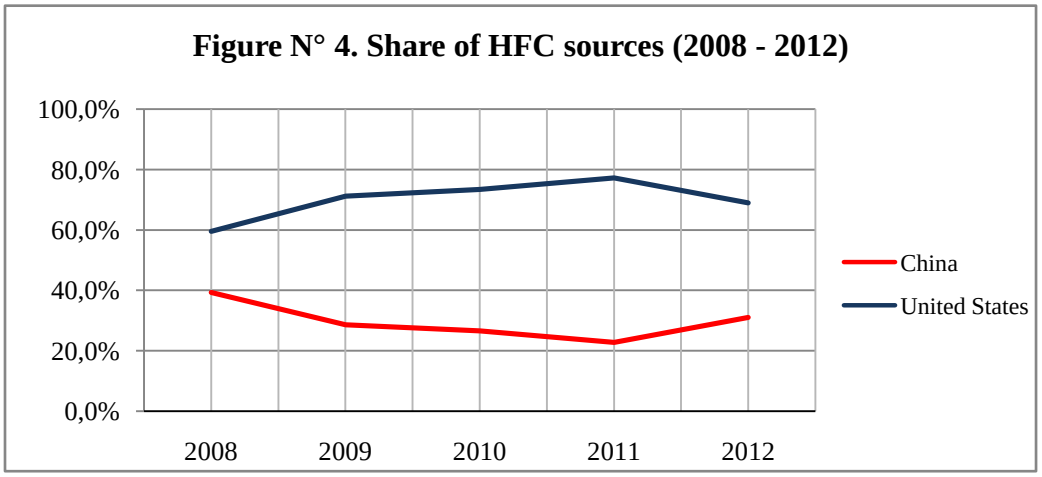
The United States and China are the traditional source of HFCs imported by Colombia. Relatively small amounts of HFCs were imported from Europe in 2008 and 2009.Table N° 5 shows the imported quantities from each sourcing point and the corresponding shares for the period 2008-2012.

As it is illustrated in figure N° 4, since2009the United States has enjoyed a dominant position inthe HFC supply that fluctuated around a participation of 70 %.

Table N° 5. Source of imported HFCs										
Substance	**2008**		**2009**		**2010**		**2011**		**2012**	
	kg	**%**	**kg**	**%**	**kg**	**%**	**kg**	**%**	**kg**	**%**
HFC-134a										
China	166,750	28	156,992	23	192,942	22	159,173	22	220,246	22
United States	430,197	72	524,317	77	682,073	78	566,727	78	768,192	78

Table N° 5. Source of imported HFCs										
Substance	**2008**		**2009**		**2010**		**2011**		**2012**	
	kg	**%**	**kg**	**%**	**kg**	**%**	**kg**	**%**	**kg**	**%**
HFC-152a										
United States	8,263	100	16,135	100	3,541	100	8,263	100	14,755	100
HFC-227ea										
China			2,300	79	2,500	100	2,700	100	2,900	80
United States			625	21					714	20
HFC-125										
China			780	30	1,740	48			1,740	100
United States			1,856	70	1,856	52				
HFC blends										
China	132,972	84	85,687	55	117,441	39	71,356	25	200,589	55
United States	15,606	10	69,406	44	184,744	61	217,597	75	162,883	45
Europe	8,848	6	1,635	1						

Source: Data from the Ministry of Commerce, Industry and Tourism & Analysis of customs importation records



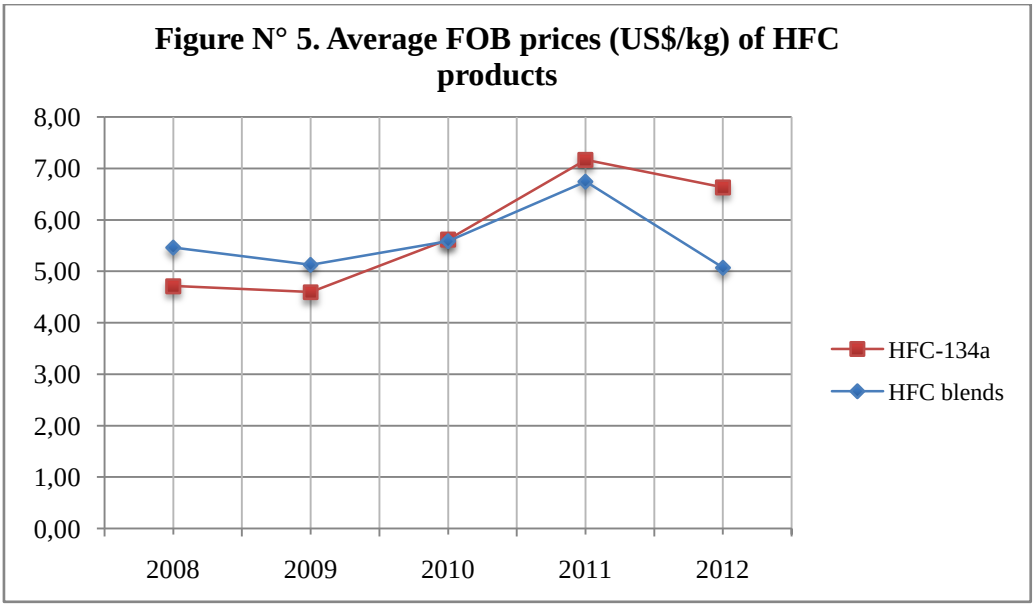
The HFC used in the refrigeration/air conditioning (RAC) market (HFC-134a and HFC blends) -that accounts for 98.5% of the total imports- are not submittedto any repackaging process in the country. They are imported in containers in the same presentation that will reach the end users (cylinders from 10.9 to 13.6 kg and small cans of around 340, 425 and 750 g). Table N° 6 lists the different capacities of containers used in the market.

