Anthesis-Caleb
The Stables, Somerset House
Church Road, Tormarton
Badminton, Gloucestershire
GL9 1HT, United Kingdom

HFC Emissions Report for Indonesia

Prepared under contract to UNDP for CCAC

PROJECT OBJECTIVE

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

------------------------"-------------------------

OUTLINE OF THE BASIC METHODOLOGY

The CCAC sponsored HFC Survey on the historic consumption of HFCs in Indonesia 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 Indonesia 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 manufacture/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.

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, are reliable. In view of the significant activity involving solvents in Indonesia, the use and emissions of hydrofluoroethers (HFEs) has also been considered. Overall, the data 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 & HFEs 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 Indonesia, this was assisted not only by the HFC Survey itself, but also from the 2014 UNDP Work Programme which provided important information on the use patterns for HCFCs in 2011 and 2012. This was particularly important, since foam manufacture represents a significant element of the overall use of fluorocarbons in Indonesia when compared with other countries. While only a minority of these foam applications would have selected HFCs thanks to Indonesia's proactive responses to Decision XIX/6 of the Montreal Protocol with regard to low-GWP alternatives, an amount of 156.68 metric tonnes of HCFC-141b was converted to HFC-245fa. This may be due to the fact that the phase-out of HCFC-141b has taken place earlier than in most other countries.

Although data for each sub-sector of use was very comprehensive it was only given for every other year (2009, 2011, 2013…..etc.). In order to interpolate for the intervening years the numerical average was taken in each case. Generally, the sub-sector categorization provided in the Indonesian HFC Study was very similar to that consistently adopted in this series of emissions reports. The one significant difference was the fact that Commercial and Industrial Refrigeration were combined. In some senses this is an appropriate approach because the distinctions are often difficult to make and may vary from one country to another. In this instance, Anthesis-Caleb elected to split the annual consumption 50/50 between the two categories.

With HFC-134a being the largest element of consumption, the following table illustrates those consumption trends.

Kg						Consumption of Gas by Sector - HFC134a									
		%	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***
Total Consumption			5,254,545	5,531,100	5,940,605	6,350,110	6,904,060	7,458,010	8,130,720	8,803,430	9,624,730	10,446,030	11,479,340	12,512,650	13,753,720
Growth Rate				*5%*	*7%*	*7%*	*9%*	*8%*	*9%*	*8%*	*9%*	*9%*	*10%*	*9%*	*10%*
Refrigeration	Domestic	11%	380,038	400,040	448,705	497,370	576,490	655,610	777,665	899,720	1,077,095	1,254,470	1,509,855	1,765,240	2,110,050
	Commercial	0%	7,657	8,060	11,420	14,780	16,803	18,825	31,605	44,385	49,480	54,575	60,070	65,565	71,045
	Industrial/Supermarkets	0%	7,657	8,060	11,420	14,780	16,803	18,825	31,605	44,385	49,480	54,575	60,070	65,565	71,045
	Transport	0%	0												
Air Conditioning	Stationary A/C	0%	2,432	2,560	2,800	3,040	3,325	3,610	3,950	4,290	4,695	5,100	5,580	6,060	6,600
	Mobile Air Conditioning	49%	2,537,070	2,670,600	2,873,580	3,076,560	3,377,505	3,678,450	4,012,695	4,346,940	4,766,215	5,185,490	5,711,430	6,237,370	6,859,760
	Other A/C	0%	0												
Solvents	Chesterton (45%)	0%	0												
Foams		0%	0												
Aerosols		39%	2,319,691	2,441,780	2,592,680	2,743,580	2,913,135	3,082,690	3,273,200	3,463,710	3,677,765	3,891,820	4,132,335	4,372,850	4,635,220
Fire Protection		0%	0		0		0		0		0		0		
Other Uses		0%	0												

Table 1 – Consumption trends by sub-sector for HFC-134a (2008-2020)

