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NATIONAL HYDROFLUOROCARBON (HFC) INVENTORIES:

A summary of the key findings from the first tranche of studies

This document has been developed by OzonAction as part of UN Environment's work programme under the Climate and Clean Air Coalition (CCAC).

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UN Environment would like to thank the author, the CCAC HFC Initiative Lead Partners, the reviewers, UNDP, UNIDO, the World Bank, and the CCAC Secretariat for their guidance and contributions to this document.

Design by: Anna Mortreux
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CONTENTS

1. INTRODUCTION

The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC) is a voluntary global partnership of governments, intergovernmental organisations, business, scientific institutions and civil society committed to catalysing concrete, substantial action to improve air quality and protect the climate by reducing emissions of 'short-lived climate pollutants' – methane, black carbon, and hydrofluorocarbons.[1] The CCAC aims to achieve this through:

- Improving scientific understanding and raising awareness of short-lived climate pollutant impacts and mitigation strategies.
- Enhancing and developing new national and regional actions, including by identifying and overcoming barriers, increasing capacity, and mobilising support.
- Promoting best practices and showcasing successful efforts.

1.1 THE CCAC'S HFC INITIATIVE

Hydrofluorocarbons (HFCs) are currently the fastest growing category of greenhouse gases. Synthetic chemicals used in applications such as refrigeration and air-conditioning, foams, solvents and aerosols, their use is expanding rapidly in part because they are substitutes for the ozone-depleting chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) that are being phased out under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. Atmospheric observations show that the volume of HFCs in the atmosphere is increasing rapidly, currently at a rate of about 10–15 per cent per year.[2]

Significant growth in HFC use is occurring in particular in developing countries because of population growth, rapid urbanisation and electrification and changing patterns of consumption (the increased use of refrigeration and air-conditioning will also result in higher energy consumption and associated greenhouse gas emissions). If no measures are taken, it is estimated that HFC emissions will be equivalent to 9–19 per cent of total carbon dioxide (CO_2) emissions by 2050.[3] Most HFCs have high global warming potentials (GWP); HFC-134a, for example, the most widely used HFC, has a GWP of 1,430 (CO_2 has a GWP of 1).

The CCAC's HFC Initiative aims to reduce significantly the projected growth in the use and emissions of high-GWP HFCs in coming decades.[4] More specifically, it aims to mobilise the efforts of the private sector, civil society, international organisations and governments, with a view to:

- Promote the development, commercialisation, and adoption of climate-friendly alternatives to high-GWP HFCs for all relevant industry sectors.
- Build international awareness and support for approaches to curb HFC growth, such as a global phase-down of HFC consumption and production under the Montreal Protocol and commitments/ pledges by CCAC partners.
- Encourage national, regional and global policies or approaches to reduce reliance on high-GWP HFCs and support the uptake of climate-friendly alternatives.
- Overcome barriers that limit the widespread introduction of these climate-friendly technologies and practices, including those related to the establishment of standards.
- Encourage the responsible management of existing equipment and better designs for future equipment in order to minimise leaks.

1 For more details, see http://www.ccacoalition.org
2 See Institute for Governance and Sustainable Development, *Primer on HFCs* (IGSD, September 2016).
3 *HFCs: A Critical Link in Protecting Climate and the Ozone Layer – A UNEP Synthesis Report* (UNEP, 2011).
4 See http://www.ccacoalition.org/en/initiatives/hfc

1.2 HFC INVENTORIES

One of the main challenges for developing countries wanting to take early action on high-GWP HFCs has been the relatively limited availability of national data on current levels of HFC use and projected future demand. To help remedy this situation, the CCAC's HFC Initiative is funding voluntary national-level inventories in fourteen developing countries. Each inventory includes surveys of current and projected future use of HFCs, and outlines opportunities to avoid growth in the use of high-GWP HFCs and to phase down existing consumption.

Inventories for Bangladesh, Chile, Colombia, Ghana, Indonesia and Nigeria have been completed with the assistance of UNDP.[5] The remaining eight inventories – in Bahamas, Cambodia, Jordan, Kyrgyzstan, Maldives, Mongolia, South Africa and Vietnam – are under way with the assistance of UN Environment, UNIDO, and the World Bank and will be completed by end 2016.

After the CCAC initiated these inventories, the Montreal Protocol's Multilateral Fund also approved surveys of alternatives to ozone-depleting substances in 129 developing countries. The pioneering work of the CCAC's HFC Initiative to develop the fourteen inventories, including the various methodologies used, should provide valuable experiences and lessons learned that will aid the work of the countries and the agencies involved in those other projects.

This short paper summarises the findings of the first six HFC inventories carried out with CCAC support. Sections 2–7 summarise the main findings for each country, while Section 8 provides an aggregate analysis across all six countries. Section 9 contains some key points from the preliminary results for Kyrgyzstan and Vietnam, and from similar, bilaterally funded, exercises under way in Moldova and Sri Lanka assisted by UNDP.

A revised and expanded version of this document will be produced in early 2017, summarising and analysing the full range of fourteen national HFC inventories.

1.3 INVENTORY METHODOLOGY

The six national inventories completed so far were published in 2014 (Bangladesh, Chile, Colombia and Indonesia) and 2015 (Ghana and Nigeria). Each contains details of enterprises that import and use HFCs, a detailed breakdown of the use of each particular HFC or HFC blend by sector, and estimates of the total consumption per year, usually for a range of several years in the recent past and projected consumption forward, normally to 2020. Each inventory also identifies opportunities and challenges for the transition away from high-GWP HFCs to low-GWP alternatives.

The inventories relied on two sources of data: import data and surveys of end users of HFCs. For five of the six countries, HFC import figures were the primary source of consumption data, corrected to allow for any re-exports. None of the six countries is a producer of HFCs, so import figures represent final consumption according to the Montreal Protocol definition of 'consumption' as 'production plus imports minus exports'. In Indonesia, which does not possess HFC import data, consumption figures were estimated (see further in Section 6).

The surveys of end users covered importers (including sales reports), companies installing and maintaining equipment, and companies using the equipment, including supermarkets, appliance manufacturers, hospitals, building firms and others. These provided a means of double-checking the import data (or identifying differences from it) and generating sectoral breakdowns for HFC use.

While it is difficult and time-consuming to ensure complete coverage through user surveys – particularly in very large countries – in most countries there is a limited number of importers (who can accordingly be surveyed relatively easily), and the inventory authors put considerable effort into maximising the number of survey respondents. Accordingly, the data reported here can be considered to be reasonable approximations.

5 Available via http://www.ccacoalition.org/en/news/hfc-inventories-six-countries-now-available

1.4 HFCs IN COMMON USE

A small number of substances and blends account for the vast majority of HFCs in use in the six countries (and more widely). Table 1.1 lists them, alongside their main uses and GWPs.

TABLE 1.1 Commonly used HFCs and HFC blends

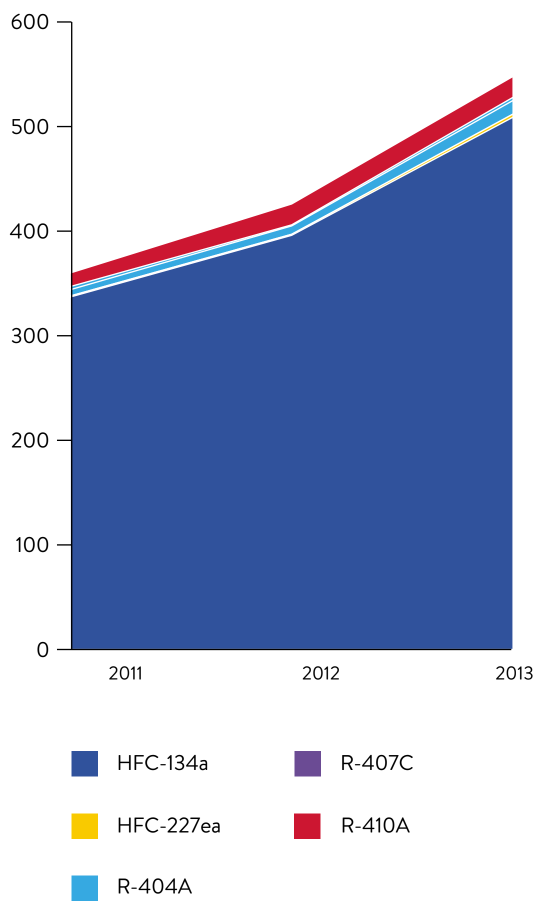
HFC or HFC blend	HFCs included (if blend)	Uses	GWP (100 years)[6]
HFC-125		Fire suppression	3,500
HFC-134a		Chillers, domestic, commercial and transport refrigeration, stationary and mobile air-conditioning, aerosols	1,430
HFC-227ea		Fire suppression	3,220
HFC-23		Fire suppression	14,800
HFC-32		Stationary air-conditioning (including room air-conditioning)	675
R-404A	HFCs 125, 134a, 143a	Commercial, industrial and transport refrigeration, bus and train air-conditioning	3,900
R-407A	HFCs 32, 125, 134a	Stationary air-conditioning	2,107
R-407C	HFCs 32, 125, 134a	Chillers, stationary air-conditioning	1,800
R-410A	HFCs 32, 125	Chillers, stationary air-conditioning (including room air-conditioning)	2,100
R-507A	HFCs 125, 143a	Industrial refrigeration	4,000