Table N° 6. Capacity of containers used for HFC	
Substance	**Container Capacity (kg)**
HFC-134a	13.6 kg
HFC-227ea	9 – 453.5 kg (20 lbs. – 1,000 lbs.)
R-404A	10.9 kg
R-407C	11.3 kg
R-410A	11.3 kg
R-507A	11.3 kg

Source: Information from major importers

Figure N° 5 shows the evolution of average FOB prices of relevant HFC (HFC-134a and HFC blends). A peak in the price of all substances is observed in 2011. According to the information gathered in the market, this situation was the result of a product supply uncertainty motivated by the movement of several production facilities from the Western countries to Asia that boosted the demand.

Figure N° 5. Average FOB prices (US$/kg) of HFC products



3. HFCs exports

In comparison to the imports, the amounts of exported HFC, pure substances and blends, in the period 2008-2012 were small (Table N° 7). There were no exports in 2008 and 2009 and the amounts for 2010 and 2012 represented 2.83 and 1.90% of the total imports respectively. A peak of 11.9% was reached in 2011 when significant amounts of HFC-134a were shipped to Guatemala and Peru. The largest exported product is HFC-134a (around 80% of total exports in 2010 and 2011 and 96% in 2012) followed by HFC blends.

Table N° 7. HFC exports by country of destination and company, kg

Substance	Country	Company	2010	2011	2012
HFC-134a	Argentina	Importer 1		5,448	
	Costa Rica	Importer 2		8,401	327
	United States	Importer 1	5,859		
	Finland	Other*	13,630		
	Guatemala	Importer 2	7,628	40,553	24,738
	Peru	Importer 6		42,290	
Total HFC-134a			**27,118**	**96,692**	**25,065**
HFC blends	Argentina	Importer 1		7,082	
	Costa Rica	Importer 2		2,045	102
	Guatemala	Importer 2	4,674	2,725	904
	India	Importer 1		9,302	
	Mexico	Importer 1		2,880	
	Venezuela	Importer 4		9	
Total HFC blends			**4,674**	**24,044**	**1,006**
HFC-152a	Brazil	Importer 1	1,771	1,180	
Total HFC-152a			**1,771**	**1,180**	
TOTAL			**33,562**	**121,916**	**26,071**
Percent of total imports, %			**2.83**	**11.88**	**1.90**

*Refrigerant exported for destruction

Source: Data from the Ministry of Commerce, Industry and Tourism & Analysis of customs importation records

Since 2010 amajor Colombian distributor of chemicals started to export HFC-134a and HFC-based refrigerant blends to Central America (Guatemala and Costa Rica) following what could be seen as a medium term commercial strategy and not only a spot business.

4. HFC consumption

As it has been defined by the Montreal Protocol, in the context of this survey *consumption*isdefined by the addition of *imports* plus *production* minus *exports*. Since there are no production facilities of HFC in Colombia and the exported amounts are relatively small, the consumption figures follow those of imports.

Table N° 8 shows the amounts of HFCs consumed in Colombia. HFCs are basically used in the Refrigeration and Air Conditioning (RAC) sector. In 2012 this market segment accounted for 98.3 % of the total volume used in the country (Table N° 9). The remaining 1.7 % is represented by the use of HFC-152a in the glass industry (1.1 %), Chesterton® SP 296 as cleaning agent for electronics (0.2 %) and HFC-227ea and HFC-125 for fire protection (0.4 %). There is no HFC consumption in the foam industry, where pentanes -for domestic refrigeration- and HCFC-141b -for commercial refrigeration, discontinuous panels and spray- are the preferred blowing agents.

Table N° 8. HFC consumption by substance (kg)

Substance	2008	2009	2010	2011	2012
HFC-134a	596,947	681,309	847,898	629,209	963,372
HFC-152a	8,263	16,135	1,771	7,082	14,755
HFC-125	0	2,636	3,596	0	1,740
HFC-227ea	0	2,925	2,500	2,700	3,614
R-404A	61,221	57,041	73,987	67,988	122,799
R-407C	35,854	15,347	18,118	13,698	19,142
R-410A	4,953	13,308	24,931	35,299	44,872
R-413A	0	16,572	86,749	75,768	49,632
R-417A	0	2,270	2,946	1,349	1,816
R-422A	0	25,067	2,615	872	1,743
R-422D	0	454	6,810	9,060	11,895
R-507A	55,390	26,660	80,992	59,221	108,418

Table N° 8. HFC consumption by substance (kg)					
Substance	**2008**	**2009**	**2010**	**2011**	**2012**
R-508B	9	9	82	68	18
Chesterton® 296 EU[1]	0	0	172	1,586	2,132
TOTAL	**762,637**	**859,732**	**1,153,165**	**903,905**	**1,346,399**

The main product used in 2012 in the RAC sector was HFC-134a (72.8%), followed by R-404A (9.3%), R-507A (8.2%), R-413A (3.7%), R-410A (3.4%) and R-407C (1.4%). These six products accounted for 98.8% of the total HFC used in RAC (Table N° 9).