With respect to consumption in the aerosols sector, there is little quantitative information in the HFC Survey itself about the downstream uses for aerosols using HFC-134a as a propellant. Unlike Bangladesh, where it was clear that most production was for MDIs, there seems likely to be more demand going to technical aerosols for the cosmetics, insecticide and other consumer applications. Interestingly, the authors note that it had not been possible to talk to the industry directly and that the demand for the period from 2008-2014 had resulted from a model based on the experiences of the CFC phase-out in 1995-1997 with growth rates of 6% per annum assumed from that point. In addition, the choice of propellant following the CFC phase-out had been assumed to be 60% HFC and 40% hydrocarbon.

A similar modelling approach had also been used for mobile air conditioning, but ultimately the overall consumption estimates could be mapped against the number of vehicles and other relevant metrics. Although there are no import reporting requirements for HFCs (unlike HCFCs) in Indonesia, the overall mass balance arising from the demand shown in Table 1 could be checked against known imports of HFC-134a to give some form of top-line validation.

------------------- " ------------------

In a second step dealing with emissions, the consumption by agent (substance or blend), as set out by example in Table 1, 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 2 below.

Sub-Sector	***Annual Emission Rate***	***Growth in Installed Base (2008-2020)***
Refrigeration – Domestic	1%	487%
Refrigeration – Commercial	25% reducing to 19%	479%
Refrigeration – Industrial	20%	490%
Refrigeration – Transport	40%	168%
Stationary A/C	10%	485%
Mobile A/C	25%	265%
Other A/C	10%	N/A
Solvent	50% reducing to 26%	283%
Foams	4%	134%
Aerosols	100%	100%
Fire Protection	5%	314%

Table 2 – Adopted IPCC Annual Emission Rates and resulting Growth in Installed Bases

INSTALLED BASES BY SUB SECTOR AND RESULTING EMISSIONS

Since it is not only emissions from the current year's consumption that need to be considered, focus was also placed on the determination of actual banks of agents in 2008. To do this it is necessary to understand the size of that installed base of equipment and the related average charge of agent. In areas such as domestic refrigeration and other RAC sectors, the HFC Survey provided very helpful estimates of the equipment population which made assessment of banks relatively easy using average charge sizes from the 2005 IPCC Special Report on Ozone & Climate (SROC, 2005). For other sectors of use (e.g. fire protection), the information was less prevalent, leading to the need to back calculate from the knowledge of what is likely to be being used for servicing based on average annual leakage rates.

Annual emissions arising from these banks of HFCs in installed products and equipment were then developed for each sub-sector of use. As was the case for Bangladesh, there was a need to consider what proportion of the aerosol products manufactured in Indonesia would be re-exported. Although, there was little information about re-export in the HFC Survey itself, it was mentioned that the CFC phase-out was driven in the late 1990s by the need to respond to the requirements of the non-Article 5 countries. With this is mind, we have modelled emissions for two scenarios:

1. Use of manufactured aerosols totally within the Indonesian borders

2. 80% of manufactured aerosol exported for use elsewhere.

Using the information derived from the approach set out above, Figures 1 & 2 show the emissions projected by gas and by sector based on the worst-case assumption that all aerosols (whether technical or MDIs) produced in Indonesia are used 'in country':

