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HFC Emissions Report for Colombia

Prepared under contract to UNDP for CCAC

PROJECT OBJECTIVE

TO DEVELOP AN EMISSIONS MODEL FOR HFCs IN COLOMBIA BASED ON INFORMATION AND MATERIALS GENERATED IN AN EARLIER COUNTRY REVIEW OF HFC CONSUMPTION.

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OUTLINE OF THE BASIC METHODOLOGY

The CCAC sponsored HFC Survey on the historic consumption of HFCs in Colombia and the predictions in growth in demand to 2020 has been used as the basis for the assessment of likely emission profiles. Annual demand within Colombia can be viewed as being consumed in either one of two ways:

1. Servicing demand to replace refrigerants and fire protection agents emitted during the year

or

2. Demand created by the installation of new products or equipment within the year

All demand for sectors such as foam will fall into the 'new product' category, since no servicing of foam products takes place once installed. However, the split between (1) and (2) for refrigerants and fire protection agents will depend on the balance between annual leakage rates by sector and the growth in the overall installed base of relevant equipment.

Nevertheless, for the purposes of this work, it has been assumed that the historic and projected consumption values for each HCFC and HFC (and blends thereof), as presented in the HFC Survey and its Supplement, are reliable. This sets a clear value on the sum of (1) + (2). Hence, the identification of leakage rates in each sub-sector will have an immediate bearing on the projected growth of the installed base, since diversion of consumption into servicing will result in lower allocations to new equipment and vice versa.

ANALYSIS OF CONSUMPTION AND DERIVATION OF EMISSIONS

The model to assess emissions of HFCs from various sources was developed by firstly generating an analysis of consumption patterns for each agent (whether an individual substance or a blend) by sub-sector of use. In the case of Colombia, there were two primary sources:

In general, these sources were found to be reliable, although there were some inconsistencies in the tabular presentations within the 2014 HFC Study. For example, there was some confusion about the historic consumption pattern of R-437A will allocations being made in several tables (e.g. Table 1 and Table 8). However, this was rectified in the October 2015 Executive Summary. There was also some discrepancy about the intended use of R-437A imports with Table 3 indicating Domestic and Commercial Refrigeration use while Table 10 indicated almost sole use in mobile air conditioning. Further desk research indicated that R-437A is typically marketed as a replacement for CFC-12 in MAC applications, so the Table 10 analysis was taken as being pre-eminent.

The 2014 HFC Study showed a strong focus on the analysis of refrigerants in the reports, with the result that some quantitative information was missing for other sectors (e.g. HFC-134a use in MDIs). Although there is only one MDI producer in Colombia, it was possible to establish that only 2.3% of annual HFC-134a consumption should be allocated to this use. It was also assumed that all manufacture of MDIs in Colombia were for 'in-country' use rather than for re-export.

Despite these limitations, there was a wealth of information available in the 2014 HFC Study Report, leading to the following general observations about the Colombian situation:

1. The range of refrigerants being used in Colombia is larger than in other countries so far studied with R-417A, R-422A, R-422D, R-437A and R-508B all being used to some extent. In order to limit the complexity of the modelling, it was decided to only include those reaching an annual consumption level of >10tes/year. In addition, R-422A and R-422D were included as one refrigerant with an average composition of HFC-125 (75%) and HFC-134a (25%)

2. The use of R-437A in MAC applications had not been observed in other jurisdictions, indicating that there is a willingness in Colombia to innovate with blends containing marginal amounts of hydrocarbon.

3. While demand for HCFC-141b remains relatively high in Colombia as a foam blowing agent, the alternatives are all anticipated to be low-GWP and hence the sector does not get much coverage in the 2014 HFC Report. Indeed information suggests that there is no HFC use in the foam sector whatsoever. Nevertheless, the progress in phase-out of HCFC-141b is not only important for Colombia itself, but also for surrounding countries, since over 50% of the reported consumption goes into pre-blended polyols, a proportion of which are likely to be subject to export.

4. The analysis of refrigerant uses by RAC sub-sector in Table 10 was particularly revealing, although it highlighted some of the difficulties in distinguishing between Commercial Refrigeration and Industrial Refrigeration categories – particularly when dealing with cold-chain activities such as meat processing and the dairy industry leading through to the supermarkets themselves.

For consistency with previous approaches, the cross-references in Table 1 were used. In addition, this allowed the assignment of installed banks to the respective sub-sectors of the market, as shown.