Table N° 9. Most consumed HFCs, %			
HFC	**2012 consumption, kg**	**% of total HFC consumption**	**% of total HFC consumption in RAC**
HFC-134a	963,372	71.55	72.78
R-404A	122,799	9.12	9.28
R-507A	108,418	8.05	8.19
R.413A	49,632	3.69	3.75
R-410A	44,872	3.33	3.39
R-407C	19,142	1.42	1.45
Total HFC blends	360,333	26.76	27.22
TOTAL HFC-134a & Blends	**1,323,706**	**98.31**	**100.00**

Along with the HFC, the other important players in the refrigeration industry are HCFC-22 and the HCFC based refrigerant blends (R-406A and R-409A), introduced in the market as CFC-12 replacement. The figures N° 6 and N° 7 show the evolution of its consumption compared to that of the HFC used in RAC.

[1] Chesterton® 296 is a mixture of HFC-134a (40-50 %), HFC-365mfc (20-30%), HFC-245fa (20-30%) and isopropyl alcohol (1-5%).

Figure N° 6. HFC vs. HCFC-consumption in RAC, Kg

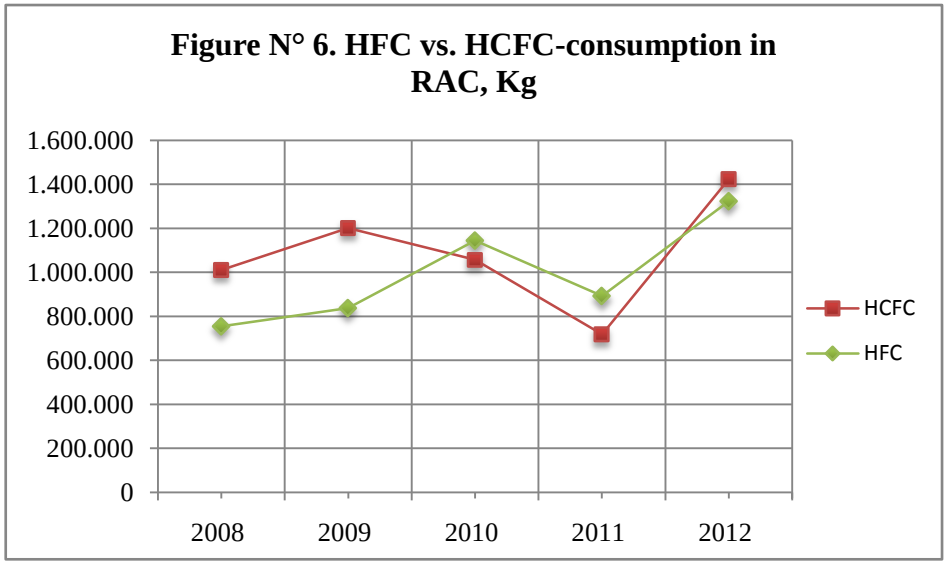


Figure N° 7. HFC consumption in 2008-2012 vs. HCFC-22 used in RAC, kg

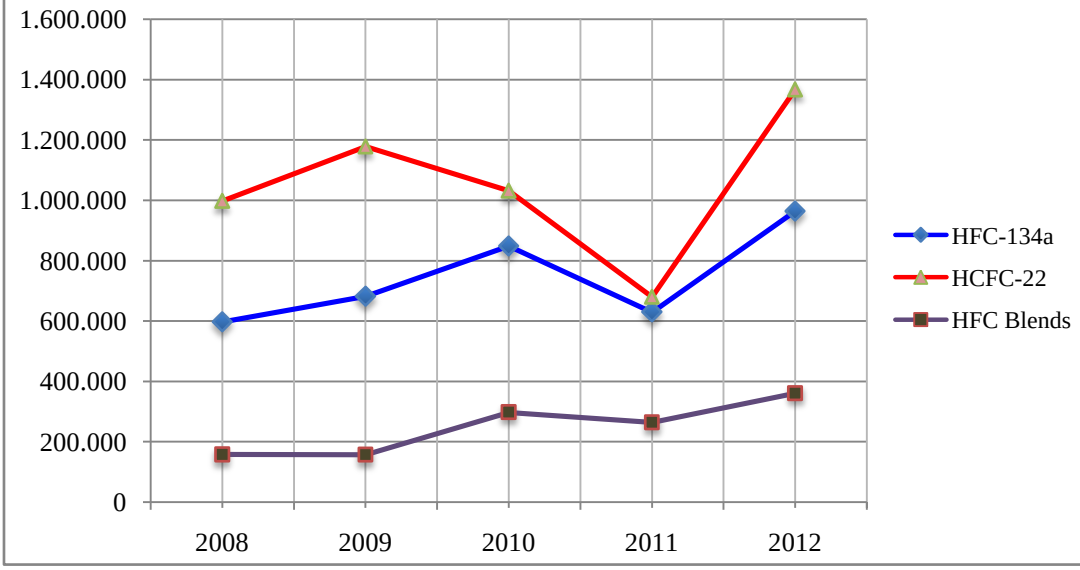
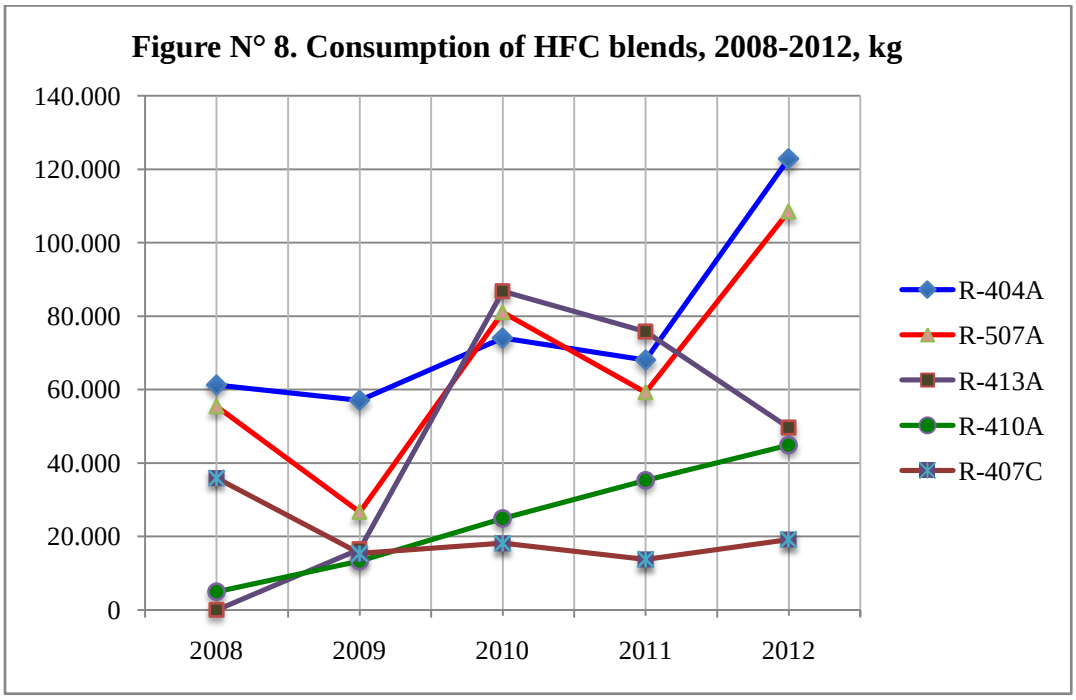