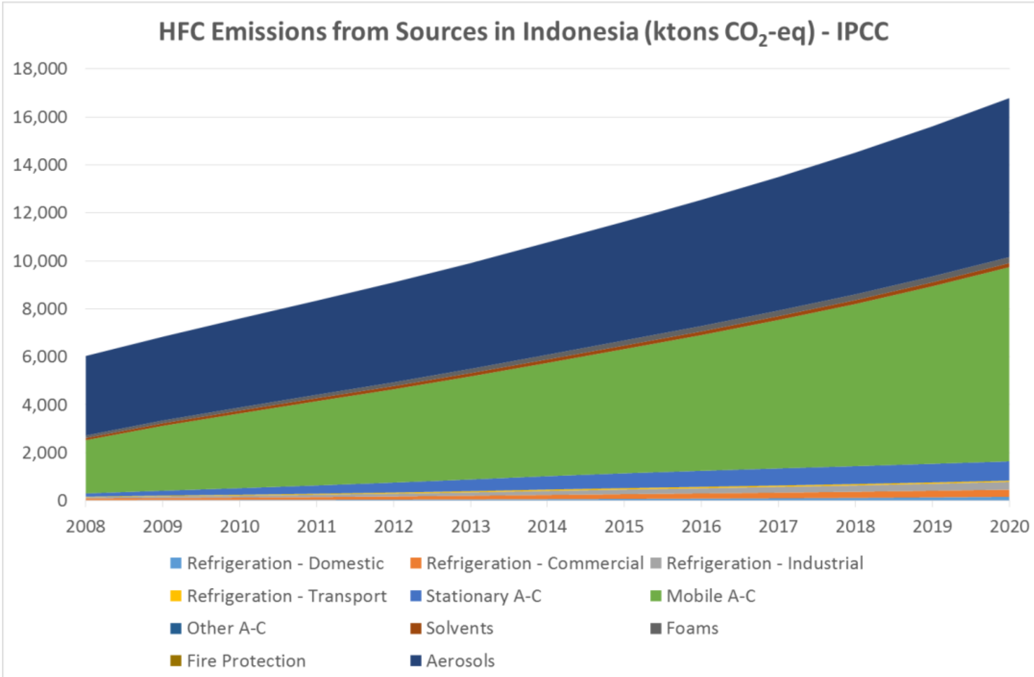

Figure 1 – Growth in HFC Emissions in Indonesia by sector based on all aerosol use 'in country'

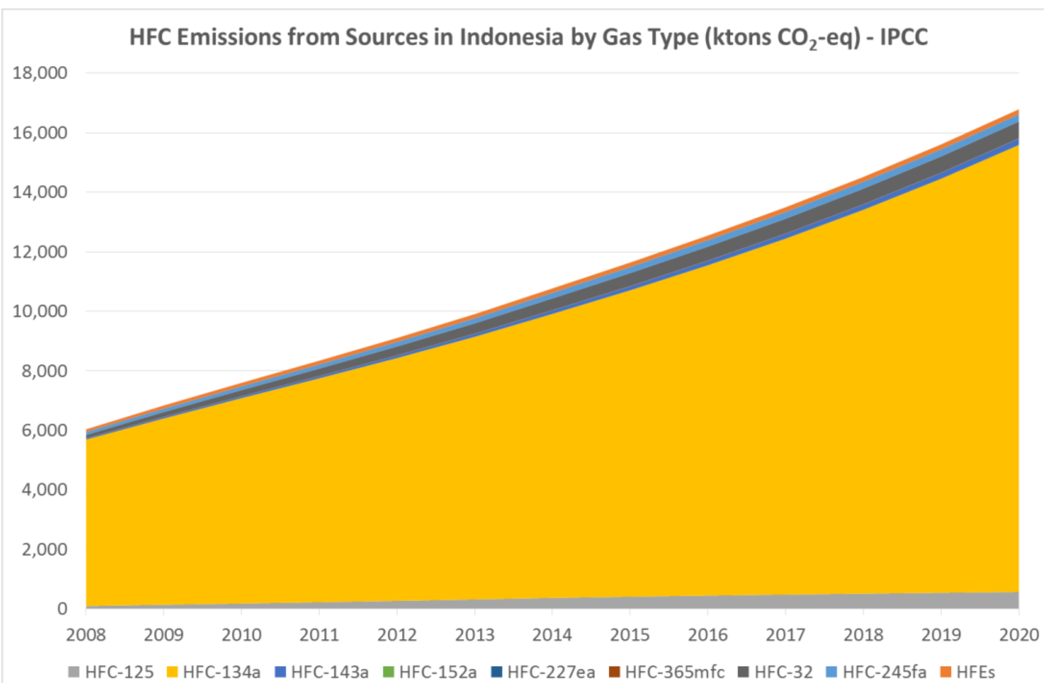

Figure 2 – Growth in HFC Emissions in Indonesia by gas based on all aerosol use 'in country'

The dominance of HFC-134a emissions is self-evident from Figure 2 under this scenario.