6 GWP values taken from IPCC, *Climate Change 2007* (4th Assessment Report).

2. BANGLADESH

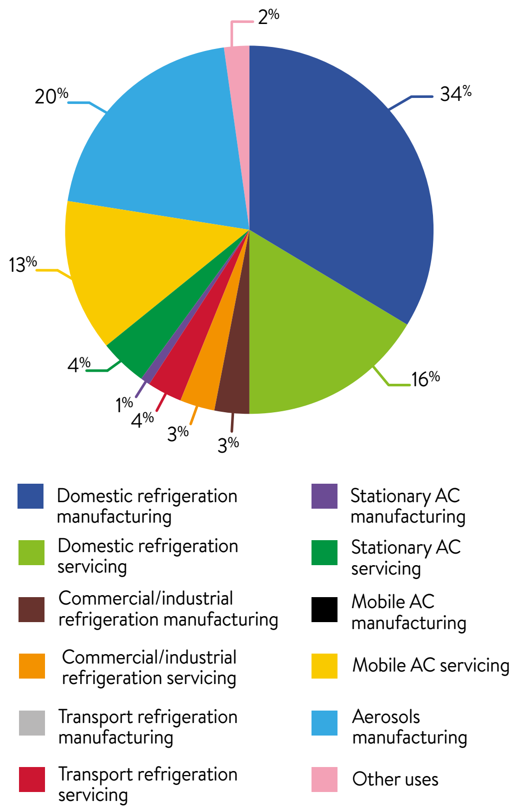
HFC consumption in Bangladesh is dominated by the main HFC in use globally – HFC-134a, which accounted for 93 per cent of total consumption in the period 2011–13 (see Chart 2.1). R-410A accounted for a further 4 per cent and R-404A for 2 per cent; three other substances or blends together accounted for the remaining 1 per cent. Overall, HFC consumption grew from about 360 tonnes in 2011 to 550 tonnes in 2013, a growth rate of about 23 per cent per year.

CHART 2.1 HFC consumption in Bangladesh, 2011–13 (metric tonnes)



Domestic refrigeration accounts for most HFC consumption: 50 per cent in 2013, about two-thirds in manufacturing and a third in servicing (see Chart 2.2). Mobile and stationary air-conditioning and commercial/industrial and transport refrigeration account for a further 28 per cent (including both manufacturing and servicing). Bangladesh is unlike the other countries surveyed here in experiencing significant consumption in the aerosols sector (20 per cent in 2013) – specifically, in the manufacture of metered-dose inhalers (MDIs) for the treatment of asthma and other pulmonary diseases, for both domestic use and exports. There is a very small use of HFCs in fire suppression (included under 'other uses' in the chart), and no use in foam-blowing.

CHART 2.2 Sectoral breakdown of HFC consumption in Bangladesh, 2013

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Consultations with stakeholders suggest that a high rate of growth of HFC use will continue in the absence of any new policy initiative. To date there has been very little uptake of hydrocarbons or other non-fluorocarbon alterative refrigerants. Despite some increase in the use of isobutane (R-600a) in domestic refrigeration, consumption of HFC-134a for domestic refrigeration, mobile air-conditioning and chillers is expected to grow as a result of an increase in the number of units in use following from economic growth and the higher buying capacity of middle-income and lower-middle-income households. In addition, rising summer temperatures consequent upon climate change are changing perceptions: refrigeration and air-conditioning are increasingly seen as necessities, not luxuries.

Alongside these uses, HFC consumption is expected to increase in fire suppression, foam-blowing (as HCFC-141b is phased out under the provisions of the Montreal Protocol), and, especially, in aerosols, with the continued expansion of MDI manufacturing and exports; this sector has already seen a doubling in the consumption of HFC-134a between 2011 and 2013.

In total, and taking into account the accelerating phase-out of HCFCs (Bangladesh is currently implementing the first stage of its HCFC Phase-out Management Plan), HFC consumption is projected to increase by an additional 100 tonnes per year over the period 2014–18. This would result in an estimated total HFC consumption of just over 1,000 tonnes by 2018, representing an annual growth rate of about 14 per cent over this period. This is much lower than growth between 2011 and 2013, however, so it may be an under-estimate.

Bangladesh HFC Inventory (Mohammad Reazuddin, UNDP, CCAC, 2014) (http://www.ccacoalition.org/en/resources/bangladesh-hfc-inventory)

3. CHILE

A wider range of HFCs and blends are in use in Chile than in any of the other countries surveyed here (apart from Colombia), but three predominate: HFC-134a (46 per cent of use over the survey period, 2008–12), R-404A (26 per cent) and R-507A (13 per cent). Smaller quantities of HFC-227ea, R-407C and R-507A are also used, whereas the 'others' category in Chart 3.1 includes very small quantities of HFC-125, HFC-23, HFC-152, HFC-365mfc, R-417A, R-422D, R-508B and Chesterton 296 (a blend of HFC-134a, HFC-245a, HFC-365mfe and isopropanol).

Overall, total consumption of HFCs almost doubled between 2008 (500 tonnes) and 2012 (900 tonnes), representing an average annual growth rate of over 16 per cent.

The refrigeration and air-conditioning sector accounts for almost all consumption of HFCs, though small amounts of HFC-23, HFC-125 and HFC-227ea are used for fire suppression, and smaller amounts, mainly of HFC-134a, for solvents and other uses such as glass-blowing (see Chart 3.2; separate figures for manufacturing and servicing are not available). The largest end-user sector is large-scale commercial and industrial refrigeration, which includes supermarkets; air-conditioning (mobile and stationary) and transport refrigeration are the next most significant. HFC use in aerosol products is extremely small, and HFCs are not used for foam-blowing.

CHART 3.1 HFC consumption in Chile, 2008–12 (metric tonnes)