Figure N° 8 shows the evolution of consumption for the different HFC blends throughout the period 2012-2012. Meanwhile HFC-134a had an annual CGR of 12.71%;meanwhile, R-410A enjoyed a growth rate of 73.49% in the last four years.



5. Characterization of the HFC´s market

5.1. Methodology

Two approaches were used for the HFCs market characterization:

- *Top-down*, starting from the statistical data on importers, import quantities, etc., and following downstream in the supply chain with their customers, and,
- *Bottom-up*, focused on the qualitative and quantitative description of the end-users. Once the country industrial sectors that consume HFCs were identified, personal interviews were held with the key playersand the collected data was extrapolated for the whole sector based on available statistical information. It should be noted that *Bottom-up* has only been used to a very limited degree, and the end results should be interpreted with that in mind.

The survey was developed in a sequential mode and the following steps were pursued:

- Analysis of the official data from which the list of HFC importers with the associated quantities was obtained.
- The companies that account for 80% of the HFC imports to Colombia were identified and, from each one, the 2012 sales report was obtained. Critical Information on customers, sold substances, quantities and end users was collectedand the key players to interview in the subsequent commercialization level were defined.
- Comprehensive interviews were held with the players and detailed information was obtained on the industrial sectors that use HFCs, key companies by sector, quantities, etc.

5.2. HFC market characterization

The industrial sectors that use HFCs in Colombia are:

- Refrigeration and Air Conditioning (RAC).
- Manufacture of Metered-dose-inhalers (MDI)
- Surface treatment of glass bottles
- Solvents and aerosols.
- Fire extinguishing.

There is no use of HFCs in the foam sector in Colombia. Since the RAC sector represents 98.3% of the total use of HFCs in the country (table N° 9), the main efforts were devoted to its characterization.

5.2.1. Refrigeration and Air Conditioning (RAC)

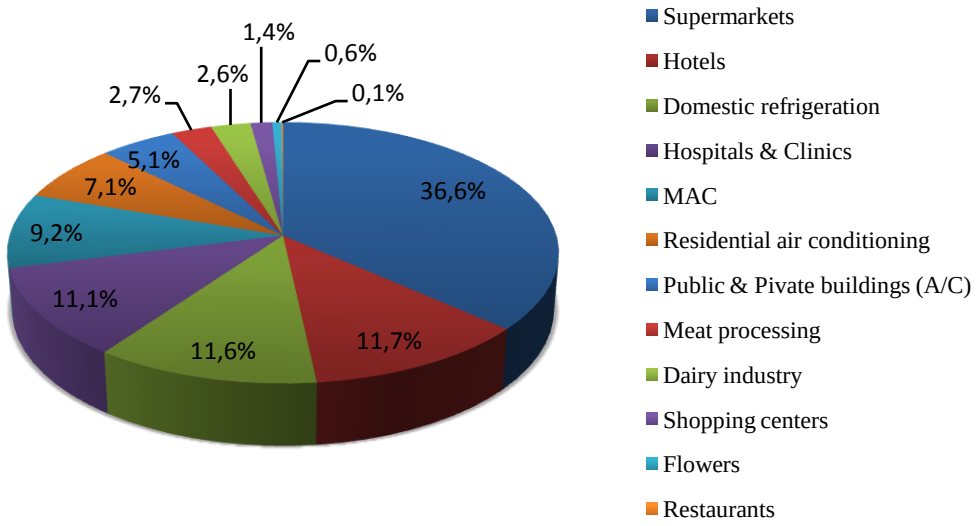
The per cent distribution of the HFCs & HCFCs used in the different RAC sub-sectors is described in table N°10.HCFC-22 accounts for more than 99% of the total HCFCs used in RAC and -as discussed above (figure N° 7) still is the major player in the RAC industry (67.1% of total consumption). For this reason its inclusion in an analysis of the RAC sector is mandatory.