		HFC Survey - Tables 3 & 10	*Installed HFC Bank (kg)*
Refrigeration	Domestic	Domestic Refrigeration	508,289
	Commercial	Restaurants	1,900
	Industrial/Supermarkets	Meat Processing	46,341
		Dairy Industry	
		Flowers	
		Supermarkets	
	Transport		0
Air Conditioning	Stationary A/C	Hotels	1,956,532
		Hospitals & Clinics	
		Residential Air Conditioning	
		Public & Private Buildings	
		Restaurants	
		Shopping Centres	
	Mobile Air Conditioning	MAC	1,210,809
	Other A/C		
Solvents		Electronics (Chesterton solvent)	2,132
Foams		Commercial Refrig. + Panels + Spray + Polyols	0
Aerosols		Pharmaceutical Applications (MDIs)	22,800
Fire Protection		Fire Extinguisher Manufacturing	5,354
Other Uses		Glass manufacture	14,755

Table 1 – Allocation of RAC sub-sectors to standardized format + installed HFC bank in each

The more extensive list of refrigerants used in Colombia is shown below in the consumption analysis for industrial refrigeration:

Kg					Consumption of Gas by Sector - Refrigeration Industrial									
	%	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***
Total Consumption		900,596	976,219	942,569	663,905	1,239,121	943,049	1,101,262	1,076,221	1,189,909	1,195,076	1,222,599	1,274,523	1,192,755
			8%	*-3%*	*-30%*	*87%*	*-24%*	*17%*	*-2%*	*11%*	*0%*	*2%*	*4%*	*-6%*
HCFC-22	65%	790,175	875,297	788,521	534,515	1,011,827	675,314	785,364	703,276	749,376	674,438	606,995	546,295	330,909
HCFC-141b	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
HFC-134a	1%	5,599	6,390	8,207	6,808	9,271	10,184	11,479	12,938	14,582	16,435	18,525	20,879	23,533
R404A	19%	60,321	56,202	72,899	66,989	120,994	143,992	171,361	203,932	242,694	288,825	343,723	409,055	486,806
R406A	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
R407C	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
R410A	0%	11	31	57	81	103	153	226	334	493	729	1,079	1,595	2,358
R422A-D	1%	0	16,601	6,131	6,461	8,872	9,315	9,781	10,270	10,783	11,323	11,889	12,483	13,107
R437A	0%	0	284	1,700	1,485	973	1,090	1,220	1,367	1,531	1,714	1,920	2,151	2,409
R507A	13%	44,489	21,413	65,053	47,566	87,081	103,002	121,832	144,105	170,449	201,611	238,469	282,065	333,632
R507C	0%	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2 – Significant use of R-422 blends + R-437A in the Industrial Refrigeration sector

In a second step dealing with emissions, the consumption by agent (substance or blend) as set out by example in Table 2 was then transposed to an analysis by sub-sector, which then assembled the different agents used and the emission factors related to each of those sub-sectors. In some instances, where there was evidence of a potential reduction in emission rates over time, this was factored into the modelling of emissions, as shown in Table 3 below.

Sub-Sector	*Annual Emission Rate*	*Growth in Installed Base (2008-2020)*
Refrigeration – Domestic	1%	1,042%
Refrigeration – Commercial	25% reducing to 19%	467%
Refrigeration – Industrial	20%	301%
Refrigeration – Transport	40%	N/A
Stationary A/C	10%	93%
Mobile A/C	25%	86%
Foams	4%	N/A
Solvent	50% reducing to 26%	N/A
Fire Protection	5%	245%

Table 3 – Adopted IPCC Annual Emission Rates and resulting Growth in Installed Bases

INSTALLED BASES BY SUB SECTOR AND RESULTING EMISSIONS

The installed base of HFC-134a is taken from Table 12 of the HFC Survey as 508,289kg. This assessment is based on the number of households in Colombia being 9.8 million and the refrigerator ownership level being 75.5% of the total (i.e. 7.4 million). Since around 3.6 million refrigerators are known to still contain CFC-12[1], this leaves 3.8 million based on HFC-134a which, with a charge of 130-135g/unit, would account for the reported bank. The high growth rate in the installed HFC base between 2008 and 2020 is consistent with the on-going replacement of existing CFC-based refrigerators coupled with a further increased in the proportion of households with a refrigerator, especially if a proportion of the HFC is going into refrigerators scheduled for export. Projected growth rates in other RAC sub-sectors also look realistic.