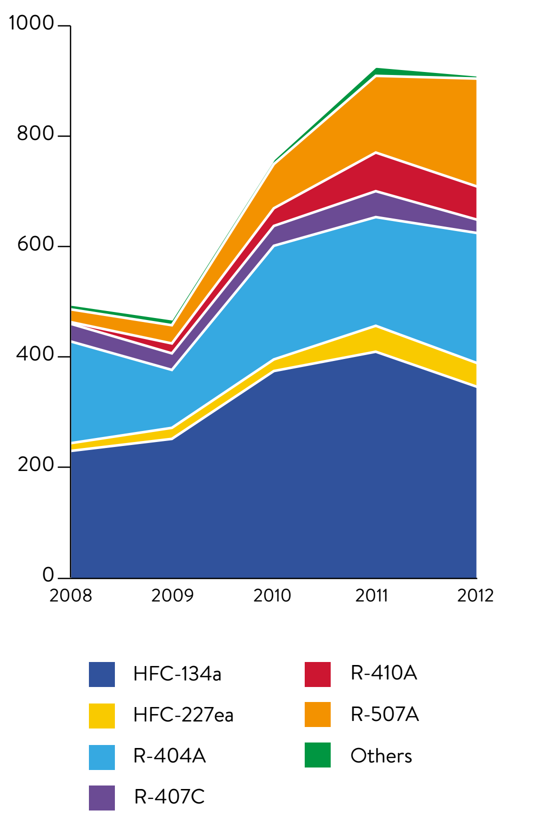


CHART 3.2 Sectoral breakdown of HFC consumption in Chile, 2012

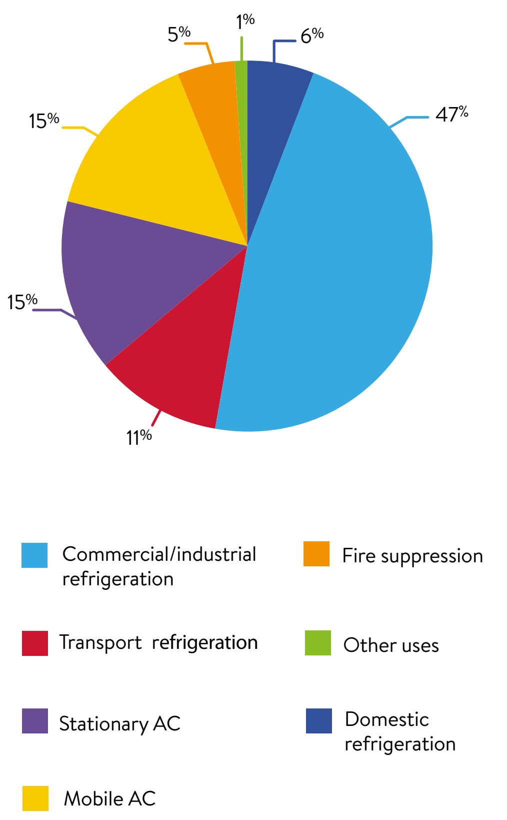
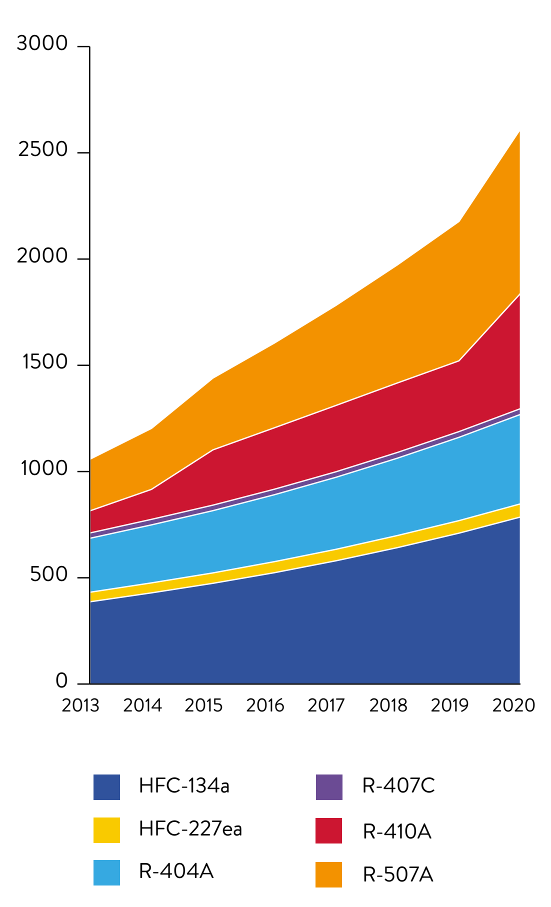


CHART 3.3 Projected (2013–20) HFC consumption in Chile (metric tonnes)



Forward projections for the future use of HFCs were derived by calculating average growth rates for the main six substances or blends in use in refrigeration and air-conditioning over the period 2008–12. The consumption of HCFC-22 was also analysed; currently the most commonly used refrigerant, HCFC-22 accounted for 52–67 per cent of total fluorocarbon use in refrigeration and air-conditioning over this period, but is expected to decline as it starts to be phased out under the provisions of the Montreal Protocol. It was assumed that growth in the consumption of fluorocarbon refrigerants would remain constant at the rate of the last five years (7.5 per cent per year), but within this overall figure, the different HFCs were assumed to grow more or less rapidly, in line with historic trends. Allowance was also made for the gradual replacement of HCFC-22 by R-410A. The slight fall in the consumption of most HFCs, particularly HFC-134a, between 2011 and 2012 was considered by local experts to be only a temporary fluctuation, not likely to be repeated.

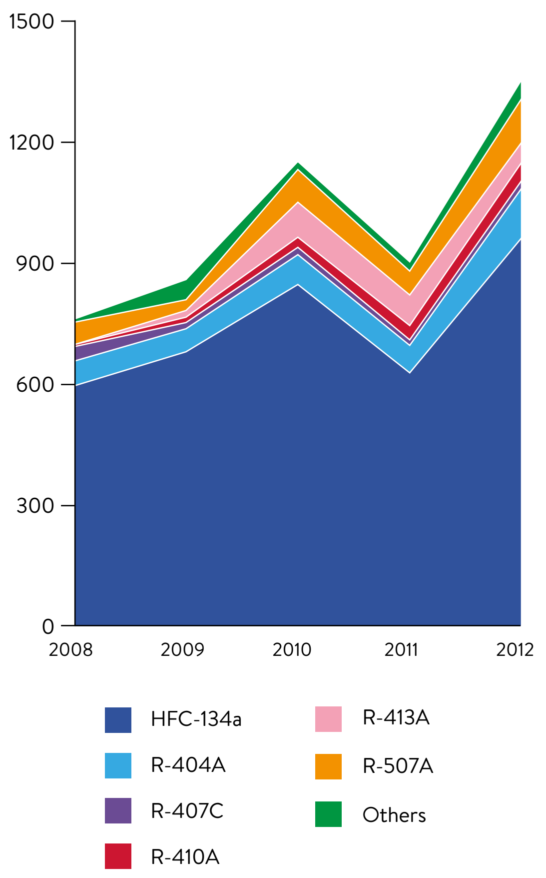
The results are shown in Chart 3.3, suggesting almost a tripling of consumption from 2012 (900 tonnes) to 2020 (2,600 tonnes). Assuming that HCFC consumption is phased out in line with the Montreal Protocol control schedules, HFC consumption is projected to increase by 14 per cent a year.

Chile HFC Inventory (Chile Ministry of Environment, Gisma, UNDP, CCAC, 2014) (http://www.ccacoalition.org/en/resources/chile-hfc-inventory)

4. COLOMBIA

A wide range of HFCs – similar to those in Chile – is in use in Colombia. As in all other countries, HFC-134a is the single most commonly used, accounting for 74 per cent of total HFC consumption over the survey period (2008–12). R-404A and R-507A accounted for a further 14 per cent between them, and R-407C, R-410A and R-413A for 9 per cent in total. The remaining 3 per cent comprised a wide range, including HFC-125, HFC-152A, HFC-227ea, R-417A, R-422A, R-422D, R-508B, R-437A and Chesterton 296. In total, HFC use almost doubled over the survey period, from 760 tonnes to 1,350 tonnes, an average growth rate of about 15 per cent per year (see Chart 4.1).

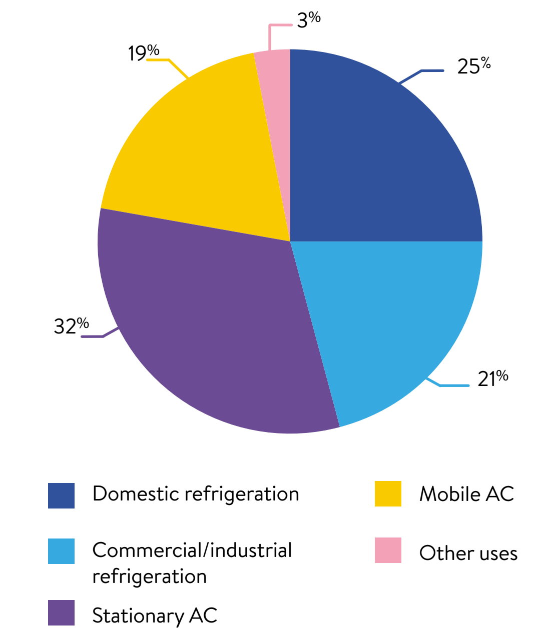
CHART 4.1 HFC consumption in Colombia, 2008–12 (metric tonnes)



The sharp increase of consumption in 2010, followed by a fall in 2011, was attributed to stockpiling by major importers in anticipation of government controls related to the phase-out of CFCs under the Montreal Protocol.

As in other countries, the refrigeration and air-conditioning sector accounts for almost all consumption of HFCs. In 2014 stationary air-conditioning accounted for 32 per cent of consumption, of which more than two-thirds was used in chillers; domestic refrigeration, commercial and industrial refrigeration and mobile air-conditioning accounted for between 19 and 25 per cent each (see Chart 4.2). The 'other uses' category in the chart, accounting for 3 per cent in total, is mostly for transport refrigeration, but also includes small quantities used mostly in glass manufacturing and fire suppression equipment, with some for solvents. There is no HFC consumption in the foams industry, and no HFC consumption has been reported for aerosol products, even though the one company that manufactures MDIs has been converted to HFC-134a.

CHART 4.2 Sectoral breakdown of HFC consumption in Colombia, 2014



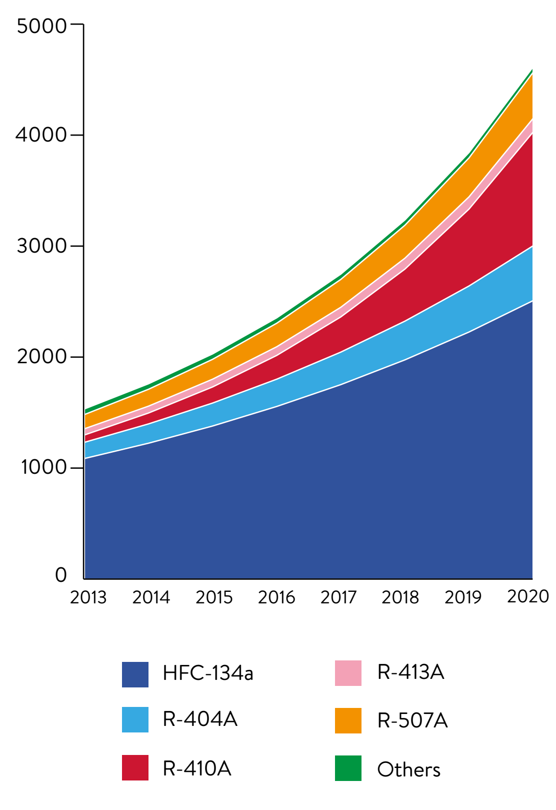
HCFC use for refrigeration and air-conditioning was roughly equal to that of HFC use over the survey period.