Supermarkets are by far the sub-sector with the largest consumption of refrigerant (36.59%) and along with the next three greatest (hotels, domestic refrigeration and hospitals & clinics) cover 71.05% of the total use (figure N° 9).

Table N° 10. Distribution (%) of the HFCs & HCFCs use in RAC by sector

Sector	HCFC-22	HFC-134a	R404A	R-410A	R-407C	R-507A	R-437A	Total
Supermarkets	58.69	0.69	83.37	0.00	0.00	1.42	0.00	36.59
Hotels	9.56	14.27	0.00	3.60	94.41	19.68	0.00	11.69
Domesticrefrigeration	0.00	37.91	0.00	0.00	0.00	0.00	0.00	11.63
Hospitals&Clinics	10.67	14.49	1.48	2.53	5.59	0.00	0.00	11.14
MAC	0.00	29.23	0.00	0.00	0.00	0.00	98.04	9.24
Residential air conditioning	6.48	0.00	0.00	66.49	0.00	0.00	0.00	7.10
Public &Pivate buildings (A/C)	6.28	0.00	0.00	27.15	0.00	0.00	0.00	5.11
Meatprocessing	2.37	0.04	8.37	0.00	0.00	73.99	0.00	2.69
Dairyindustry	3.99	0.23	6.79	0.23	0.00	4.91	1.96	2.65
Shopping centers	0.83	3.07	0.00	0.00	0.00	0.00	0.00	1.45
Flowers	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.61
Restaurants	0.12	0.08	0.00	0.00	0.00	0.00	0.00	0.10
% by substance of total RAC use	**60.90**	**30.68**	**0.74**	**4.75**	**1.08**	**1.59**	**0.28**	**100.00**

Figure N° 9. HFC & HCFC percent by sector

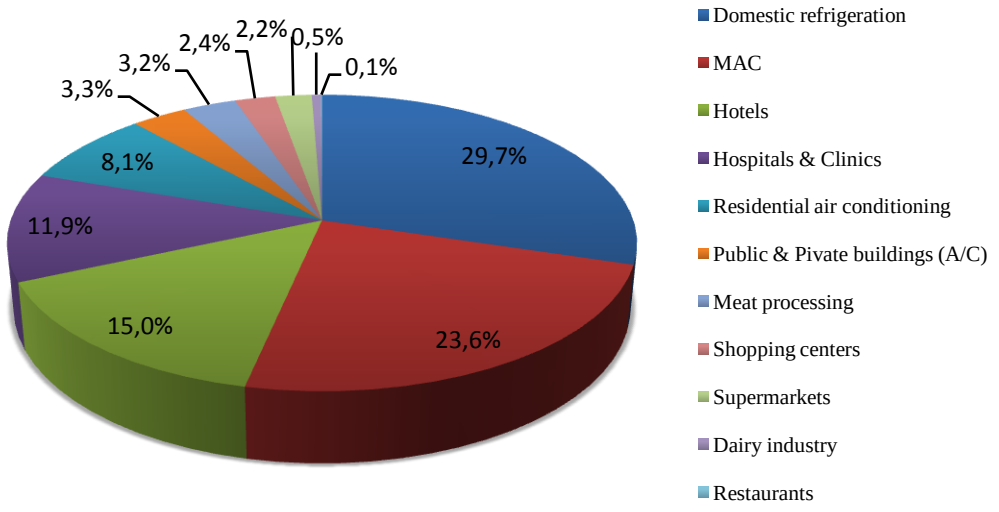


The relative consumption by sub-sector changes dramatically if we observe the refrigerant use without including HCFC-22 (Table N° 11). Domestic refrigeration becomes the sub-sector with the largest consumption of HFC (29.74%) followed by MAC (23.64), hotels (15.02), hospitals & clinics and residential A/C. These five segments represent 88.3% of the total HFC use (figure N° 10). It is clear from a comparison between table N° 10 and table N° 11 that one of the major challenges is the conversion of the supermarkets sector out of HCFCs to non-Ozone-depleted options of low impact on climate change.

Table N° 11. Distribution (%) of the HFCs use in RAC by sector							
Sector	**HFC-134a**	**R404A**	**R-410A**	**R-407C**	**R-507A**	**R-437A**	**Total**
Domesticrefrigeration	37,91	0,00	0,00	0,00	0,00	0,00	29,74
MAC	29,23	0,00	0,00	0,00	0,00	98,04	23,64
Hotels	14,27	0,00	3,60	94,41	19,68	0,00	15,02
Hospitals&Clinics	14,49	1,48	2,53	5,59	0,00	0,00	11,85
Residential air conditioning	0,00	0,00	66,49	0,00	0,00	0,00	8,07
Public &Pivate buildings (A/C)	0,00	0,00	27,15	0,00	0,00	0,00	3,30
Meatprocessing	0,04	8,37	0,00	0,00	73,99	0,00	3,19

Table N° 11. Distribution (%) of the HFCs use in RAC by sector							
Sector	**HFC-134a**	**R404A**	**R-410A**	**R-407C**	**R-507A**	**R-437A**	**Total**
Shopping centers	3,07	0,00	0,00	0,00	0,00	0,00	2,41
Supermarkets	0,69	83,37	0,00	0,00	1,42	0,00	2,17
Dairyindustry	0,23	6,79	0,23	0,00	4,91	1,96	0,55
Restaurants	0,08	0,00	0,00	0,00	0,00	0,00	0,06
% by substance of total RAC use	**78,45**	**1,88**	**12,14**	**2,75**	**4,06**	**0,72**	**100,00**