The absence of actual data on the equipment base makes validations more difficult, as is already illustrated above. Such data would enable average charge sizes to be derived and reviewed for credibility. This may be something that could be pursued separately. Meanwhile, Table 4 below illustrates the emissions arising from the domestic refrigeration sector based on a 1% annual emissions rate:

[1] Report for Colombian Ministry of the Environment, *Guillermo Rudas Lleras (2011)*

	Kg					Consumption of Gas by Sector - Refrigeration Domestic									
		%	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***
	Total Consumption		214,987	245,370	315,133	261,429	355,981	391,053	440,758	496,781	559,925	631,094	711,309	801,721	903,624
				14%	*28%*	*-17%*	*36%*	*10%*	*13%*	*13%*	*13%*	*13%*	*13%*	*13%*	*13%*
By Gas	HCFC-22	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	HCFC-141b	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFC-134a	100%	214,987	245,370	315,133	261,429	355,981	391,053	440,758	496,781	559,925	631,094	711,309	801,721	903,624
		GWP													
Emissions	HCFC-22	1810	0	0	0	0	0	0	0	0	0	0	0	0	0
(kg)	HCFC-141b	730	0	0	0	0	0	0	0	0	0	0	0	0	0
	HCFC-142b	2310	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFC-125	3500	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFC-134a	1430	5,083	7,182	9,564	12,620	15,108	18,516	22,242	26,427	31,130	36,418	42,365	49,055	56,581
	HFC-143a	4470	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFC-152a	124	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFC-227ea	3140	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFC-365mfc	782	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFC-245fa	1030	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFC-32	675	0	0	0	0	0	0	0	0	0	0	0	0	0
All	$ktCO_2$ -eq		7.27	10.27	13.68	18.05	21.60	26.48	31.81	37.79	44.52	52.08	60.58	70.15	80.91
w/o HCFCs			7.27	10.27	13.68	18.05	21.60	26.48	31.81	37.79	44.52	52.08	60.58	70.15	80.91

Table 4 – Consumption and Emissions of HFC-134a in the Domestic Refrigeration sector

MODELLED EMISSIONS

Using the information derived from the analysis set out above, Figures 1 & 2 show the HFC emissions projected by gas and by sector for Colombia.

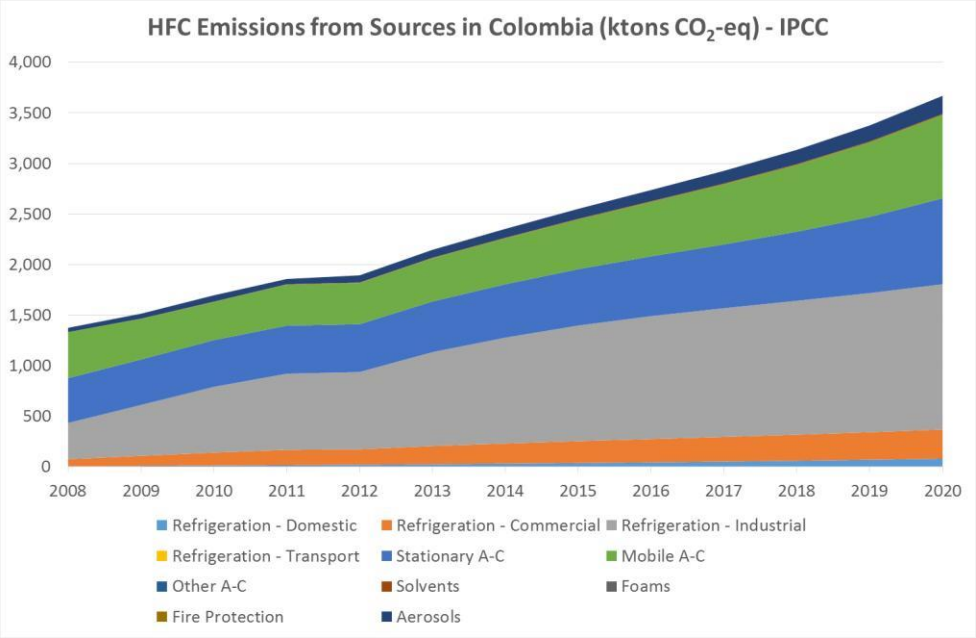

Figure 1 – Growth in HFC Emissions in Colombia by sector from the various sources