A more detailed breakdown by end user suggests that supermarkets are the main users of both HCFCs and HFCs, followed by hotels, domestic refrigerators and hospitals and clinics. Considering only HFCs, domestic refrigeration was the main use, followed by mobile air-conditioning, hotels and hospitals and clinics.

Forward projections for 2013–20 were calculated on the assumptions that the refrigeration and air-conditioning sector would grow at an average annual growth rate of 8.7 per cent (3 per cent lower than the actual growth rate between 2008 and 2012, based on discussions with sector experts); that HCFC consumption would start to be phased out in line with the provisions of the Montreal Protocol; that the different refrigerants would grow at annual rates equivalent to their actual growth over the period 2008–12; and that HFC use for fire protection, solvents and glass production would grow at the projected annual GDP growth rate (4.7 per cent). Chart 4.3 shows projections to 2020.

HFC-134a maintains its dominant position in the market, but R-410A grows at the fastest rate. In total, HFC consumption more than triples from 1,350 tonnes in 2012 to 4,600 tonnes in 2020, an average annual growth rate of more than 16 per cent.

CHART 4.3 Projected HFC consumption in Colombia, 2013–20 (metric tonnes)



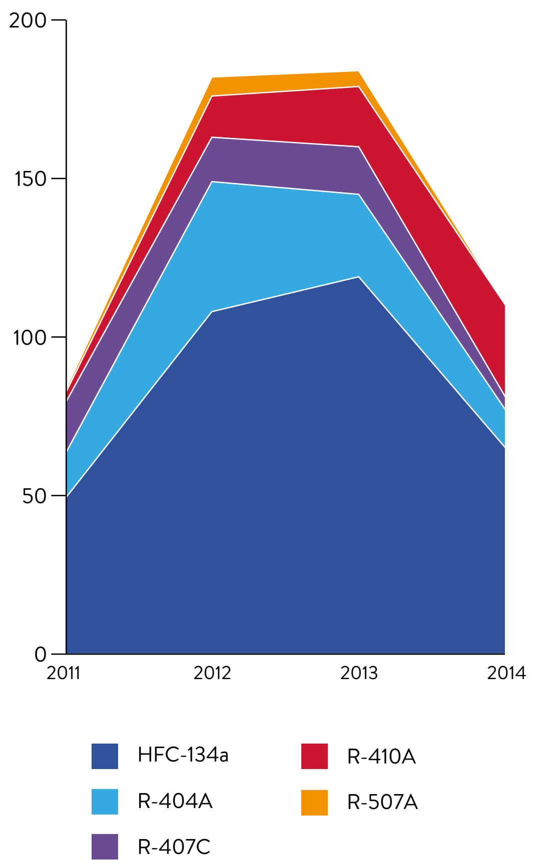
Colombia HFC Inventory (National Ozone Unit of Colombia, Ministry of Environment and Sustainable Development, UNDP, CCAC, 2014) (http://www.ccacoalition.org/en/resources/colombia-hfc-inventory)

5. GHANA

Ghana's HFC consumption includes five HFCs or HFC blends. HFC-134a is by far the most common, accounting for over 60 per cent of total consumption over the survey period (2011–14); R-404A, R-407C and R-410A together accounted for almost all the rest, together with a small quantity of R-507A (see Chart 5.1).

In 2014, HFCs accounted for almost half (48 per cent) of total installed refrigerants in Ghana; HCFCs accounted for another 47 per cent. Most of the remaining 5 per cent was isobutane (R-600a). Almost all consumption of HFCs was for servicing in the refrigeration and air-conditioning sector; there was no manufacturing of equipment. Chart 5.2 shows the sectoral breakdown of HFC use.

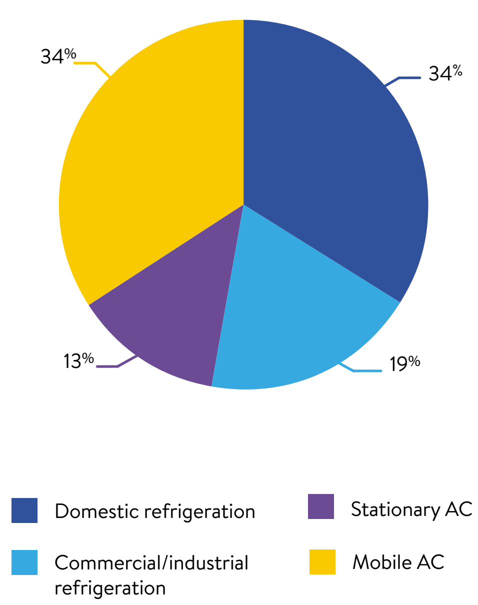
CHART 5.1 HFC consumption in Ghana, 2011–14 (metric tonnes)



An insignificant quantity of HFCs was used in fire protection, and a small amount was imported as aerosol propellants in MDIs manufactured outside Ghana; this would not qualify under the Montreal Protocol's definition of consumption.

As can be seen from Chart 5.1, after significant growth in HFC consumption from 2011 to 2012, consumption levels remained almost static in 2013 and declined sharply in 2014. The growing use of natural refrigerants (particularly R-600a, whose use has been encouraged under Ghana's Refrigerant Management Plan and Terminal Phase-out Management Plan as a substitute for CFC-12) is thought to be partly responsible, along with the implementation of a national energy efficiency programme from 2013; this included a turn-in scheme for owners of old refrigerators (who were given a discount on the purchase of new energy-efficient refrigerators), together with a ban on the import of second-hand refrigeration equipment.

CHART 5.2 Sectoral breakdown of HFC consumption in Ghana, 2014[7]



7 Note this is based on adjusted figures for 2014; see below.

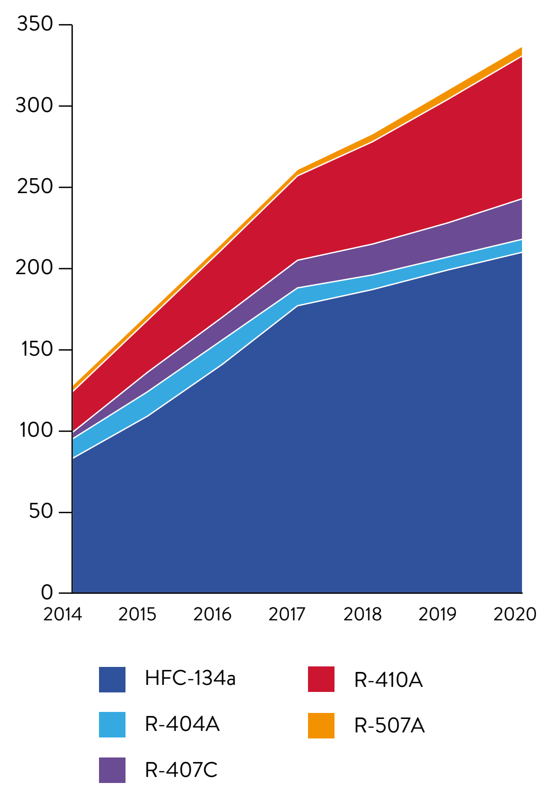
A more significant factor, however, is thought to be the severe nation-wide power disruptions which affected commercial and industrial activities in 2014. Given that this was supposed to be a temporary phenomenon (although in fact power disruptions have continued since 2014), and given also that the survey of end users revealed significant differences from the import data, it was assumed that the 2014 data used above in Chart 5.1 underestimated the true consumption level. Chart 5.3 accordingly incorporates slightly higher levels of consumption of HFC-134a and R-507A in 2014, and includes projections forward to 2020 (the data are currently being reviewed and may be revised further).

In the absence of any new policy framework to reduce HFC use, consumption of most HFCs is projected to increase, in total from 130 tonnes in 2014 to 340 tonnes in 2020, an annual growth rate of almost 18 per cent. The expansion of the economy, rising household incomes, rapid urbanisation and a rural electrification programme are all pushing upward the demand for household and commercial refrigeration and air-conditioning, and vehicles with mobile air-conditioning, with an accompanying increase in the consumption of HFC-134a and R-410A.

This growth may be constrained, however, by a greater uptake of hydrocarbons, particularly of R-600a in domestic refrigeration. In 2014 consumption of R-600a reached 21.8 tonnes, compared to 65.3 tonnes of HFC-134a; the fact that it is significantly cheaper than HFC-134a is rendering it steadily more attractive, and large numbers of technicians have been trained to retrofit and service domestic refrigerators and freezers using hydrocarbons. Propane (R-290) is a potential alternative for residential and commercial air-conditioning; a project to convert HCFC-based split air conditioners started in 2013.

Growth in the use of R-407C and R-507A is expected to be slower. R-407C is mostly used in chillers in local processing industries, which have been particularly affected by erratic power supplies, and competition from cheaper alternative substances. R-507A is used mainly in refrigerated trucks and supermarket display cabinets, though its high GWP (3,800 – alongside R-404A, the highest of the HFC blends on the Ghanaian market) may constrain future growth. Demand for R-404A, used mainly in cold stores, is projected to fall; given the high GWP of this HFC blend (3,922), ammonia is increasingly being used as an alternative, a step which can bring energy efficiency improvements too.