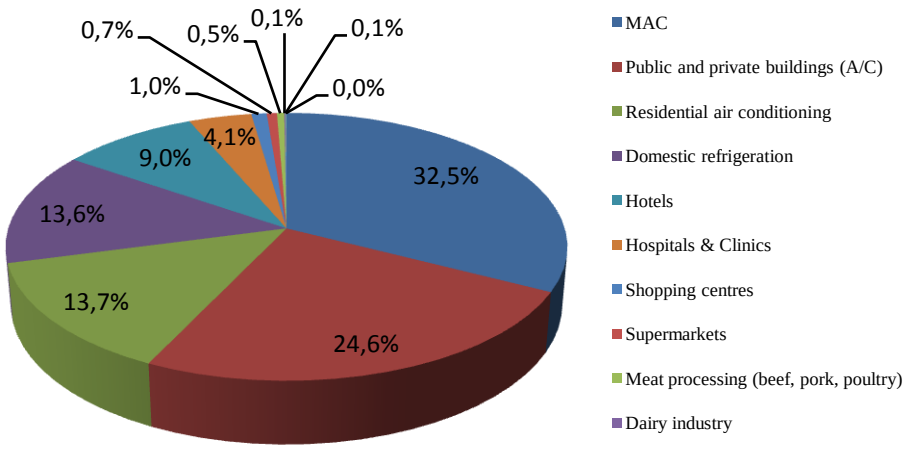
Figure N° 10. HFC percent by sector



The per-cent estimates shown above were calculated based on the figures of the total refrigerant charge by sub-sector (table N° 12). These figures were obtained through detailed surveys conducted with key players in each sub-sector.

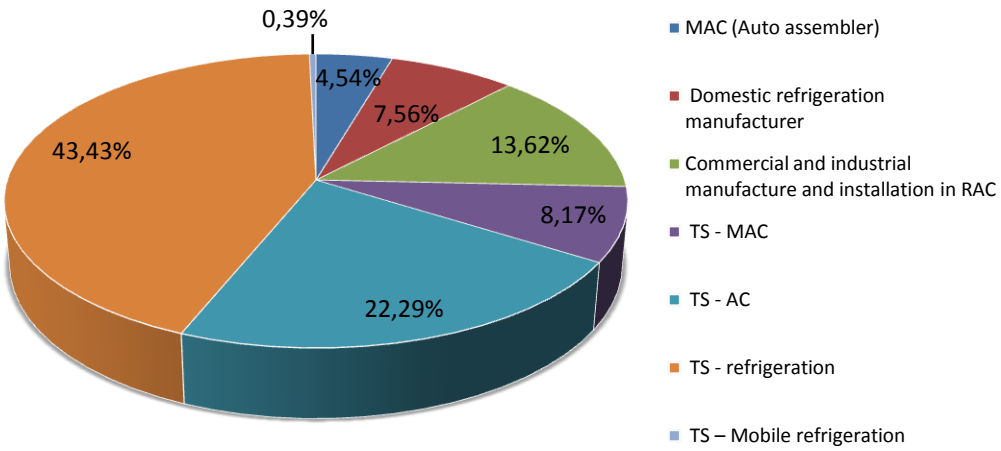
Table N° 12. Installed charge of refrigerant by RAC sub-sector, kg								
Sector	**HCFC-22**	**HFC-134a**	**R-404A**	**R-410A**	**R - 407C**	**R-507A**	**R-437A**	**Total**
Residential air conditioning	212,992	0	0	511,577	0	0	0	724,569
Domestic refrigeration	0	508,289	0	0	0	0	0	508,289
Flowers	45,470	268	0	0	176	0	0	45,914
Dairy industry	30,681	1,720	197	269	0	653	203	33,723
Meat processing (beef, pork, poultry)	22,731	686	793	0	0	16,435	0	40,646
Hotels	138,853	234,171	0	27,699	62,735	11,445	0	474,903
Hospitals & Clinics	84,298	133,427	6,078	12,962	1,579	0	0	238,345
Shopping centres	237,702	37,590	0	0	0	0	0	275,292
Supermarkets	1,156,567	8,205	14,918	0	0	1,818	0	1,181,508
Public and private buildings (A/C)	907,019	458,634	0	458,634	0	0	0	1,824,287
Restaurants	3,900	1,900	0	0	0	0	0	5,800
MAC	0	1,210,809	0	0	0	0	0	1,210,809
Total	**2,840,213**	**2,595,699**	**21,987**	**552,507**	**64,490**	**30,351**	**203**	**6,564,084**

Figure N° 11. Percent distribution of installed HFC charge by RAC sub-sector



The top-down approach provides relevant data on how (by which distribution channels) the substances reach the end users. 52.6% of the total refrigerant comes through retail sales in stores normally supplying a complete refrigeration package (equipment, technical service, etc.) located in the large and medium cities. This refrigerant is acquired by several technicians that own small maintenance shops throughout the country. After the direct purchase to the importers and their distributors (typical for mobile A/C and manufacturing of domestic and commercial equipment), the RAC engineering companies are the largest distribution channel.

Figure No. 12. HFC + HCFC consumption by actor of supply chain



At the different commercialization levels it is estimated that 74% of the substances go to maintenance and 26% to new installations. (Figure No. 12 &Table No. 13).