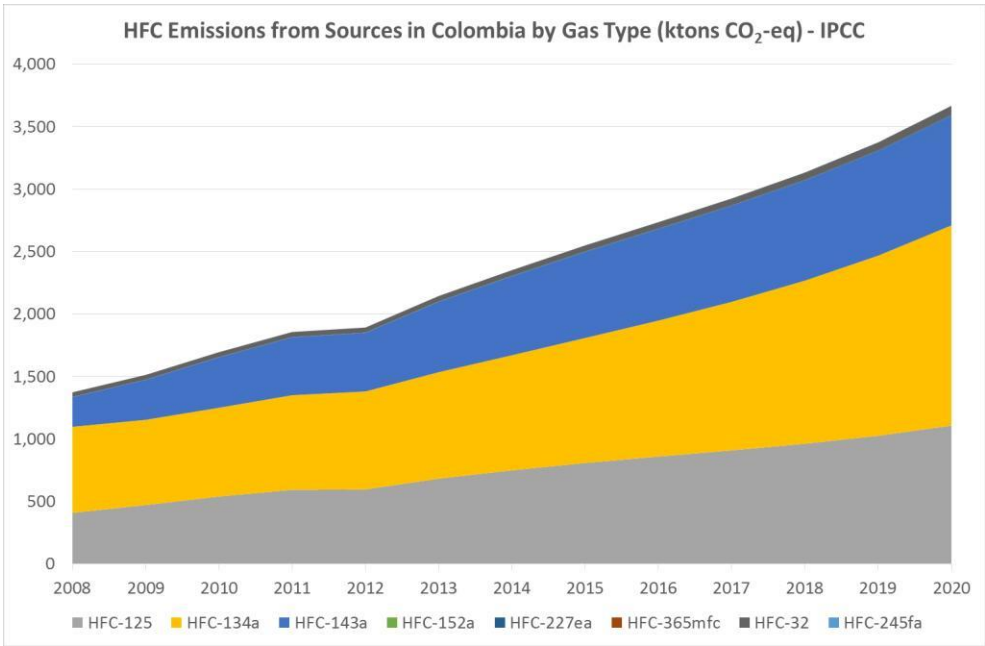

Figure 2 – Growth in HFC Emissions in Colombia by gas from the various sources

LIMITATIONS OF ANALYSIS

The emissions forecasts for this assessment have not been extended beyond 2020 in the absence of annual consumption projections beyond that date. Since a proportion of future annual emissions will always be dependent on the consumption in the same year, it seemed inappropriate to assign beyond the constraints of the respective HFC Surveys and related sources.

HCFC emissions have been omitted from this Report in line with the sponsor's scope of assessing HFC emissions only. However, since HCFC's are being replaced, there should be a commensurate reduction in HCFC emissions over time. Accordingly, these are aggregated into the analysis within the graphs included in Annex 1.

It should be noted that the transport refrigeration sector was not included within the 2014 Colombian HFC Survey, even though there was known activity in the sector.

CONCLUSIONS

The assessment of annual trends in HFC emissions for Colombia has proved possible based on the availability of the 2014 HFC Study and the subsequent Executive Summary prepared for CCAC in 2015 and its Supplement (April 2016). The approach adopted has assumed that the annual consumption figures reported in both publications are reliable, although there were some inconsistencies within the data reported in the 2014 HFC Study.

The lack of specific information on equipment inventories made some of the validation processes more challenging, but there remains a high level of confidence in the final outputs which show growth in aggregated HFC emissions from 1,375 Ktons CO_2-eq. in 2008 to 3,668 Ktons CO_2-eq. in 2020.