CHART 5.3 Projected HFC consumption in Ghana, 2014–20 (metric tonnes)



Ghana HFC Inventory (Dr Kwame Owusu-Achaw, UNDP, CCAC, 2015) (http://www.ccacoalition.org/en/resources/ghana-hfc-inventory)

6. INDONESIA

In Indonesia, import data for HFCs is not collected by customs, so there is no fully reliable method of estimating consumption levels. The inventory was therefore assembled from information on the installed base of equipment (refrigerators, air conditioners, mobile air-conditioning systems in cars, etc.) from surveys conducted in 2002 and 2009 as part of Indonesia's phase-out management plans for CFCs and HCFCs, together with data such as the numbers of vehicles sold and information collected from industry stakeholders. Projections for consumption in subsequent years were made on the basis of actual and anticipated economic and population growth, and expected rates of expansion in each sub-sector, modified by assumptions about the speed of phase-out of HCFCs and the rate of take-up of the substances with which they are likely to be replaced.

The results can be seen in Chart 6.1, which presents estimates of Indonesia's HFC consumption between 2009 and 2020. Overall, HFC consumption is projected to triple from 5,700 tonnes in 2009 to 18,000 tonnes in 2020, an annual average growth rate of about 12 per cent.

Consumption is overwhelmingly dominated by HFC-134a, which accounts for 83 per cent of total HFC consumption over the period, and almost all consumption until 2013. After 2015, as the phase-out of HCFCs accelerates, a range of other HFCs occupy growing shares of the market, most notably HFC-32, which accounts for 13 per cent of market share in the period 2015–20. HFC-245fa, R-404A and R-410A between them account for about 9 per cent of consumption between 2015 and 2020; the remaining less than half a per cent is made up of small quantities of HFC-365mfc, R-407C and R-507C.

Chart 6.2 shows the sectoral breakdown of estimated HFC consumption in 2013. The most notable difference from the other countries discussed here is the high proportion of the total consumed in the aerosol sector – an estimated 40 per cent. Unlike Bangladesh, however, this does not appear to be due to the manufacture of MDIs; about 80 per cent of the aerosol-using companies listed in the survey report are producers of cosmetics and perfumes, with the rest split between insecticides and 'aerosol products'. The figure for consumption of HFC-134a in this sector was derived from the figures for CFC consumption in aerosol products in 1995–97, multiplied by an assumed annual growth rate of 6 per cent from 1997; 40 per cent of the total consumption thus calculated was assumed to be replaced by isobutane (R-600a) and the remaining 60 per cent by HFC-134a. Given that in other countries fluorocarbon propellants have been widely phased out for non-medical aerosols, however, it is possible that this may over-estimate consumption in this sector (and, therefore, in Indonesia as a whole).

Mobile air-conditioning accounts for almost all of the remaining consumption of HFCs (10 per cent for manufacturing, 38 per cent for servicing), supplied entirely by HFC-134a. Car manufacturing is a priority sector in Indonesia's development strategy, so continued growth in this sector seems likely. Domestic refrigeration accounts for almost all the rest; use of HFCs in stationary air-conditioning, and commercial and industrial refrigeration is very low. No figures are given for use in transport refrigeration.

As noted above, the take-up of HFCs in several sectors is expected to accelerate after 2015, when, as part of its HCFC phase-out plans Indonesia was expected to ban the use of HCFCs in the production of refrigeration and air-conditioning equipment and in foam-blowing. HFC-134a is expected to be the main HFC in use for domestic refrigeration and mobile air-conditioning, but other HFCs, especially HFC-32, become steadily more important for commercial and industrial refrigeration and stationary air-conditioning. There is currently very little use of hydrocarbons for refrigeration; appropriate equipment and technical skills are both largely lacking.

Larger manufacturers of foams are expected to replace HCFCs by cyclopentane, but HFC-245fa and HFC-365mfc are projected to be used by smaller manufacturers. Solvent use is important, but HFC solvents are regarded as too expensive to be taken up to any significant extent; hydrofluoroethers and hydrocarbons are expected to be introduced instead.

CHART 6.1 HFC consumption in Indonesia, 2009–20 (metric tonnes)

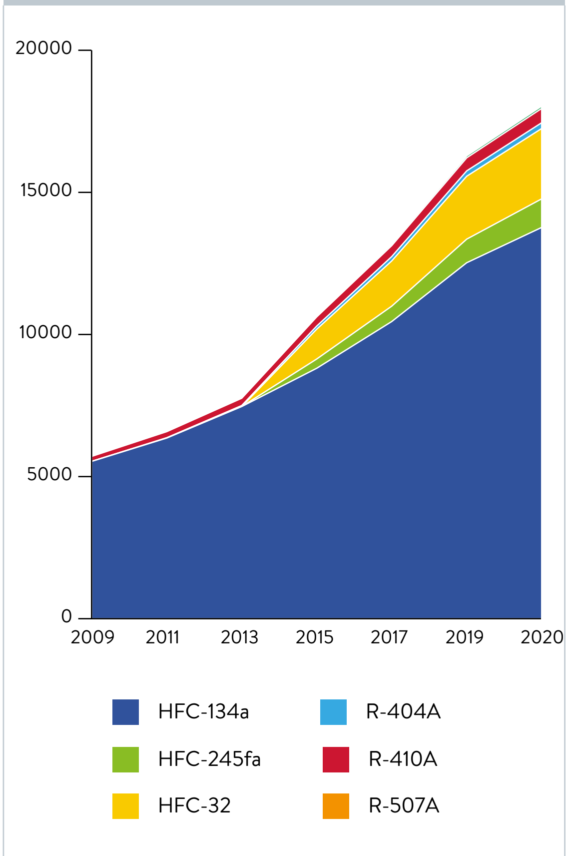
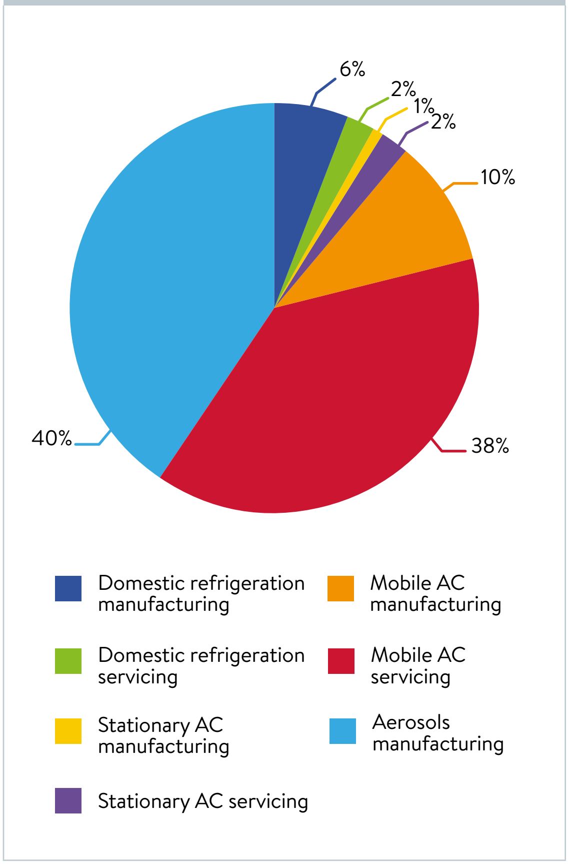


CHART 6.2 Sectoral breakdown of HFC consumption in Indonesia, 2013



Indonesia HFC Inventory (Ari Darmawan Pasek, UNDP, CCAC, 2014) (http://www.ccacoalition.org/en/resources/indonesia-hfc-inventory)

7. NIGERIA

Nigeria's HFC consumption includes five HFCs or blends.[8] HFC-134a is the most common, accounting for more than 40 per cent of total consumption over the survey period (2008–14). Four HFC blends have also been in use, mostly since 2012. Chart 7.1 shows figures for HFC-134a and for combined mixtures (no breakdown of mixtures was available for 2008–11). Total HFC consumption grows from almost zero in 2008 to 1,200 tonnes in 2012.

Chart 7.2 includes more detailed figures for the quantities of HFCs (including blends) imported between 2012 and 2014. The most widely used was R-410A, accounting for 42 per cent of consumption over this period (in comparison with 35 per cent for HFC-134a). Smaller quantities of R-404A and R-407A, and trivial amounts of R-507A, had also been used.

As can be seen, the use of HFC-134a increased sharply from 2008 to 2012 (with a slight dip in 2011), and then fell slightly in 2013 and very sharply in 2014. The reason for the increase in consumption in 2009–10 is not fully clear, though it is thought that it may have been a reaction to the approach of phase-out of CFCs in 2010, with HFC-134a imported in large quantities and then stockpiled for future use, in advance of an anticipated price rise.

The reason for the very sharp drop in imports of HFC-134a in 2014, and slightly smaller falls in imports of the HFC blends, is also not clear, and it is intended that this will be examined further in the future; one possible factor is the introduction of other non-HFC-based alternatives, particularly hydrocarbons.