On the more likely assumption that most aerosols will be exported for use outside of Indonesia, the following graphs assume that only 20% of aerosols are used 'in-country'.

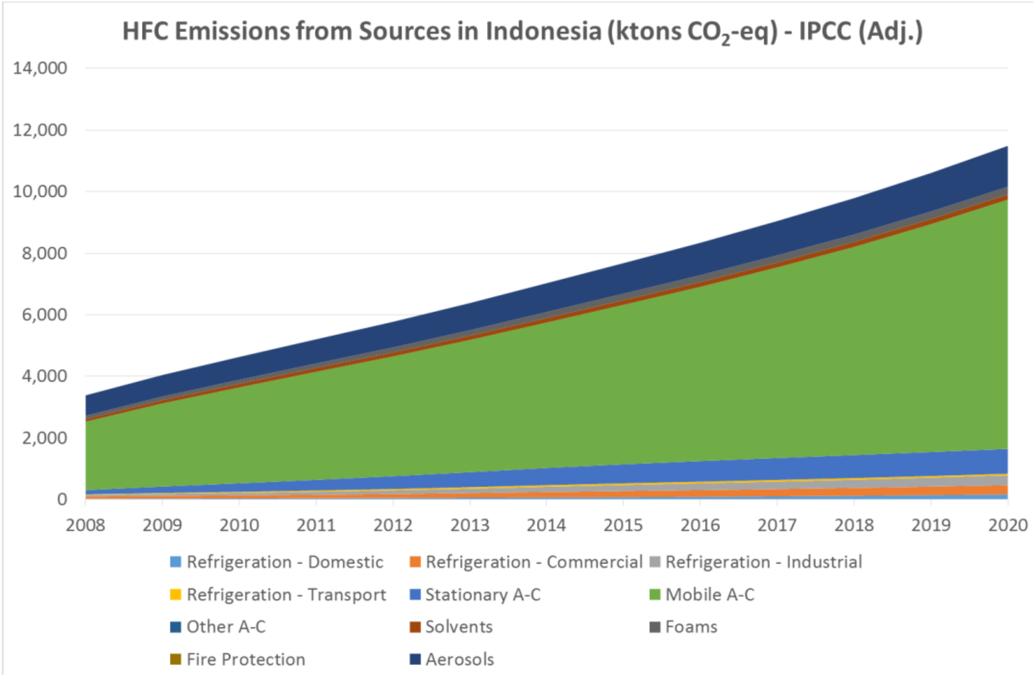

Figure 3 – Growth in HFC Emissions in Indonesia by sector based on 20% aerosol use 'in country'