Table N° 13. HFC y HCFC Consumption for RAC, Kg

Sector	HCFC 22	HCFC-123	HFC 134a	R 404A	R-413A	R 507	R 410A	R-409	R 407C	Otros HFC	Total general
MAC (Auto assembler)	-	-	75.500	-	-	-	-	-	-	-	75.500
Domesticrefrigerationmanufacturer	-	-	125.815	-	-	-	-	-	-	-	125.815
Commercial and industrial manufacture and installation in RAC	92.015	1.135	76.111	8.807	738	24.754	14.830	203	5.314	2.539	226.445
Technical Service (TS) - MAC	-	-	131.153	835	3.307	352	170	110	23	14	135.964
Technical Service – (TS) - AC		-	73.838								

Table N° 13. HFC y HCFC Consumption for RAC, Kg											
Sector	**HCFC 22**	**HCFC-123**	**HFC 134a**	**R 404A**	**R-413A**	**R 507**	**R 410A**	**R-409**	**R 407C**	**Otros HFC**	**Total general**
	277.600			1.894	4.406	1.728	8.965	135	1.588	504	370.658
Technical, Service (TS) - refrigeration	418.387	-	115.696	51.945	61.028	41.626	1.681	3.695	19.739	8.501	722.297
Technical Service (TS) – Mobile refrigeration	219	-	2.516	2.740	581	452	-	-	-	-	6.509
TOTAL	**788.221**	**1.135**	**600.629**	**66.222**	**70.060**	**68.912**	**25.646**	**4.143**	**26.664**	**69**	**1.663.189**

5.2.2. Fire protection

HFC-227ea, imported by Productos de Seguridad S.A., and HFC-125, imported by ProveerSuramericana Ltda., are used only for fire protection. Their selection depends on the type of equipment technology: Kidde or Fike.

Theyare usedin fixed systems that have a container and a distribution system, mainly in the petroleum industry and -in lower proportion- in electric power substations and data centres subsectors. Novec™ 1230, a fluoroketone, thatis slowly penetrating the market as HFC replacement in the data centre subsector.

There is no use of HFCs for portable fire extinguishers.

5.2.3. MDI manufacture

There is only one companythat manufacturesmetered-dose inhalers (MDI) in Colombia. This laboratorywas converted from CFC-11 and CFC-12 to HFA-134a (pharmaceutical grade HFC-134a) with Funds from the Multilateral Fund for the Montreal Protocol.

5.2.4. Manufacture of glass bottles

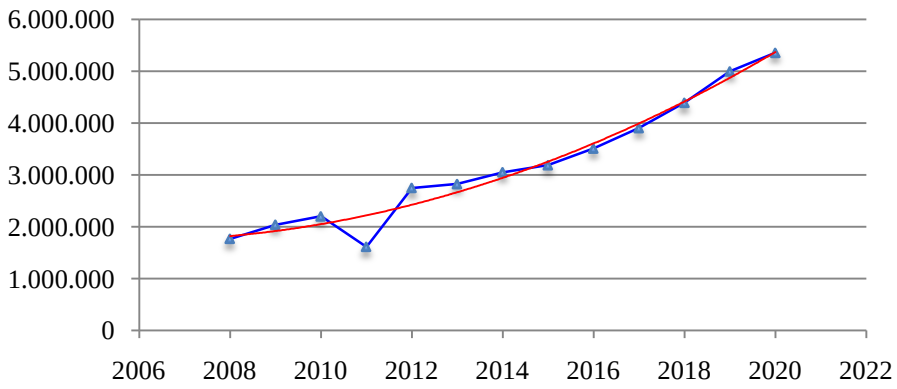
HFC-152a is the product choice for the surface treatment of glass bottles; being Peldar the major producer in Colombia.

6. Trends of HFC consumption (2013-2020)

Table 4 shows the estimated HFC consumption for years 2013-2020 in a business-as-usual (BAU) scenario. This projection was calculated assuming the following items:

- The refrigeration sector in Colombia grew through years 2008-2012 with an average compounded growth rate of 11.70%. Based on the interviews held with the sector experts it was defined as the growth rate to forecast the future market consumption a figure three points lower than that of the historical growth (8.70%).

Figure N° 13. Future HCFC/HFC consumption in RAC, kg



- The HCFC consumption will follow the chronogram defined by the Montreal Protocol in Decision XIX/6 for the HCFC phase-out in the Article 5 parties.
- In accordance with the historical data the refrigeration products will grow at differentiated rates following in magnitude the same historical order (R-410A> R-404A> R-507A> HFC-134a> R-437A>R-407C).
- The rest of the HFC products that go to the fire protection and solvents markets and to the glass production will grow at the same rate of the GDP: 4.7 %.

Based on table N° 13, in the business-as-usual scenario the HFC consumption will triple in 2020 (4,615 tonnes) the value of 2012 (1,534 tonnes). The two most popular products will be HFC-134a and R-404A. They will represent 54.4 and 22.2% of the total HFC consumption respectively.