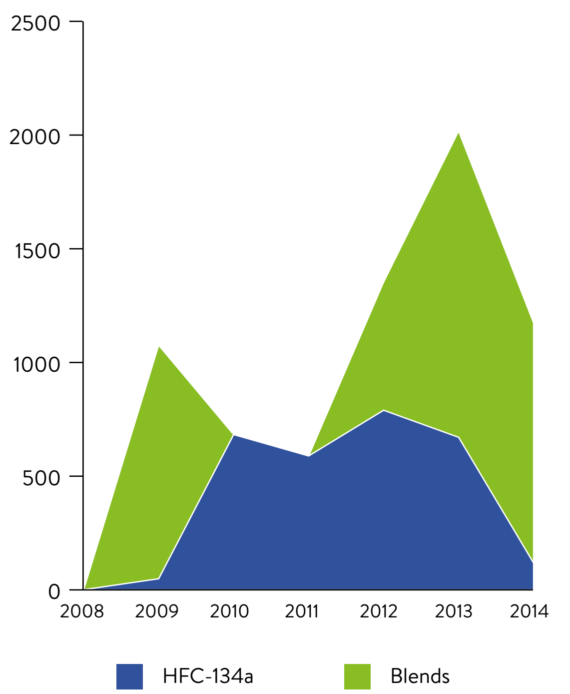
Against this background, it is difficult to derive estimates of future levels of consumption, but Chart 7.3 adds projections for 2015–17 to the data displayed above in Chart 7.1.

The projections are based on the average growth rate in recent years applied to a base figure calculated as the average of imports over the same period: for HFC-134a, figures for 2011–14 were used (giving an average growth rate of –21 per cent) and for HFC blends, 2012–14 (giving an average growth rate of +59 per cent). Overall, total consumption grows from 2,000 tonnes in 2013 to 4,200 tonnes in 2017, an annual growth rate of just over 20 per cent. Growth between 2014 (1,200 tonnes) and 2017 (4,200 tonnes) is dramatic, at an average of more than 50 per cent a year.

No information on the sectoral breakdown was included in the survey, other than a division between use in the manufacturing and the servicing of refrigeration and air-conditioning equipment; these were calculated on the assumption that servicing accounted for 40 per cent of HFC-134a, 75 per cent of R-410A and 100 per cent of R-404A, R-407A and R-507A. On this basis manufacturing accounted for 20 per cent and servicing for 80 per cent of consumption in 2014.

Several low-GWP alternatives to HFCs are already available and in use in Nigeria, including hydrocarbons (butane/isobutane and propane), ammonia and water. Many new domestic refrigerators, which are manufactured to European standards, use hydrocarbons, and these refrigerants are generally cheaper than HFCs. Demonstration projects are also under way, including one for the production and safe use of hydrocarbons in refrigeration servicing. Some large companies, such as Unilever (which holds a significant share of the ice cream market) are already replacing HFCs with natural refrigerants; another company is piloting the production of methyl formate for foam-blowing.

CHART 7.1 Consumption of HFC-134a and HFC blends in Nigeria, 2008–14 (metric tonnes)



8 Import data for 2010 showed a much larger figure for HFC-134a imports than data from the National Agency for Food and Drug Administration and Control (which collects data on some industrial chemicals), but similar figures for 2011–13; the import figure for 2010 was regarded as possibly suspect, and the data adjusted downwards accordingly.

CHART 7.2 HFC consumption in Nigeria, 2012–14 (metric tonnes)

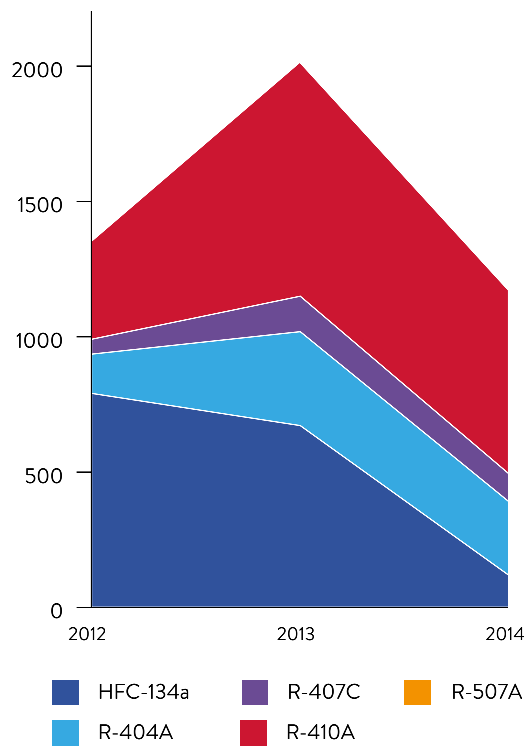
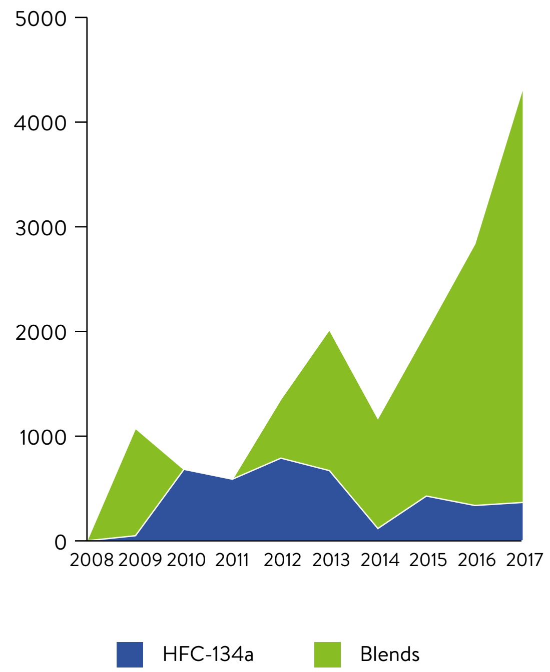


CHART 7.3 Actual (2008–14) and projected (2015–17) HFC consumption in Nigeria (metric tonnes)



Nigeria HFC Inventory (David Bola Omotosho UNDP, CCAC, 2015)
(http://www.ccacoalition.org/en/resources/nigeria-hfc-inventory-0)

8. OVERVIEW

8.1 SUMMARY ANALYSIS

While the inventories include differing ranges of years for reported or projected data, all cover the years 2011–17, summarised in Chart 8.1. In total across all six countries, consumption of HFCs increases from 9,500 tonnes in 2011 to 23,200 tonnes in 2017, an average annual growth rate of 16 per cent.

As noted in Chapter 1, none of these six countries are producers of HFCs; all import the substances from elsewhere. Information on the source of imports is not included in detail in all of the reports, but China clearly dominates the export market everywhere other than Latin America – and even there, Chile imports more from China than anywhere else. Colombia is the only country to import more from elsewhere – the United States, which is also Chile's second largest source of imports, but insignificant elsewhere. No other country supplies more than a trivial quantity (and some of those listed, such as Singapore or the United Arab Emirates, have no production of their own, so are trans-shipment points).

Actual and projected growth rates for HFC consumption vary across the countries, though, with the exception of Nigeria, not all that much. Table 8.2 summarises the information included above in sections 2–7 on each country.

Notes:
(a) Data not adequate to calculate figure – see discussion above in Sections 5 and 7
(b) All the Indonesian figures are estimates – see discussion above in Section 6

CHART 8.1 HFC consumption by country, six countries, 2011–17 (metric tonnes)[9]

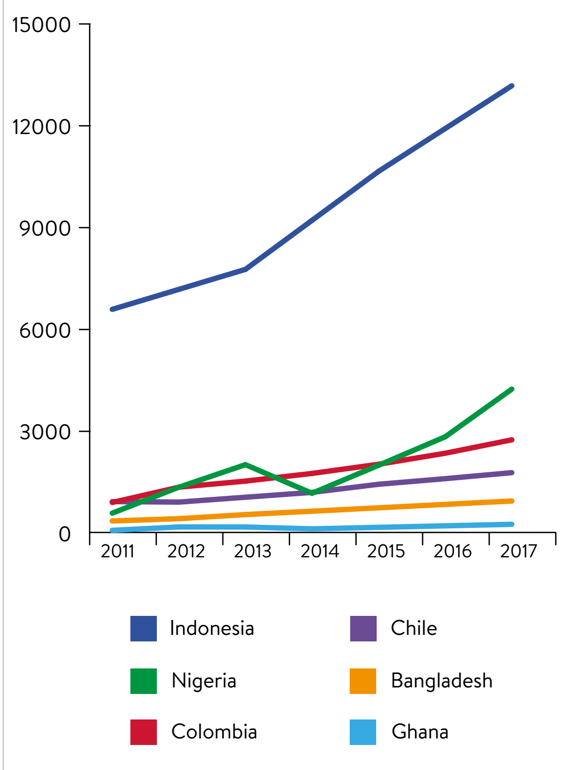


TABLE 8.2 Annual growth rates of HFC consumption, observed and projected

Country	Observed growth rate per year	Period	Projected growth rate per year	Period
Bangladesh	23%	2011–13	14%	2014–18
Chile	16%	2008–12	14%	2013–20
Colombia	15%	2008–12	16%	2013–20
Ghana	(a)		18%	2014–20
Indonesia	(b)		12%	2009–20
Nigeria	(a)		50%	2014–17

9 Reported consumption: 2011–12, all six countries apart from Indonesia; 2013: Ghana and Nigeria. All other figures are projections. Indonesia figures for 2012, 2014 and 2016 are midpoint interpolations. Bangladesh data beyond 2013 adds 100 tonnes to each successive year, divided amongst the chemicals according to the aggregate proportional consumption in 2011–13.