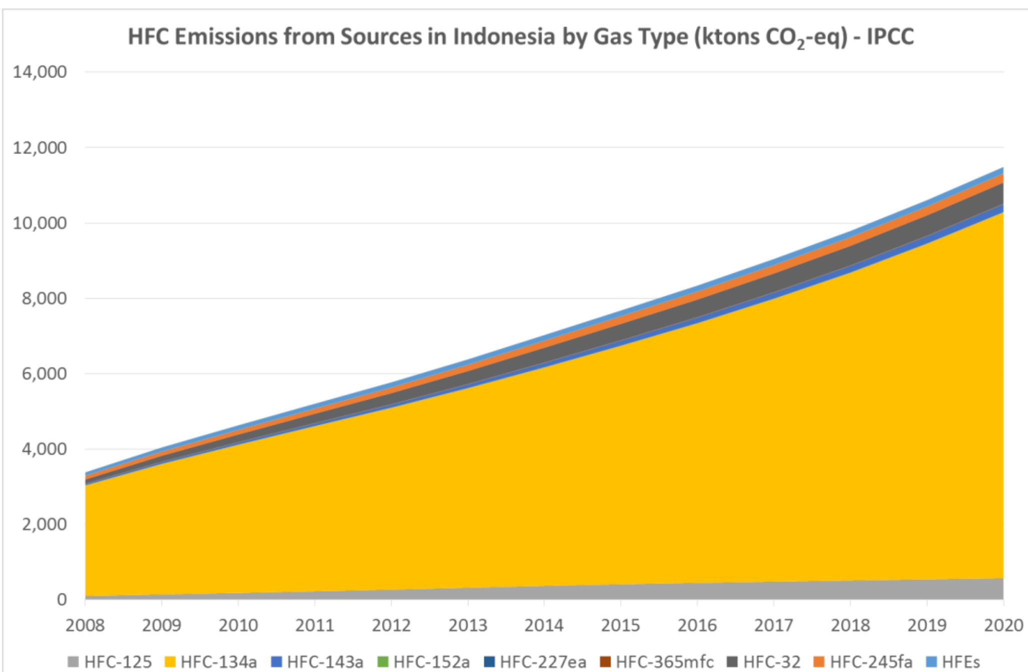

Figure 4 – Growth in HFC Emissions in Indonesia by gas based on 20% aerosol use 'in country'

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 Survey. In addition, despite the comprehensive level of information available within the Indonesian HFC Survey, there is some concern that some elements of consumption have been modelled for the period from 2008-2014 rather than measured. Nonetheless, it is believed that the overall consumption and emission assessments are robust at the macro-level.

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.

CONCLUSIONS

The assessment of annual trends in HFC emissions for Indonesia has proved possible based on the availability of the CCAC HFC Survey and some supplementary information found in the 2014 UNDP Work Plan on the use of HCFCs in 2011 and 2012. The approach adopted has assumed that the annual consumption figures reported in both documents are reliable.

A major source of uncertainty in the projected emissions for Indonesia arises from the fate of aerosols manufactured in the country. It is expected that a large proportion (est. 80%) are manufactured for re-export and this scenario has been included within this assessment.

The decision to include hydro-fluoro-ethers (HFE) in the consumption and emissions analysis was taken because of the significant global warming potential (GWP) of these alternatives and the fact that they have widespread use as solvents in the Indonesian electronics manufacturing sector. The contribution to emissions can be seen in the ‘by gas’ assessments shown in Figures 2 & 4.