Table N° 14. Estimated HFC consumption for 2013 - 2020, Business-as-usual scenario (kg)								
HFC	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
HFC-134a	1,085,822	1,223,836	1,379,392	1,554,720	1,752,333	1,975,064	2,226,105	2,509,055
R-404A	146,140	173,918	206,975	246,315	293,134	348,851	415,158	494,069
R-507A	128,239	151,683	179,413	212,213	251,010	296,899	351,177	415,379
R-410A	66,348	98,103	145,057	214,483	317,138	468,925	693,360	1,025,212
R.437A	55,587	62,258	69,729	78,096	87,468	97,964	109,720	122,886
R-407C	16,362	13,986	11,955	10,219	8,735	7,467	6,383	5,456
Other HFC refrigerant blends	15,608	15,764	15,922	16,081	16,242	16,404	16,568	16,734
HFC-152a	15,448	16,175	16,935	17,731	18,564	19,437	20,350	21,307
Chesterton 296EU	2,232	2,337	2,447	2,562	2,682	2,808	2,940	3,079
HFC-125	1,822	1,907	1,997	2,091	2,189	2,292	2,400	2,513
TOTAL	**1,533,608**	**1,759,966**	**2,029,821**	**2,354,511**	**2,749,494**	**3,236,110**	**3,844,160**	**4,615,687**

7. Conclusions

- The market sectors that use HFCs in Colombia are refrigeration and air conditioning (RAC), MDIs manufacturing, surface treatment for glass bottles, fire protection and solvents.
- The most popular HFCs currently consumed in Colombia are HFC-134a (71.5%), R-404A (9.1%) and R-507A (8.0%). However, in spite of only representing 3.3% of today´s consumption, R-410A enjoyed the highest growth rate (73.5%)in the last five years (2008-2012).
- The RAC sector represents 98.3% of the total use of HFCs in Colombia.It mainly covers the subsectors of domestic refrigeration (29.74%), MAC (23.64%) and hotels (15.02%).
- HCFC-22 accounts for 67.1% of total consumption of refrigerants. It is mainly used in supermarkets (58.7%), hospitals /clinics (10.7%) and hotels (9.6%). Its replacement following the Montreal Protocol control measures represents the greatest driving force for the HFCs growth in a BAU scenario.
- In a business-as-usual scenario the HFC consumption will triple in 2020 (4,615 tonnes) the 2012 value (1,534 tonnes). The two most popular products will be HFC-134a and R-404A. They will represent 54.4 and 22.2% of the total HFC consumption respectively.

8. Future Actions

Based on the recent reports published by the Refrigeration Technical Options Committee of the Montreal Protocol (RTOC) low GWP options have been identified for several market subsectors (table N° 14).

Table N° 15. Low GWP options for relevant RAC sectors

Sector	Subsector	Current substance	Low GWP options
Refrigeration	Domestic	HFC-134a	HC-600a, HFC-1234yf.
	Commercial	Stand-alone equipment: HFC-134a y R-404A.	HC-600a and HC-290 for small units with charges lower than 1.5 kg. HFC-1234yf and CO_2.
	Supermarkets	R-404A, R-507A y HFC-134a.	Transcritical CO_2, cascade systems using CO_2 at the low temperature level combined with a variety of refrigerants at the high temperature level such as ammonia, HC-290 and HC-1270
	Transportation, trucks	R-404A, HFC-134a.	HFC-1234yf as replacement of HFC-134a
	Transportation, reefers	R-404A, HFC-134a.	CO_2
Air Conditioning	Split and window type	R-407A, R-410A.	HC-290
	Mobile	HFC-134a	HFC-1234yf, CO_2

The significant growth in HFC consumption in the BAU scenario, driven partially by the HCFC phase-out, constitutes a relevant challenge for the country because of the associated climate change impact. Within the frame work of the Colombian strategy of low carbon based development, the calculation of the green-house emissions due to HFCs along with the preparation of the abatement cost curves and the definition and prioritisation of mitigation actions are the path forward.

9. Projects

The following demonstration/investment projects are pertinent:

Table N° 16. Proposed projects		
Sector	**Project**	**Outputs**
Institutional strengthening	Integration of HFCs inventory results in the Colombian strategy of low carbon based development	Green-house emissions due to HFCs in Colombia calculated. Abatement cost curves developed. Mitigation actions defined and prioritised.
RAC sector	Promotion of cogeneration systems with heat recovery absorption chillers, providing cooling capacity as an alternative to existing CFC, HCFC and HFC based Chillers.	Implementation of a demonstrative District Cooling System, phasing out high GWP substances consumption.
	Conversion of the production of domestic and stand-alone commercial units to hydrocarbon technology (replacement of R-134a by R-600a).	3 enterprises converted to R-600a in the domestic and stand-alone commercial units manufacture sector
	Demonstration project in the supermarket subsector aiming at HFC replacement.	Implementation of a demonstrative project with a cascade system using R-717 (ammonia)/R-744 (CO2). Implementation of a demonstrative project with a cascade system using R-290 (propane)/R-744 (CO2). Implementation of a demonstrative

Table N° 16. Proposed projects		
Sector	**Project**	**Outputs**
		project with a trans-critical CO_2 system.
	Demonstration project for the use of a low GWP option for air conditioning in buildings.	Implementation of a demonstrative project with a hydrocarbon air conditioning system in hotels.
Foam sector[2]	Demonstration project to develop cost effective non-flammable PU formulations based on unsaturated HFCs (HFO) for spray and discontinuous panels (small and medium enterprises) to be applied in low and high altitudes over sea level.	Implementation of a demonstrative project with HFO, optimizing the cost/performance balance of these substances, achieving a similar foam thermal behaviour to HCFC-141b at the lowest possible cost.

[2]While HFCs is currently not used in Foams (as mentioned in the report), this may change due the currect HCFC-phase-out efforts, which explains the need for a project in that sector.