CHART 8.3 Aggregate HFC consumption by chemical, six countries, 2011–14 (metric tonnes)[10]

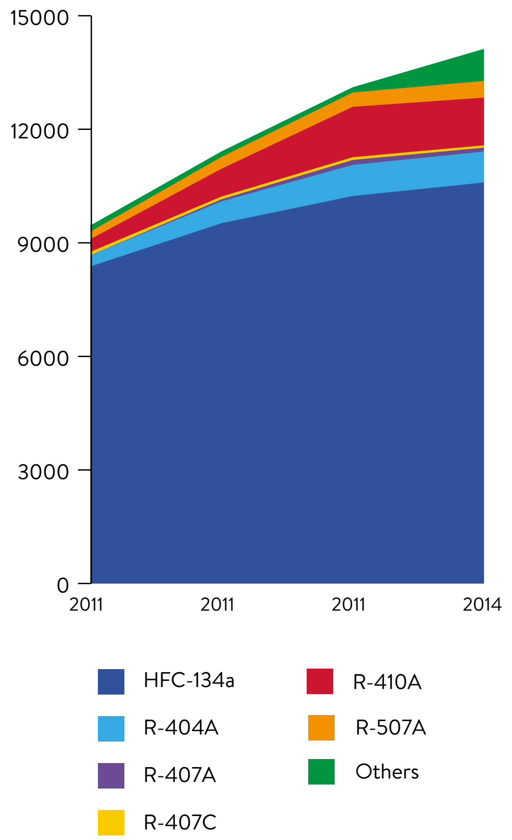


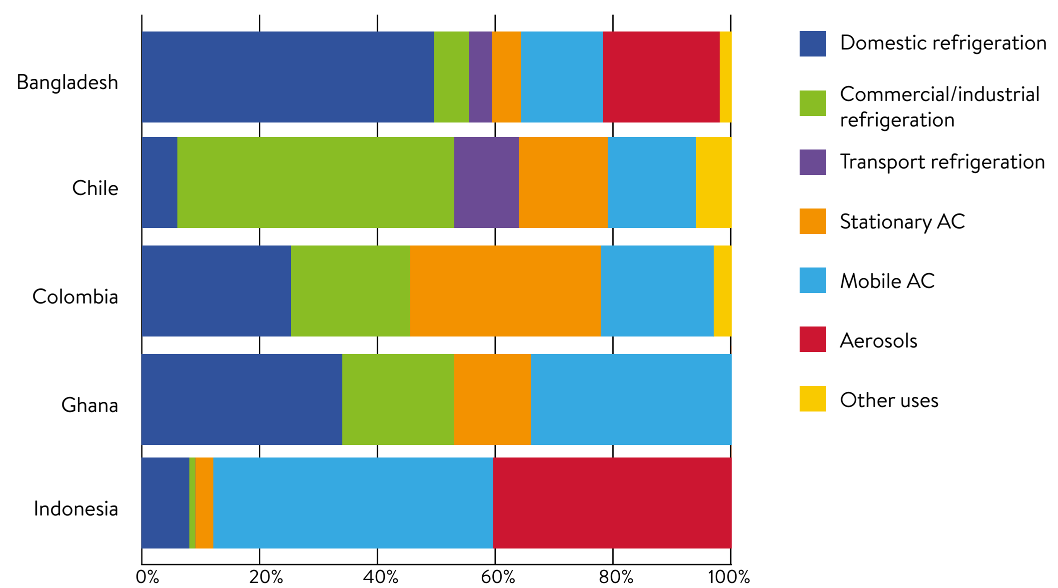
Chart 8.3 includes data for the consumption of each HFC or HFC blend; the six most common substances are identified separately (the data only extends to 2014, as projections beyond that date for Nigeria simply give aggregate figures for blends).

HFC-134a is the most commonly used chemical, accounting for over 80 per cent of total use over the four-year period covered by the chart. This is followed by R-410A (8 per cent), R-404A (5 per cent) and R-507A (3 per cent); R-407A, R-407C and all remaining HFCs and blends supply the remaining 4 per cent.

While HFC-134a is widely used in all these countries (and is almost the only HFC consumed in Bangladesh and Indonesia), there is greater variation in the other chemicals. R-410A features heavily in Ghana and Nigeria and to a certain extent in Chile; forward projections beyond the period covered in this chart, however, see it growing strongly almost everywhere. R-404A is used heavily in Chile and to a lesser extent in Colombia and Nigeria. R-507A is used most extensively in Chile. R-407A is only consumed in Nigeria, while R-407C is only significant in Ghana. Chile and Colombia each use a much wider range of HFCs than any of the other countries.

There is also substantial diversity in the breakdowns of use by sector across countries (though some of this may be due to inconsistent allocation of uses to particular sectors). Chart 8.4 summarises the information included above in the country sections (apart from Nigeria, where the inventory did not include a sectoral breakdown.

CHART 8.4 Comparative sectoral breakdown of HFC consumption, five countries[11]



10 Reported and projected consumption: as above, Chart 8.1.

11 Data is included for the latest year for which a sectoral breakdown is available – Chile: 2012; Bangladesh and Indonesia: 2013; Ghana and Nigeria: 2014.

Manufacturing and servicing are combined, as some of the reports did not separate them). Across the five countries as a whole, domestic refrigeration and mobile air-conditioning are the two largest sectors, but the aerosols sector is significant in Bangladesh and, especially, Indonesia, commercial and industrial refrigeration in Chile and stationary air-conditioning in Colombia.

Projections for future developments are also diverse. As can be seen above, all countries are anticipating continued expansion of HFC consumption following from an increased uptake of household and commercial refrigeration and air-conditioning, and vehicles with mobile air-conditioning. In Ghana and Nigeria, non-fluorocarbon equivalents such as hydrocarbons are expected to slow down the rate of growth of HFC use in domestic refrigeration and stand-alone air-conditioning in particular, but this is not anticipated in Bangladesh or Indonesia, due to a lack of appropriate equipment and technical skills.

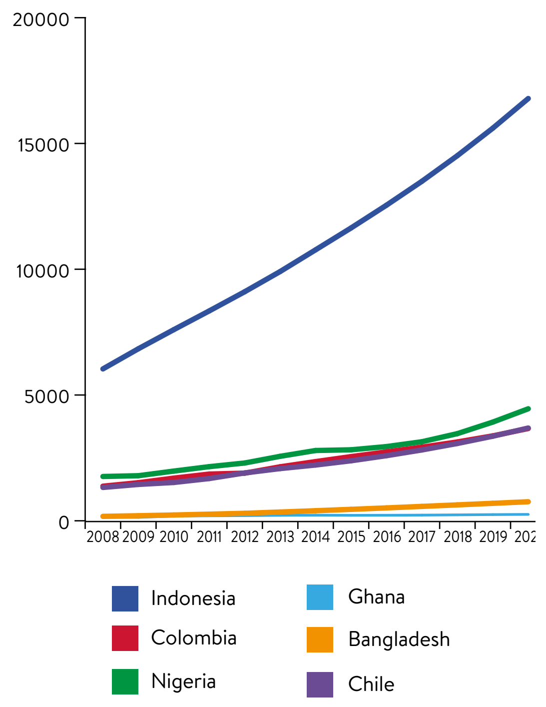
The phase-out of HCFCs is also likely to increase the demand for HFCs, particularly R-410A in stationary air-conditioning. HFCs may also replace HCFCs in foams, but several of the reports mentioned options for using hydrocarbons or hydrofluoroethers instead. In addition, Bangladesh is anticipating continued growth in consumption of HFCs for MDIs.

8.2 CLIMATE IMPACTS

As noted in Section 1, most HFCs are powerful greenhouse gases, with high GWPs (see Table 1.1). A systematic analysis of the climate impact of the quantities of HFCs currently in use and projected in the inventory countries is still under way at the time of publication; its results will be included in the final version of this report, due out in 2017.

Preliminary estimates of GWP-weighted emissions from recent and projected forward HFC use are now available from a UNDP analysis of the six countries considered here (see Chart 8.5).