Paul Ashford – Anthesis-Caleb, June 2017

Annex 1 – Graphs inclusive of HCFC emissions

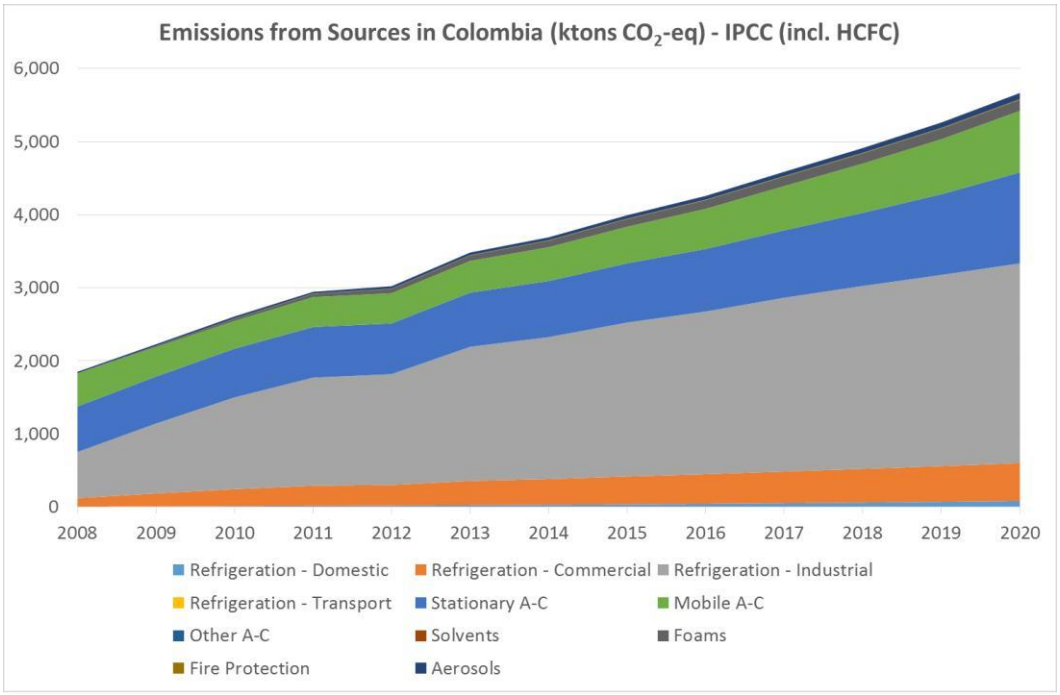

Figure A1 – Emissions from Sources in Colombia based on IPCC Emission Rates (incl. HCFCs)

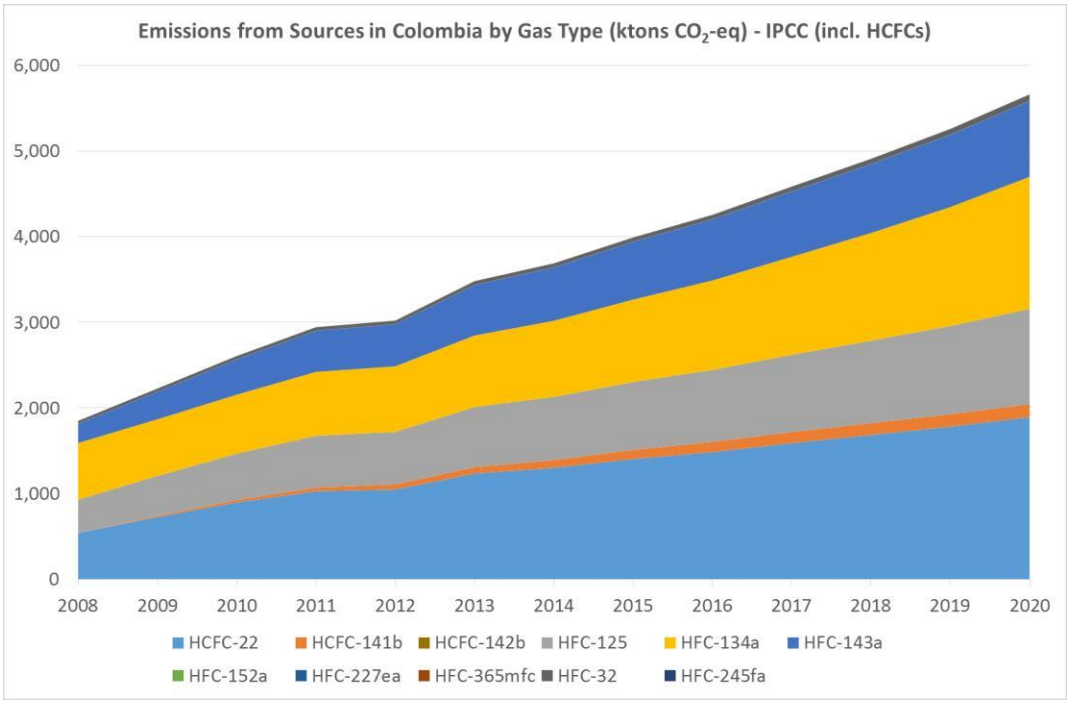

Figure A2 – Emissions by Gas Type in Colombia based on IPCC Emission Rates (incl. HCFCs)