<u>Paul Ashford – Anthesis-Caleb, July 2016</u>

Annex 1 – Graphs inclusive of HCFC emissions

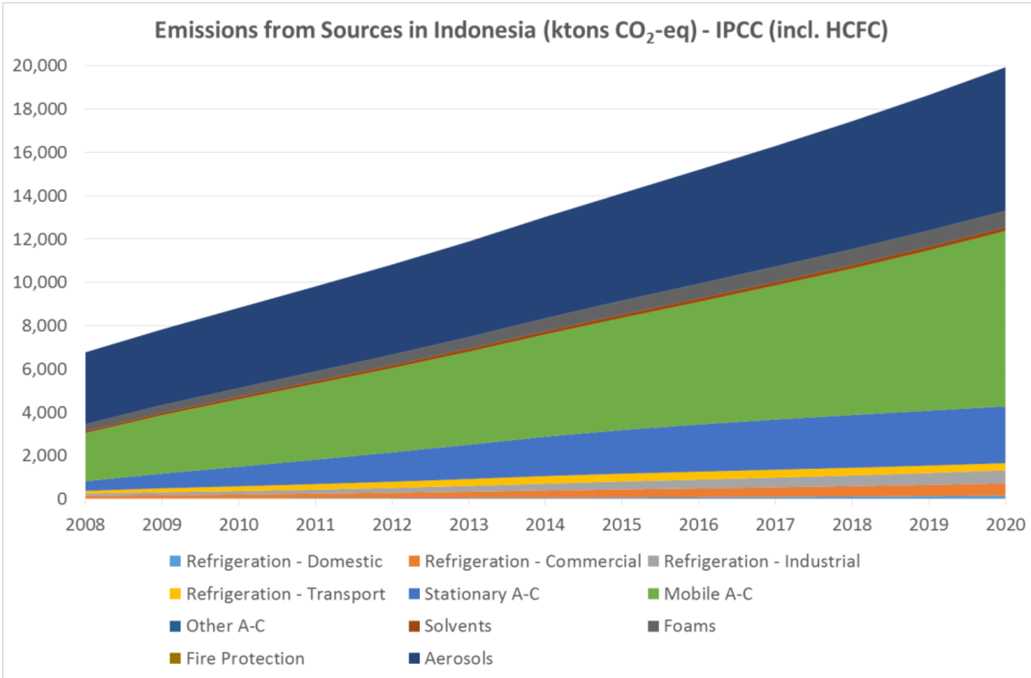

Figure A1 – Emissions from Sources in Indonesia based on IPCC Emission Rates (incl. HCFCs)

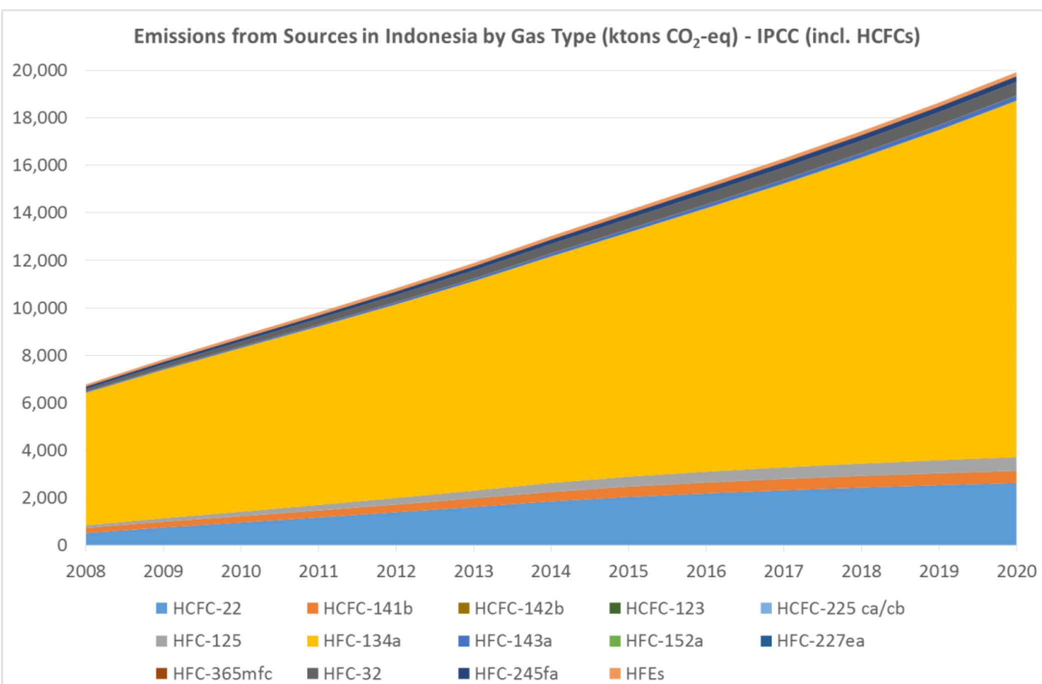

Figure A2 – Emissions by Gas Type in Indonesia based on IPCC Emission Rates (incl. HCFCs)