CHART 8.5 HFC emissions, six countries, 2008-20 (1000 tonnes CO2-equivalent)[12]



8.3 OPPORTUNITIES FOR HFC REDUCTION AND AVOIDANCE

Each of the inventory reports identify possible activities to encourage the phase-down of the use of high-GWP HFCs. There are considerable similarities between activities identified by each country; they can be grouped into five main categories:

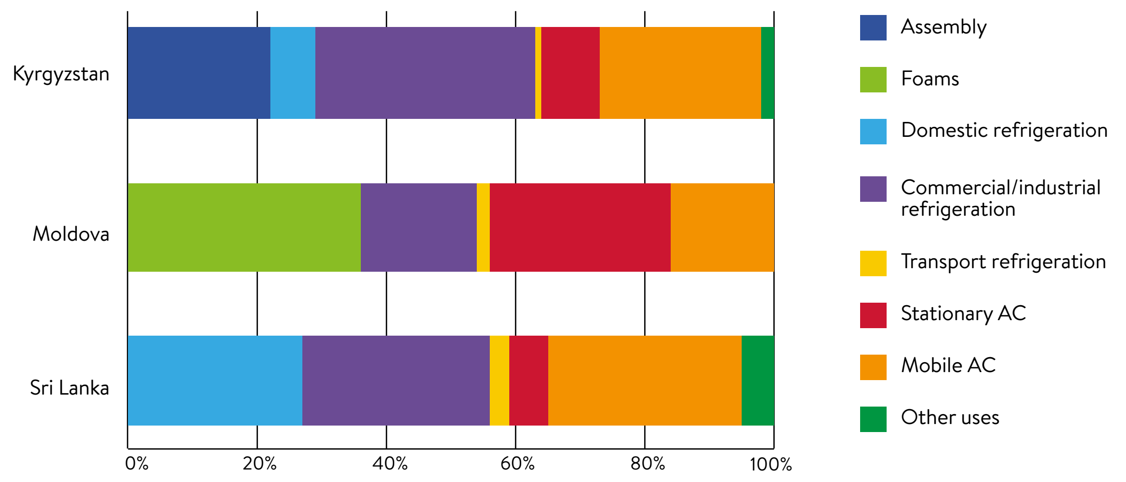
- Establishing the policy and regulatory framework / institutional strengthening, including drawing up an HFC phase-down strategy and integrating it into other appropriate strategies; implementing an import and export licensing scheme and introducing or modifying a green building code.
- Awareness-raising directed at key industry stakeholders, policy-makers, end users and investors.
- Demonstration investment projects for the conversion of particular uses or sub-sectors to low-GWP alternatives – generally hydrocarbons, but sometimes ammonia or HFOs. The particular sub-sectors to be targeted depends on a range of factors, including the availability, price, effectiveness and safety of alternative substances, and specific national circumstances. This also includes developing alternatives in sectors where HFCs are not currently used but may be after HCFC phase-out – most notably, foams.
- Training, targeted at all stakeholder groups – not only service and maintenance technicians, but also design engineers, production line and factory workers, etc.
- Leak control, and efforts to improve recovery, recycling and reuse of HFCs, all helping to reduce the quantity of HFCs needed for any particular use.

12 Taken from Paul Ashford, 'Experience of estimating HFC emissions based on CCAC-funded HFC surveys', presentation given on behalf of UNDP, Vienna, July 2016.

9. PRELIMINARY ANALYSIS:
Kyrgyzstan, Moldova, Sri Lanka, Vietnam

In addition to the completed inventories for the six countries summarised here, preliminary analyses of another four countries became available shortly before this report was finalised. This chapter summarises briefly the main conclusions arising from these analyses; a full analysis will be included in the final report. Chart 9.1 summarises the sectoral breakdown figures available for Kyrgyzstan, Moldova and Sri Lanka (it should be stressed that the data included below are preliminary figures only and may be subject to revision).

CHART 9.1 Comparative sectoral breakdown of HFC consumption, three countries[13]



13 Data is included for the latest year for which a sectoral breakdown is available – Moldova and Sri Lanka: 2014; Kyrgyzstan: 2015.

9.1 KYRGYZSTAN

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Annual consumption of HFCs in Kyrgyzstan climbed from 43.2 tonnes in 2010 to 95.6 tonnes in 2015, at an average annual growth rate of about 17 per cent. The main substances consumed in 2015 were HFC-134a (52 per cent), R-404A (30 per cent) and R-410A (17 per cent), together with very small quantities of R-407C and R-507A. The largest HFC-using sectors in 2015 were commercial and industrial refrigeration servicing (34 per cent; also the fastest growing sector), mobile air-conditioning servicing (25 per cent) and equipment assembly (22 per cent) (this is not broken down between refrigeration and air-conditioning).

A substantial proportion of these HFCs are imported into Kyrgyzstan directly across its border with China, often in small quantities, which may not be tracked and recorded accurately. Along with Armenia, Belarus, Kazakhstan and the Russian Federation, Kyrgyzstan is a member state of the Eurasian Economic Union. Since there are no border controls between the Union's members, it has become necessary to introduce national legislation and adopt a multilateral agreement to authorise enforcement agencies to conduct any necessary checks of road and rail transport to monitor the movement of ODS or other controlled goods; this does not yet, of course, include HFCs.

9.2 MOLDOVA

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Annual consumption of HFCs in Moldova fell from 112.40 tonnes in 2010 to 96.09 tonnes in 2014, with a peak of 118.62 tonnes in 2011. In 2014, HFC-134a accounted for 60 per cent of consumption, R-410 for 25 per cent and R-404A for 10 per cent.

Unlike the other countries covered here, however, the Moldovan inventory includes a sizeable (though falling) quantity of HFCs imported in closed-cell foams, accounting for 55 per cent of total consumption in 2010 and 36 per cent in 2014. If these figures are excluded, consumption has increased from 50.98 tonnes in 2010 to 61.30 tonnes in 2014, an average annual growth rate of 5 per cent. Growth was an average 12 per cent per year between 2010 and 2013, however (reaching 70.89 tonnes in 2013); the fall from 2013 to 2014 was due to a sharp reduction in imports of new stationary air-conditioning equipment.

Including foams, the largest sectoral consumption in 2014 was in foams (36 per cent), stationary air-conditioning (28 per cent), commercial and industrial refrigeration (18 per cent) and mobile air-conditioning (16 per cent). All figures are for servicing; there is no manufacturing.

9.3 SRI LANKA

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Data for the import of HFCs into Sri Lanka suggests that consumption increased from 496 tonnes in 2011 to 587 tonnes in 2014, an average annual growth rate of 6 per cent. Almost all of it (more than 96 per cent in each year) was recorded as HFC-134a, but the report notes that since import licenses are not required for HFCs, most importers used the Harmonised System (HS) customs code code allocated for HFC-134a for other HFCs too. An analysis of the importers' own records suggests that HFC-134a was in fact about 80 per cent of imports. About half of the rest was R-404A, with smaller quantities of R-407C and R-410A and very small amounts of R-507A.

A bottom-up sectoral analysis for 2014 was only able to derive figures for just over a third (217 tonnes) of the total consumption figure; the report noted that this was probably due to importers not keeping comprehensive records. The largest sectors were mobile air-conditioning servicing (30 per cent), commercial and industrial refrigeration servicing (20 per cent), domestic refrigeration manufacturing (16 per cent) and domestic refrigeration servicing (11 per cent).

HFC consumption is expected to continue to grow in the next few years, by at least 40–50 tonnes and perhaps as much as 80–100 tonnes a year. This follows from the increasing liberalisation of the economy and growth in foreign investment together with a rapid rise in the number of motor vehicles; in the first six months of 2015 vehicle imports were 200–300 per cent higher than in previous years.

9.4 VIETNAM

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At this stage, only import data is available; the survey of importers and end users is still under way.

In recent years imports of HFCs have grown strongly, from 583 tonnes in 2011 to 1,885 tonnes in 2015, an average annual growth rate of 19 per cent. The report notes, however, that the country has introduced a National Database on Chemicals only recently; data for the two most recent years (2014–15) is likely to be more accurate than for earlier years.

Across the five-year period, the main substance imported was HFC-134a (75 per cent of imports in 2011, falling to 65 per cent in 2015). The rest is accounted for by R-404A, R-407C and R-410A, together with small amounts of HFC-32 and R-507C and very small amounts of HFC-23, HFC-152a, R-417A and R-422D.

NATIONAL HYDROFLUOROCARBON (HFC) INVENTORIES:

A summary of the key findings from the first tranche of studies

Hydrofluorocarbons (HFCs) are potent greenhouse gases used as alternatives to ozone-depleting substances being phased out under the Montreal Protocol. HFC emissions to the atmosphere are increasing rapidly, at a rate of about 10–15 per cent per year, and significant increases in HFC use is expected in developing countries because of population growth, rapid urbanisation, electrification and changing consumer patterns. The increased use of refrigerants will also result in increased energy consumption and greenhouse gas emissions. If no measures are taken, it is estimated that HFCs will amount to 9–19 per cent of total CO_2 emissions by 2050.

The Climate and Clean Air Coalition (CCAC) is supporting the development of national HFC inventories to help countries better understand the present situation and inform decision-making about policies and technologies to replace or avoid HFCs. This booklet presents a summary of the key findings from the first tranche of inventories completed to date – Bangladesh, Chile, Colombia, Ghana, Indonesia and Nigeria – plus initial draft findings from other countries whose inventories are still under way.

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